Preparing Activity: NASA Superseding
UFGS-21 21 00.00 40 (November 2013)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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DIVISION 21 - FIRE SUPPRESSION

SECTION 21 21 00.00 40

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11/16

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USACE / NAVFAC / AFCEC / NASA **UFGS-21 21 00.00 40 (November 2016)**

Preparing Activity: NASA **Superseding**
UFGS-21 21 00.00 40 (November 2013)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023

****

SECTION 21 21 00.00 40

CARBON-DIOXIDE FIRE-EXTINGUISHING SYSTEMS
11/16

****

NOTE: This guide specification covers the requirements for carbon dioxide fire-protection systems.

Indicate protected spaces and affected equipment on the drawings.

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

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

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

****

PART 1 GENERAL

****

NOTE: If Section 23 30 00 HVAC AIR DISTRIBUTION is not included in the project specification, applicable requirements should be inserted and the following paragraph deleted.

****

[Section 23 30 00 HVAC AIR DISTRIBUTION applies to work specified in this section.
]

1.1 REFERENCES

****

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

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

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

****

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

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B36.10M	(2022) Welded and Seamless Wrought Steel Pipe

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

MASTER PAINTERS INSTITUTE (MPI)

MPI 9	(2016) Alkyd, Exterior Gloss (MPI Gloss Level 6)

MPI 48	(2016) Alkyd, Interior, Gloss (MPI Gloss Level 6-7)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

RCBEA GUIDE	(2004) NASA Reliability Centered Building and Equipment Acceptance Guide

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 12	(2022) Standard on Carbon Dioxide Extinguishing Systems
NFPA 72	(2022; ERTA 22-1) National Fire Alarm and Signaling Code

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS TT-P-645	(Rev C; Notice 1) Primer, Paint, Zinc-Molybdate, Alkyd Type

1.2 ADMINISTRATIVE REQUIREMENTS

1.2.1 Pre-Installation Requirements

Prior to the commencement of work, submit installation drawings conforming to NFPA 12, to the Contracting Officer for review and approval, Indicate on drawings the general physical layout of all controls, and internal tubing and wiring details. Include connection diagrams indicating the relations and connections of the carbon dioxide cylinders and piping.

Submit design analysis and calculations with drawings. Include with drawings all equipment foundation data for carbon dioxide fire-protection systems consisting of the following information:

a. Equipment weight and operating loads.

b. Horizontal and vertical loads.

c. Size, location, and projection of anchor bolts.

d. Horizontal and vertical clearances for installation, operation and maintenance.

e. Plan dimensions of foundations and relative elevations.

f. Installation requirements such as noise abatement, vibration isolation, and utility service.

1.3 SUBMITTALS

****

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

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

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

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

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

****

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

SD-02 Shop Drawings

Installation Drawings; G[, [____]]

Connection Diagrams; G[, [____]]

SD-03 Product Data

Equipment Foundation Data; G[, [____]]

Carbon Dioxide Cylinders; G[, [____]]

Piping Materials; G[, [____]]

Escutcheons; G[, [____]]

SD-05 Design Data

Design Analysis and Calculations; G[, [____]]

SD-06 Test Reports

Pressure Test

System Test

Impedance Test

Request for Inspection and Test

SD-07 Certificates

Listing of Product Installation

Certificates of Conformance

Performance Certificate

SD-08 Manufacturer's Instructions

Operating Instructions

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals

1.4 QUALITY CONTROL

1.4.1 Qualification and Regulatory Requirements

Submit listing of product installation carbon dioxide fire-protection systems showing at least five installed units, similar to those proposed, that have been in successful service for a minimum period of five years. Include purchaser, address of installation, service organization, and date of installation.

Submit certificates of conformance verifying conformance with the standards referenced in this specification for the following:

a. Piping Materials

b. High-Pressure Cylinders

c. Escutcheons

d. Supporting Elements

1.4.2 Predictive Testing and Inspection Technology Requirements

****

NOTE: The Predictive Testing and Inspection (PT&I) tests prescribed in Section 01 86 12.07 40 RELIABILITY CENTERED ACCEPTANCE FOR MECHANICAL SYSTEMS are MANDATORY for all [NASA] [_____] assets and systems identified as Critical, Configured, or Mission Essential. If the system is non-critical, non-configured, and not mission essential, use sound engineering discretion to assess the value of adding these additional test and acceptance requirements. See Section 01 86 12.07 40 RELIABILITY CENTERED ACCEPTANCE FOR MECHANICAL SYSTEMS for additional

information regarding cost feasibility of PT&I.
****

This section contains systems and equipment components regulated by NASA's Reliability Centered Building and Equipment Acceptance Program. This program requires the use of Predictive Testing and Inspection (PT&I) technologies in conformance with RCBEA GUIDE to ensure building equipment and systems have been installed properly and contain no identifiable defects that shorten the design life of a system and its components. Satisfactory completion of all acceptance requirements is required to obtain Government approval and acceptance of the work.

Perform PT&I tests and provide submittals as specified in Section 01 86 12.07 40 RELIABILITY CENTERED ACCEPTANCE FOR MECHANICAL SYSTEMS.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Design Requirements

****
NOTE: Modify the following paragraph to suit project requirements.
****

Give full consideration to built-in spaces, piping, electrical equipment, ductwork, and all other construction and equipment. Ensure system is free from operating and maintenance difficulties.

Design the system and construct to include a fixed supply of carbon dioxide cylinders connected to properly sized, fixed piping with fittings and nozzles to direct this agent into an enclosure surrounding the hazard.

Provide devices and equipment of a make and type listed by the Underwriters Laboratories, (UL), or FM Global (FM) approved. In the UL and FM publications, the advisory provisions are considered to be mandatory. Interpret reference to the "authority having jurisdiction" to mean the Contracting Officer.

****
NOTE: Select system type.
****

Provide an approved high-pressure carbon dioxide [hand] [hose] [reel] total flooding type system conforming to NFPA 12.

Ensure electrical work associated with the system meets the requirements of the appropriate electrical sections pertaining to fire detection.

****
NOTE: Section 23 05 48.00 40 VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT may be used as a guide for vibration isolation.
****

2.1.2 Performance Requirements

****

NOTE: Discharge of carbon dioxide into an enclosed space creates a dangerous oxygen deficiency for personnel. Dilution of oxygen in the air by the carbon dioxide concentrations necessary to extinguish the fire will create atmosphere that will not sustain life.
****

Provide carbon dioxide supplied from 25-, 40-, 50-kilogram 50-, 75-, or 100-pound high-pressure cylinders stored in rechargeable containers designed to hold pressurized carbon dioxide in liquid form at atmospheric temperatures corresponding to a normal pressure of 5860 kilopascal at 21 degrees C 850 pounds per square inch (psi) at 70 degrees F.

Arrange system for fully automatic, manually operated, and remote pushbutton electric control operation. Provide enclosed release type operating controls to prevent accidental operation.

2.2 EQUIPMENT

Provide only UL-listed or FM-approved equipment and devices in the systems.

2.3 COMPONENTS

2.3.1 Pipe

****
NOTE: Revise the following paragraph to suit project requirements.
****

Provide galvanized, ferrous piping, Schedule [40] [80], manifolds and distribution piping materials, conforming to [ASTM A53/A53M] [ASTM A106/A106M] [ASME B36.10M].

Provide pipe and fittings having a minimum bursting pressure of 34.5 Megapascal 5,000 psi. Provide Schedule 40 for DN15 and DN20 1/2 inch and 3/4 inch iron pipe size (ips). Provide Schedule 80 for DN25 1 inch or greater. Use standard malleable iron banded fittings or ductile iron fittings up through DN20 3/4 inch ips. Use extra heavy malleable iron or ductile iron fittings through DN50 2 inch ips. Use forged steel fittings in all sizes over DN50 2 inches.

Install a dirt trap (leg) consisting of a tee with a capped nipple, at least50 millimeter 2 inches long, at the end of each pipe run.

Use baffle-type nozzles for distribution in normal total flooding systems. Install strainers ahead of small-orifice nozzles to prevent clogging.

Conceal piping to the maximum extent possible. Inspect, test, and secure approval before concealing pipe.

2.3.2 Pipe Hangers and Supports

Provide zinc-coated, adjustable pipe hangers and supports conforming to MSS SP-58. Maximum spacing is as follows:

Nominal Pipe Size (DN)	Maximum Spacing (millimeters)
15 and under	2130
32	2440
40	2470
50	3050
65	3350
80	3660
90	3960
100	4270
125	4570
150	4880

Nominal Pipe Size (inches)	Maximum Spacing (feet)
1 and under	7
1.25	8
1.5	9
2	10
2.5	11
3	12
3.5	13
4	14
5	15
6	16

2.3.3 Threaded Fittings

For continuous pressure pipe fittings located between storage tank and selector valves, [and between selector valves and hand hose stations,] use hot-dipped galvanized fittings in conformance with ASME B16.11. For pipe not under continuous pressure, use hot-dipped galvanized fittings in conformance with ASME B16.3, Class 150.

Use pipe cement and oil, or graphite and oil for pipe thread joint compound.

2.3.4 Pipe Sleeves

Provide pipe sleeves where piping passes through masonry or concrete walls, floors, roofs, and partitions. Provide Schedule 40 zinc-coated steel pipe sleeves: in outside walls below and above grade, in floor, or in roof slabs. Provide zinc-coated sheet steel sleeves having a nominal weight of not less than 4.4 kilogram per square meter 0.90 pound per square foot in partitions.

2.3.5 Escutcheons

Provide approved one-piece or split-type escutcheons for piping passing through floors, walls, ceilings. Where pipe passes through finished walls and ceilings, use chrome-plated escutcheons. Provide steel or cast-iron escutcheons with aluminum finish paint for all other locations.

2.3.6 Carbon Dioxide Cylinders

Provide high-pressure cylinders constructed, tested, and marked in accordance with U.S. Department of Transportation specifications for seamless steel cylinders.

Provide each cylinder with a safety device to relieve excess pressure safely, in advance of the rated cylinder test pressure. Ensure devices are Interstate Commerce Commission approved frangible safety disks.

Support carbon dioxide cylinders by suitable racks attached to walls and floor. Provide cylinder framing fitted with a weighing bar bracket, weight bar, and direct-reading scale to weigh cylinders in place without deactivating the system.

2.3.7 Automatic Smoke-Fire Dampers

Provide automatic control of smoke-fire dampers in openings and ductwork penetrating the envelope of the protected area. Smoke-fire dampers are specified in Section 23 30 00 HVAC AIR DISTRIBUTION.

2.3.8 Smoke and Carbon Dioxide Exhaust System

Provide under Section 23 30 00 HVAC AIR DISTRIBUTION and as specified herein. Provide a key-operated ON/OFF switch with red and green indicator lights for control of exhaust fans from each protected space. Green light remains illuminated when exhaust system is in standby status. Green light extinguishes and red light illuminates when system is operating. Provide an interlock from the carbon dioxide system to prevent operation of exhaust system during carbon dioxide system discharge and for a minimum of [10][20] minutes after carbon dioxide discharge. [Ten][Twenty] minutes after carbon dioxide discharge, exhaust system are operable by the key switch even when smoke detectors are still in alarm mode. Locate switches outside protected spaces.

PART 3 EXECUTION

3.1 INSTALLATION

Install materials and equipment in accordance with NFPA 12.

3.1.1 Piping

Ensure space between piping and the sleeve is not less than 6 millimeter 0.25 inch. Securely place sleeves in proper position and location during construction. Ensure sleeves are of sufficient length to pass through the entire thickness of walls, partitions, or slabs. Ensure sleeves extend 5.08 cm 2 inches above finished floor slabs. Pack space between the pipe and sleeve with insulation and caulk both ends of the sleeve with plastic waterproof cement.

Set and securely fasten escutcheons in place with setscrews or other positive means.

When used, fuse brazed joints with an alloy having a melting point above 538 degrees C 1,000 degrees F.

Inspect and test piping before concealing. Provide fittings for direction changes in piping and for connections. Use Jointing compound for pipe threads such as polytetrafluoroethylene (PTFE) pipe thread tape, pipe cement and oil, or PTFE powder and oil; apply only to male threads. Provide exposed ferrous pipe threads with one coat of FS TT-P-645 primer applied to a minimum dry film thickness of 0.025 mm 1.0 mil. Use Schedule 80 steel pipe, hot-dipped galvanized for pipe nipples 150 mm 6 inches or less. Provide tapered-reducing pipe fittings for changes in piping size; bushings are not permitted. Minimum nominal pipe size for hose and systems is 20 mm 0.75 inch.

Ensure each system has an approved pressure-relief device designed to operate between 20 Megapascal 2,400 and 3,000 psi and located between the storage cylinder manifolds and any normally close valve.

3.1.2 System Control

3.1.2.1 Controls

****
NOTE: Select control type.
****

Install a[n] [manual] [combination] [electric] [pneumatic] [mechanical pull cable] actuating control system.

3.1.2.2 Control Stations for Underfloor Flooding Systems

Install actuation stations for underfloor flooding systems at the principal exits from the protected area. Provide a separate actuation station for both the main supply and reserve supply of carbon dioxide at each location.

3.1.2.3 Pressure-Operated Fire Alarm Switch

Install a pressure-operated switch to actuate the building interior fire alarm system upon the discharge of gas into the carbon dioxide system piping for each separate system.

3.1.2.4 Pressure-Operated Equipment Switch

Provide a pressure-operated switch to automatically shut down the air handling equipment serving the protected space upon the discharge of gas

into the carbon dioxide system piping for each separate system.

3.1.2.5 Control Panel

Provide a complete electrical supervision of actuating circuitry, in a modular type panel, flush- or surface-mounted steel cabinet with hinged door and cylinder lock. Ensure control panel is neat, compact, and factory-wired containing the parts and equipment required to provide specified operating and supervisory functions of the system. If a ground fault condition occurs preventing the required operation of the system, provide for the activation of a system trouble bell, which sounds continuously until the system has been restored to normal at the control panel. Provide a silencing switch to transfer the trouble signals to an indicating lamp in accordance with NFPA 72.

In addition to the normal system trouble bell, install a remote 100 millimeter, 4 inch, system trouble bell together with a rigid plastic or metal identification sign that reads CARBON DIOXIDE SYSTEM TROUBLE. Minimum lettering height is 25 millimeter 1 inch high.

3.1.3 System Power

3.1.3.1 Primary Supply

Provide 120-volt, 60-hertz service, system power, transformed through a two-winding isolation-type transformer and rectified to 24 volts dc for operating trouble signal and actuating circuits. Provide a secondary dc power supply for operation of the system if the ac power fails. Ensure transfer from normal to emergency power or restoration from emergency to normal power is fully automatic. Locate trouble lights on the door of the cabinet. Locate a 100 millimeter 4 inch trouble bell above the top of the cabinet. Finish cabinet on the inside and outside in red enamel with prominent rigid plastic or metal identification plates attached.

3.1.3.2 Secondary Supply

Provide secondary power supply including [nickel cadmium] [lead calcium] [sealed lead acid] batteries and charger. Dry cell batteries are not acceptable. Ensure batteries are housed in a well-constructed steel cabinet with cylinder lock.

3.1.3.3 Storage Batteries

Provide batteries with proper ampere-hour capacity to operate the system under supervisory conditions for [_____] [24] [60] hours, with calculations substantiating the battery capacity.

3.1.3.4 Battery Charger

Install a battery charger with completely automatic high/low charging rate capable of recovery of the batteries from full discharge to full charge in 24 hours or less. Include an ammeter showing rate of charge and a voltmeter to indicate state of battery charge, with a red pilot light indicating when batteries are manually placed on a high rate of charge, if a high-rate switch is provided.

3.1.4 Electrical Work

****

NOTE: Insert the appropriate Fire Detection and Alarm system for your project in the following paragraph if other than as shown in the first set of brackets.
****

Electrical work is specified in Section [28 31 13.00 40 FIRE DETECTION AND ALARM CONTROL, GUI, AND LOGIC SYSTEMS] [_____].

3.1.5 Operating Instructions

Provide operating instructions at each remote control station, clearly indicating the necessary steps for the operation of the system.

Submit operating instructions for carbon dioxide fire-protection systems, consisting of raised or embossed white letters on red rigid plastic or enameled steel background, and of adequate size to permit them to be easily read.

3.1.6 Field Painting

[Provide painting of the system in accordance with Section 09 90 00 PAINTS AND COATINGS.

] Clean, pretreat, prime, and paint new carbon dioxide fire extinguishing systems including valves, piping, conduit, hangers, miscellaneous metalwork, and accessories. Apply coatings to clean, dry surfaces, using clean brushes. Clean surfaces to remove dust, dirt, rust, and loose mill scale. Immediately after cleaning, provide metal surfaces with one coat of FS TT-P-645 primer applied to a minimum dry film thickness of 0.025 mm 1.0 mil. Shield operating devices with protective covering while painting is in process. Upon completion of painting, remove protective covering from operating devices. Remove devices which are painted and replace with new devices. Provide primed surfaces with the following:

a. Systems in Unfinished Areas

Unfinished areas are defined as attic spaces, mechanical rooms, spaces above suspended ceilings, crawl spaces, pipe chases, and spaces where walls or ceiling are not painted or not constructed of a prefinished material. Provide primed surfaces with one coat of MPI 48 red enamel applied to a minimum dry film thickness of 0.025 mm 1.0 mil.

b. Systems in Other Areas

Provide primed surfaces with two coats of paint to match adjacent surfaces, except provide valves and operating accessories with one coat of red enamel in accordance with MPI 48 for interior and MPI 9 for exterior areas applied to a minimum dry film thickness of 0.025 mm 1.0 mil. Provide piping with 50 mm 2 inch wide red enamel bands or self-adhering red plastic tape bands spaced at maximum of 6 meters 20 foot intervals throughout the piping systems[, except in finished areas, such as offices, red bands may be deleted].

3.2 FIELD QUALITY CONTROL

Provide a complete system ready for operation.

Conduct testing to determine conformance with the requirements in the

presence of the Contracting Officer.

3.2.1 Preliminary Tests

Perform and record pressure tests and system tests.

Test each piping system pneumatically at 1050 kilopascal 150 pounds per square inch gage and verify no leakage or reduction in gage pressure after 2 hours occurs. Upon completion and before final acceptance of the work, test each piping system by discharging a minimum of one 34 kilogram 75-pound high-pressure cylinders of carbon dioxide to demonstrate the reliability and proper functioning of pressure-operated switches and the discharge of carbon dioxide gas from each system discharge nozzle.

Individually test all remote control stations, and all other components, supporting elements and accessories individually to demonstrate proper functioning.

Perform an impedance test on of each cell, for all storage batteries, record and submit the results to the Contracting Officer.

Provide the pressure test, system test, and impedance test results to the Contracting Officer. Submit the test results with a cover letter/sheet clearly marked with the System name, date, and the words "Final Test Reports - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

At the completion of tests and corrections, submit a signed and dated performance certificate to the Contracting Officer attesting to the satisfactory completion of all testing and that the system is in operating condition.

Submit a written request for inspection and test to the Contracting Officer for systems formal tests.

3.2.2 Formal Tests

****
NOTE: If the specified system is identified as critical, configured, or mission essential, use Section 01 86 12.07 40 RELIABILITY CENTERED ACCEPTANCE FOR MECHANICAL SYSTEMS to establish predictive and acceptance testing criteria.
****

Perform PT&I tests and provide submittals as specified in Section 01 86 12.07 40 RELIABILITY CENTERED ACCEPTANCE FOR MECHANICAL SYSTEMS.

At a time to which the Government has agreed, the Government Fire Protection Engineer will witness formal tests and approve systems before they are accepted. Ensure an experienced technician regularly employed by the system installer is present during the inspection. At this inspection, repeat any or all of the required tests as directed by the Contracting Officer. Furnish carbon dioxide, instruments, personnel, appliances, and equipment for testing at no additional cost to the Government.

Update and resubmit data for final approval no later than [30] [_____] calendar days prior to contract completion.

[3.2.3 Manufacturer's Representative

Make provisions for an experienced manufacturer's field engineer to supervise testing of the system.

]3.3 CLOSEOUT ACTIVITIES

Submit [6] [_____] copies of the operation and maintenance manuals [30] [_____] calendar days prior to testing the carbon dioxide fire-protection systems.

-- End of Section --