
USACE / NAVFAC / AFCEC / NASA UFGS-46 73 10 (February 2011)

Preparing Activity: USACE
Superseding
UFGS-44 46 20 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated October 2017

SECTION TABLE OF CONTENTS

DIVISION 46 - WATER AND WASTEWATER EQUIPMENT

SECTION 46 73 10

FLOATING COVER FOR SLUDGE-DIGESTION TANKS

02/11

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 SUBMITTALS
- 1.3 QUALIFICATIONS
- 1.4 DELIVERY, STORAGE, AND HANDLING
- 1.5 EXTRA MATERIALS

PART 2 PRODUCTS

- 2.1 SYSTEM DESCRIPTION
 - 2.1.1 General Design Requirements
 - 2.1.2 Non-Gasholding Floating Cover
 - 2.1.3 Gasholding Floating Cover
 - 2.1.4 Coordination
 - 2.1.5 Structural Design Requirements
- 2.2 GENERAL MATERIAL AND EQUIPMENT REQUIREMENTS
 - 2.2.1 Standard Products
 - 2.2.2 Nameplates
 - 2.2.3 Special Tools
- 2.3 FRAME ASSEMBLY
- 2.4 ROOF DECK, WOOD
- 2.5 ROOF DECK, CAST-IN-PLACE CONCRETE
- 2.6 ROOF DECK, PRECAST CONCRETE
- 2.7 ROOF DECK, STEEL
- 2.8 ROOF INSULATION
- 2.9 ROOFING
- 2.10 FLASHING
- 2.11 RIM SKIRT FOR GASHOLDING COVERS
- 2.12 WALL GUIDES AND ROLLERS
- 2.13 APPURTENANCES
 - 2.13.1 Gas Dome
 - 2.13.2 Gas Pipe Housing
 - 2.13.3 Drain Sumps and Access Wells
 - 2.13.4 Manhole
 - 2.13.5 Entrance Hatch

- 2.13.6 Sampling Well
- 2.13.7 Pressure-Vacuum Relief Unit
- 2.14 FABRICATION

PART 3 EXECUTION

- 3.1 EXAMINATION
- 3.2 WELDING
- 3.3 PAINTING
 - 3.3.1 Preparation and Application
 - 3.3.2 Coating Testing
 - 3.3.3 Coating Repair
- 3.4 FIELD ERECTION
- 3.5 FRAMED INSTRUCTIONS
- 3.6 FIELD QUALITY CONTROL
 - 3.6.1 Testing
 - 3.6.2 Manufacturer's Services
- 3.7 FIELD TRAINING
- 3.8 MAINTENANCE

-- End of Section Table of Contents --

USACE / NAVFAC / AFCEC / NASA UFGS-46 73 10 (February 2011)

Preparing Activity: USACE Superseding
UFGS-44 46 20 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated October 2017

SECTION 46 73 10

FLOATING COVER FOR SLUDGE-DIGESTION TANKS 02/11

NOTE: This guide specification covers the requirements for floating cover for sludge-digestion tank.

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

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 INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325	(2017) Steel Construction Manual
AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE FUN IP	(2017) Fundamentals Handbook, I-P Edition
ASHRAE FUN SI	(2017) Fundamentals Handbook, SI Edition

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA P5	(2015) Standard for Waterborne Preservatives
---------	--

ASME INTERNATIONAL (ASME)

ASME B31.1	(2016; Errata 2016) Power Piping
ASME BPVC SEC IX	(2010) BPVC Section IX-Welding and Brazing Qualifications

ASTM INTERNATIONAL (ASTM)

ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A36/A36M	(2014) Standard Specification for Carbon Structural Steel
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B370	(2012) Standard Specification for Copper Sheet and Strip for Building Construction

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 10/NACE No. 2	(2007) Near-White Blast Cleaning
-----------------------	----------------------------------

1.2 SUBMITTALS

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project.

The Guide Specification technical editors have designated 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 submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation 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.

Use the "S" classification only in SD-11 Closeout Submittals. The "S" following a submittal item indicates that the submittal is required for the Sustainability eNotebook to fulfill federally mandated sustainable requirements in accordance with Section 01 33 29 SUSTAINABILITY REPORTING.

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" designation; submittals not having a "G" designation are for [Contractor Quality Control approval.] [information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Field Erection

SD-03 Product Data

Floating Cover

Spare Parts

Framed Instructions

SD-06 Test Reports

Testing

Coating Testing

SD-10 Operation and Maintenance Data

Operating and Maintenance Manuals; G[, [____]]

[Six] [____] [hard] [optical disc] copies of operation and [six] [____] copies of maintenance manuals for the equipment furnished. One complete set prior to performance testing and the remainder upon acceptance.

1.3 QUALIFICATIONS

Procedures and welders shall be qualified in accordance with the code under which the welding is specified to be accomplished.

1.4 DELIVERY, STORAGE, AND HANDLING

All equipment delivered and placed in storage shall be stored with protection from the weather, excessive humidity and excessive temperature variation; and dirt, dust, or other contaminants.

1.5 EXTRA MATERIALS

Submit spare parts data for each item of equipment and material specified, after approval of the related submittals and not later than [____] months prior to the date of beneficial occupancy. Include with the data a complete list of parts and supplies, with current unit prices and source of supply.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 General Design Requirements

NOTE: Include only non-gasholding covers or only gasholding covers, not both.

Floating cover shall conform to the general design requirements specified and as shown.

2.1.2 Non-Gasholding Floating Cover

NOTE: A ceiling plate serves two functions: first, it submerges floating scum; second, it protects the structural truss assembly from corrosive digester

contents and gas. However, the ceiling plate may be deleted if its worth does not exceed the cost. Covers with attic space designs will be seal welded to prevent entrance of digester gas into attic space.

The floating cover shall be a rigid steel structure designed to float on the liquid contents of the digestion tank as indicated. The cover shall consist of [structural steel radial truss sections] [arched radial beams] with cover plates welded to [trusses] [beams] and to each other to form a gas-tight support system for roof, sidewalls, [ceiling] and appurtenances required for a complete installation. [The ceiling shall be of welded steel plate and shall float on the liquid surface, keeping floatable scum submerged and in contact with actively digesting sludge. The plate shall slope radially upward from a vertical rim plate at the tank wall to a circular gas dome at the center of the tank.] The installed weight of the digester cover and appurtenances, including any necessary concrete ballast, shall be sufficient to provide a static gas pressure of at least [_____] Pa inches water column. Additional supports shall be provided as required to maintain the stability of the cover when it is subjected to uneven live loads.

2.1.3 Gasholding Floating Cover

NOTE: All volume under gasholder cover (ceiling) and in upper 300 mm 12 inches of sidesheet cylinder may not be considered as usable gas storage because gas in this portion of holder cannot be withdrawn without a sudden loss of gas pressure.

Coordinate with paragraph Non-Gasholding Floating Cover.

The gasholding floating cover shall be a rigid steel structure designed to float on a gas layer above the liquid contents of the digestion tank as indicated. The cover shall consist of [structural steel radial truss sections] [arched radial beams] with cover plates welded to [trusses] [beams] and to each other to form a gas-tight support system for roof, sidewalls, [ceiling] and appurtenances required for a complete installation. [The ceiling shall be of welded steel plate and shall float on a gas layer above the liquid contents of the digester. The ceiling shall provide scum submergence when the gas pressure is reduced and the cover is allowed to settle on the digester contents. The plate shall slope radially upward from the vertical sidewall to a circular gas dome at the center of the tank.] An extended rim skirt shall extend below the digester liquid level to contain the produced gas. The gasholder shall have an effective gas storage capacity of [_____] cubic meters feet at an operating pressure of [_____] Pa inches water column. The cover shall be capable of vertical liquid surface travel of [_____] mm feet with minimum to maximum gas storage available over this range of travel. Volume under gasholder cover [ceiling] and in upper [_____] [300] mm [12] inch of sidesheet cylinder shall not be considered as usable gas storage.

Text

2.1.4 Coordination

The floating cover and the digester gas, heating, and mixing system shall

be coordinated to ensure proper operation and interface between the two items.

2.1.5 Structural Design Requirements

NOTE: Live, snow, and vacuum loads depend upon geographical area of installation. Dead and roof loads vary depending on type of roof construction and equipment to be installed on the cover. Various manufacturers must be consulted to determine loads to be specified.

Coordinate with paragraph Non-Gasholding Floating Cover.

The floating cover shall be self-supporting when resting in an empty tank and shall be designed to withstand a live, snow, and vacuum load of [_____] kPa psf and a dead load and roof load of [_____] kPa psf. Design and construction shall be in accordance with the applicable sections of AISC 325 and AISC 360. [Ceiling plates shall not be considered as a structural member in calculations.]

2.2 GENERAL MATERIAL AND EQUIPMENT REQUIREMENTS

2.2.1 Standard Products

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.2.2 Nameplates

Each major item of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

2.2.3 Special Tools

One set of special tools, calibration devices, and instruments required for operation, calibration, and maintenance of the equipment shall be provided.

2.3 FRAME ASSEMBLY

The frame assembly shall be of minimum 6.4 mm 1/4 inch thick ASTM A36/A36M structural steel radial truss sections.

2.4 ROOF DECK, WOOD

NOTE: Select the type of roof system required by the design.

The roof deck shall consist of not less than 50.8 x 101.6 mm 2 x 4 inch

wood rafters and not less than [50.9] [_____] mm [2] [_____] inch thick tongue and groove sheeting. Lumber shall be any species and grade of sufficient quality to support the roof loads and shall be free from large cracks, knotholes, and loose material. All lumber shall be pressure treated in accordance with AWPA P5. Rafters shall be bolted to the top chord of each truss and installed in the intermediate spaces as required to provide a maximum span of 610 mm 24 inches between rafters. Sheeting shall be nailed to the rafters.

2.5 ROOF DECK, CAST-IN-PLACE CONCRETE

**NOTE: Select the type of roof system required by
the design.**

Corrugated steel sheets shall be installed directly on the steel framework. Concrete deck shall be cellular, perlite, or vermiculite in accordance with Section 03 52 16 LIGHTWEIGHT INSULATING CONCRETE.

2.6 ROOF DECK, PRECAST CONCRETE

**NOTE: Select the type of roof system required by
the design.**

A precast concrete deck shall be installed in compliance with Section 03 51 13 CEMENTITIOUS WOOD FIBER DECKS.

2.7 ROOF DECK, STEEL

**NOTE: Select the type of roof system required by
the design.**

The roof deck shall be of 6.4 mm 1/4 inch minimum thickness ASTM A36/A36M steel plate and shall be designed, installed, and welded in compliance with the applicable sections of AISC 325 and AISC 360. The roof shall be made up of fabricated assemblies which shall be piecemarked for erection. Prefabricated insulated metal panels may be provided in lieu of the roof deck, roofing, and insulation if they comply with all of the design requirements specified herein.

2.8 ROOF INSULATION

**NOTE: The coefficient of heat transmission through
the roof in W per square meter, per degree K Btuh,
per square foot, per degree F temperature difference
will be inserted. Uninsulated covers generally are
the standard practice. The boiler size generally is
increased to compensate for heat losses in the
roof. Before insulation is specified, an economic
analysis of the cost of roof insulation versus the
cost of increased boiler size will be made. In this
analysis, the cost of fuel for the boiler may be
minor where excess sludge gas is wasted. Insulation**

of covers varies with design of covers. For truss supported roof with ceiling covers, lightweight concrete or urethane may be added to ceiling plate. For designs without ceilings, urethane may be added to exterior of roof to provide insulation.

Insulation shall be of sufficient thickness to provide a coefficient of heat transmission (U-value) through the complete roof construction, air-to-air, not exceeding [_____] watt per square meter/degree K Btu per hour, per square foot/degree F temperature difference when calculated in accordance with ASHRAE FUN SIASHRAE FUN IP. Material and installation shall be in accordance with Section 07 22 00 ROOF AND DECK INSULATION.

2.9 ROOFING

NOTE: Roofing and flashing are not required on steel plate roof decks and paragraphs ROOFING and FLASHING should be deleted if only steel plate decks are specified.

Roofing shall be in accordance with Section 07 51 13 ASPHALT BUILT-UP ROOFING.

2.10 FLASHING

Flashing shall be light cold-rolled temper 340 g 12 ounce copper conforming to ASTM B370, type 301, 302, 304, or 316 stainless steel conforming to ASTM A167, or alloy 3003, 3004, alclad 3003, and alclad 3004 aluminum conforming to ASTM B209M ASTM B209. Flashing shall be installed around the periphery of the cover and shall extend approximately 150 mm 6 inches below the top of the deck. The flashing shall be formed to act as a gravel stop. Flashing shall be installed around the center dome, manholes, and other openings as required to ensure a watertight structure.

2.11 RIM SKIRT FOR GASHOLDING COVERS

NOTE: Delete this paragraph if non-gasholding covers are specified.

An extended rim skirt shall be provided around the periphery of the cover and extend below the liquid level to contain the gas. If necessary for proper operation of the pressure relief valve, a precast or cast-in-place concrete ballast ring shall be provided. Precast concrete ballast rings shall be attached to the bottom of the rim skirt by steel straps welded to the rim skirt. Cast-in-place concrete ballast ring shall be cast integrally with the rim skirt with reinforcing bars welded to the rim skirt for support.

2.12 WALL GUIDES AND ROLLERS

NOTE: Delete inapplicable types of guides. Vertical guides should be used on all covers except gasholder covers over 9 m 30 feet in diameter.

Spiral guides are recommended for gasholders over 9 m 30 feet diameter to protect against tipping. Teflon slide plates have replaced rollers on spiral guide type system on some digester cover systems. The floating cover in the low or nonoperational position will rest on tank supports or corbels. The number and size of corbels cast into the tank wall should take into account dead and live loading of floating cover. Some tank designs may utilize top cover supports instead of corbels. On truss supported covers, one corbel per truss is usually supplied around the inside wall of the digester.

[Vertically guided covers shall be equipped with [_____] peripheral guide rollers located on the cover and vertical wall guides located on the inside face of the digester tank wall. The rollers shall prevent tipping of the cover when subjected to unbalanced loads. The vertical guides shall prevent rotation of the cover during its vertical travel.] [Spirally guided covers shall be provided with spiral guides mounted in the rim skirt and arranged to engage rollers set in the wall of the tank. The spiral guides shall assure that the gasholder remains level under all operating conditions, preventing the gasholder from tilting or binding under any operating conditions.]

2.13 APPURTENANCES

Appurtenances provided shall include the following:

2.13.1 Gas Dome

A gas dome shall be provided to prevent light materials from the sludge from carrying over into the gas piping.

2.13.2 Gas Pipe Housing

A gas pipe housing shall be provided when required to allow vertical travel of the cover without conflict with interior gas piping. A gas mixing compressor and housing shall be added as required.

2.13.3 Drain Sumps and Access Wells

NOTE: Delete this paragraph if ceiling plates are not specified. If steel roof is specified, provide only two drain sumps.

[A drain sump shall be provided at every other truss] [Two drain sumps shall be provided, on opposite sides of the cover,] for collection of water that collects in the floating cover. An access well with an aluminum ventilating cover shall be provided for each drain sump.

2.13.4 Manhole

NOTE: Delete this paragraph if ceiling plates are not specified.

A manhole with cover shall be provided to allow access to the digestion tank. The manhole shall be gas tight.

2.13.5 Entrance Hatch

**NOTE: Include "cover attic space" for covers with
ceiling plates. Include "digester" for covers
without ceiling plates.**

An entrance hatch shall be provided to permit access to the [cover attic space] [digester].

2.13.6 Sampling Well

A sampling well with quick-opening gas tight cover shall be provided. The well shall extend below the liquid level to allow sampling of the digester contents without releasing the gas from the tank.

2.13.7 Pressure-Vacuum Relief Unit

A combination pressure-vacuum relief unit with a flame arrester designed to protect against excessive pressure and vacuum and to prevent accidental ignition of gas within the digester from external sources shall be provided. Valve materials shall be impervious to the attack of digester gas, and interior parts shall be readily accessible for inspection and maintenance.

2.14 FABRICATION

The floating cover shall be shop fabricated in subassemblies as large as practicable for shipping. The gas dome shall be completely shop fabricated with top and bottom rings, truss chord connection plates, and top plate in place. The gas pipe housing, sampling wells, manhole, and entrance hatch shall be completely shop assembled and match-marked for proper installation.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 WELDING

**NOTE: If the need exists for more stringent pipe
welding requirements, delete the sentences in the
first set of brackets.**

[Weld piping in accordance with qualified procedures using performance qualified welders and welding operators. Qualify procedures and welders in accordance with ASME BPVC SEC IX Boiler and Pressure Vessel Code. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. Notify the

Contracting Officer 24 hours in advance of tests and perform the tests at the work site if practical. The welder or welding operator shall apply the assigned symbol near each weld made as a permanent record. Weld structural members in accordance with Section 05 05 23.16 STRUCTURAL WELDING.] [Welding and nondestructive testing procedures for piping shall be as specified in Section 40 05 13.96 WELDING PROCESS PIPING.]

3.3 PAINTING

Paint preparation and application shall be in accordance with manufacturer's instructions and following:

3.3.1 Preparation and Application

Paint all metal surfaces, except aluminum, bronze, brass, and stainless steel, and equipment normally factory finished. Surface preparation and painting shall be performed in the field. Prepare ferrous metal surfaces in accordance with SSPC SP 10/NACE No. 2 and paint them with coal tar bitumastic for surfaces exposed to digester sludge and high build polyamide or amine epoxy system for exterior surfaces.

3.3.2 Coating Testing

Examine and test coatings for flaws, thickness, and holidays. Thickness of coatings shall be measured by a commercial film thickness gauge. Coatings shall be tested for pinholes, holidays, and other defects with an electric detector equipped with an audible signal that operates when a flaw defect is detected. The detector shall be a 90-volt wet sponge type pinhole detector.

3.3.3 Coating Repair

If welding is required after application of the coating or if the coating is damaged in any way, repair shall consist of preparing the affected area in compliance with SSPC SP 10/NACE No. 2 and reapplying the coating to that area. If holidays are detected or film thickness is insufficient, the surface shall be prepared and additional coats applied in the affected area in compliance with manufacturer's instructions.

3.4 FIELD ERECTION

Perform assembly and installation in accordance with manufacturer's written instructions. Submit drawings containing complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will function as a unit. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

3.5 FRAMED INSTRUCTIONS

Post framed instructions containing wiring and control diagrams under glass or in laminated plastic, where directed. Show with the instructions wiring and control diagrams and complete layout of the entire system. The instructions shall also include, in typed form, condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation and procedures for safely starting and stopping the system. Condensed operating instructions, prepared in typed form, shall be framed as specified above and posted

beside the diagrams. Submit a copy of the instructions proposed to be framed and posted. The framed instructions shall be posted before acceptance testing of the system.

3.6 FIELD QUALITY CONTROL

Submit performance test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall indicate the final position of controls.

3.6.1 Testing

**NOTE: Delete the bracketed part of this paragraph
if ceiling plates are not specified.**

After erection and installation of the cover, fill the tank with water and the cover floated on the water, trapping air beneath the cover. Water will be furnished by the [Government] [Contractor]. Check welded seams for leaks by application of a soapsuds solution. Repair leaks by rewelding and the cover shall be retested until no leaks are discovered. [The trapped air shall be released and the cover shall be floated on the water, testing all seams for watertightness. Leaks shall be repaired by rewelding and the cover shall be retested until the ceiling is watertight.] Volume of [water] [air] shall be added such that cover travels the full range of design in order to test vertical and/or spiral roller and guide systems.

3.6.2 Manufacturer's Services

Provide the services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified. The representative shall supervise the installation, adjustment, and testing of the equipment.

3.7 FIELD TRAINING

Provide a field training course for designated operating and maintenance staff members. Training shall be provided for a total period of [_____] hours of normal working time and shall start after the system is functionally complete but prior to final acceptance tests. Field training shall cover all of the items contained in the operating and maintenance manuals.

3.8 MAINTENANCE

Provide operating manuals that detail the step-by-step procedures required for system startup, operation, and shutdown. Operation manuals shall include the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features.

Provide maintenance manuals that list routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Maintenance manuals shall include piping and equipment layout and simplified wiring and control diagrams of the system as installed. Manuals shall be approved prior to the field training course.

-- End of Section --