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USACE / NAVFAC / AFCEC / NASA **UFGS-46 31 11 (August 2017)**

Preparing Activity: USACE **Superseding**
UFGS-43 32 76 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021
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SECTION 46 31 11

CHLORINE GAS FEED EQUIPMENT

08/17

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SECTION 46 31 11

CHLORINE GAS FEED EQUIPMENT
08/17

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NOTE: This guide specification covers the requirements for chlorine feeding equipment for the treatment of water or sewage.

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

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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.
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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 B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2016) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2017) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.11	(2016) Forged Fittings, Socket-Welding and Threaded
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2020) 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
ASTM A153/A153M	(2016a) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A587	(1996; R 2019) Standard Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry
ASTM B88	(2020) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM D1785	(2015; E 2018) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM F441/F441M	(2020) Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80

CHLORINE INSTITUTE (CI)

CI Pamphlet 1	(2008) Chlorine Basics, Edition 7
CI Pamphlet 6	(2005) Piping Systems for Dry Chlorine, edition 15

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

30 CFR 72	Health Standards for Coal Mines

1.2 SUBMITTALS

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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.

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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; G[, [_____]]

SD-03 Product Data

Framed Instructions

Manufacturer's Descriptive Data

Technical Literature

Performance Charts And Curves

Catalog Cuts

Installation Instructions

Equipment And Material; G

SD-06 Test Reports

Operating Test; G[, [_____]]

SD-07 Certificates

Service Organization

Spare Parts; G

SD-10 Operation and Maintenance Data

Operating Manuals

Maintenance Manuals

1.3 MAINTENANCE MATERIAL SUBMITTALS

1.3.1 Auxiliary Equipment and Spare Parts

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Note: Delete any items listed below that are not required. Designer shall specify, in addition to the list provided below, what additional device or devices are required to be provided by the contractor in the performance of this contract to ensure that the user of the equipment is able to measure the desired analytes that are being distributed by this system.
****

Furnish auxiliary equipment and spare parts as follows:

a. One spare flow rate indicator for each machine.

b. One flexible tank connection for each machine, except where the machine is direct cylinder-mounted.

c. Three each of all special gaskets to fit all joints and unions.

d. One set of all necessary hose clamps to suit all hose connections.

e. Fifty cylinder valve gaskets.

f. One 118 mL4 ounce bottle of ammonia.

g. Stationary metal platform scale without wheels, with a capacity of [2][4][_____] chloride containers of [1][2][_____] kgpounds size and of the [dial][beam] type.

h. [[1][2][_____] air-purifying respirators, with cartridges conforming to 30 CFR 72; Subpart 710.] [[_____] self-contained air breathing units.]

i. [1][2][_____] residual-chlorine comparator of a type employing permanent color standards and 13- or 26-millimeter viewing-depth sample tubes, with corrosion-resistant case, a color disk reading from 0.0 mg/L to [_____] mg/L, and sufficient DPD tablets for 100 tests. Provideresidual chlorine comparators that meet EPA requirements.

j. [1][2][_____] emergency repair kit for chlorine cylinders.

k. [1][2][_____] emergency repair kit for chlorine [1][_____] metric ton ton containers.

1.3.2 Special Tools

For each type of equipment furnished provide:

a. Special tools necessary for adjustment, operation, maintenance, and disassembly.

b. A grease gun or other lubricating device for each type of grease required.

c. One or more steel cases mounted on the wall complete with flat key locks, two keys, and clips or hooks to hold each tool in a convenient location. Provide high-grade, smooth, forged, tools fabricated from alloy tool steel. Provide lever type grease guns. Deliver tools at the same time as the equipment and hand over on completion of the work.

1.4 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, humidity and temperature variation, dirt and dust, or other contaminants.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide a chlorine feed system for the treatment of sewage effluent or potable water systems. System shall consist of chlorine feed pump, controls, cylinder connections, gauges, meters, etc. as described in the following paragraphs.

2.1.1 Standard Products

Provide equipment and material which are the standard products of a manufacturer regularly engaged in the manufacture of the products and that

essentially duplicate items that have been in satisfactory use for at least [2 years prior to bid opening][2 years prior to issuance of Request for Proposal]. A service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site must be proposed to support all equipment.

2.1.2 Nameplates

Secure a plate to major equipment items containing the manufacturer's name, address, type or style, model or serial number, and catalog number.

2.1.3 Miscellaneous Supports

Provide bolts, nuts, anchors, washers, and all other types of supports necessary for the installation of the equipment which are fabricated of galvanized steel, cadmium plated steel, or Type 316 stainless steel.

2.1.4 Submittal Data

Submit a complete list of equipment and material, including manufacturer's descriptive data and technical literature, performance charts and curves, catalog cuts, and installation instructions. Submit a list of Spare parts data for each different item of material and equipment specified, after approval of the detail drawings and not later than [1][3][_____] months prior to the date of beneficial occupancy. Include in the data a complete list of parts and supplies, with current unit prices and source of supply, and a list of the parts recommended by the manufacturer to be replaced after [1][and][3] year(s) of service.

2.1.5 Material Compatibility

Supply materials that are compatible with the concentration of solutions to which they are exposed. It is the contractor's responsibility to ensure all supplied materials are compatible within all submitted products.

2.1.6 Factory Painting

Use factory paint which conforms to manufacturer's standard factory finish.

2.2 CHLORINE-FEEDING MACHINE

Select components for the machine for the treatment of [water][sewage] by the application of chlorine [solution][gas] against a [positive][negative] head of [_____] mmfeet using the facility's system for operation of the machines under a variation in pressure from [_____] minimum to [_____] maximum kPapsi. The chlorine-feeding system consists of controls and devices necessary for a complete operating system including a chlorine pressure gauge or other device that indicates loss of chlorine pressure, a chlorine pressure-reducing valve, a meter with rate-of-flow, injector, pressure-relief valves, water-pressure gauges, water strainers, backflow preventer and water-pressure regulator if required.

2.2.1 Mounting

Provide each chlorine-feeding machine with means for [direct cylinder mounting][wall mounting][floor mounting on a panel or in a cabinet] so that the chlorine gas feed rate control is under [a vacuum][pressure] when the machine is in operation. [Mix chlorine gas with liquid after being measured through the meter.]It is essential that the chlorine feeding

machine function accurately regardless of normal variations in pressure in the chlorine cylinders[and in the liquid pressure operating the machines].

2.2.2 Protection of Components

Automatically protect the machine against flooding or damage in the event of a failure of the chlorine supply so that under operating conditions it is not possible for water to get back into the chlorine inlet line or dry-gas control parts. Provide parts subject to contact with chlorine made of materials resistant to the action of chlorine at the pressures and concentrations that could be encountered. Construct a system as simple as practicable that provides reliable service and is readily accessible for inspection, cleaning, adjustment, repairs, and replacements.

2.2.3 Capacity

****
NOTE: Choose chlorine feed capacity based on minimum and maximum chlorine requirements required by chemical analysis to treat water fed through the system.
****

Provide Chlorine-feeding machines capable of delivering chlorine from a minimum of [_____] kgpounds to a maximum of [_____]kgpounds in 24 hours while operating continuously at rated capacity.

2.2.4 Chlorinator Controls

Provide [fully automatic][semiautomatic][program control][manually-adjusted] type chlorine-feeding machine. [All fully automatic machines are to be equipped to receive standard 4-20 mA control signals.] [Fully automatic controls consist of devices with accessories to adjust continuously the rate of chlorine feed automatically in direct proportion to [flow][and][chlorine residual][to compensate for changes in the chlorine demand] of the [water][or] [sewage]being chlorinated. Acceptable controls are not to require manual attention other than adjustment of the required chlorine residual.] [Semiautomatic controls consist of devices with accessories to start and stop the chlorine-feeding machine automatically with the starting and stopping of the [water][or][sewage] being chlorinated or with a timer mechanism.] [Program control consists of a device with accessories to change the chlorine feed rate of the machine automatically according to a predetermined cycle.] [Manual controls consist of adjustment and indicating devices for regulating the chlorine dosage manually. Provide manually adjusted types that are capable of receiving standard 4-20 mA control signals by the addition of an automatic control device.]

2.2.5 Cylinder Connections

Provide cylinder connections for attaching standard chlorine cylinders to the chlorine-feeding machines. Connections include flexible metal tubing, an auxiliary valve for each chlorine cylinder, a manifold for connecting [2][4][_____] cylinders to each chlorine-feeding machine, and other necessary fittings, unless the machine is direct cylinder-mounted.

2.2.6 Switchover Valves

Supply two or more mechanically operated or loss of chlorine supply-operated automatic gas switchover valves to automatically regulate chlorine gas [pressure] [vacuum] and install [in the gas header] [directly on the chlorine cylinders]. Size the switchover valves appropriately and equipped with filters [and traps]. Factory set the switchover [pressure] [vacuum].

2.2.7 Chlorine Pressure Gauges

Supply chlorine pressure gauges, when applicable, of the diaphragm type with the Bourdon tube and diaphragm compartments filled completely with suitable oil. Construct the gauge on the line from the chlorine tank to indicate accurately the pressure of chlorine gas as supplied from the gas tank to the chlorine feeder.

2.2.8 Chlorine Pressure-Reducing Valves

Provide chlorine pressure-reducing valves that reduce the pressure of the gas and maintain the pressure constant for any given setting of rate of feed regardless of changes in the cylinder pressure.

2.2.9 Vacuum and Chlorine Relief

Provide vacuum and chlorine relief to limit the vacuum within the chlorine-feeding machines and provide for the release to a suitable vent to the outside atmosphere of any chlorine gas pressure build-up in the parts of the machine, normally under vacuum, through improper functioning of the equipment. A vacuum sealing valve which seals off the system when excessive vacuum is present may be substituted for the vacuum relief valve.

2.2.10 Chlorine-Metering Devices

Furnish chlorine-metering devices in sufficient numbers to cover properly the range specified. The chlorine feed rate control system must maintain the feed rate within 4 percent of the indicated rate.

2.2.11 Injectors

Provide injectors with the chlorine-feeding machines to receive all chlorine and solution water and to discharge the resulting solution to the points of application. Introduce the chlorine solution into the [water][or][sewage] main by means [of a [ceramic][hard rubber][or][plastic]injection nozzle] [of a suitable diffuser tube inserted into the main through a corporation cock].

2.2.12 Alarm Actuators

Equip each chlorine-feeding machine with alarm actuators to indicate loss of vacuum and excess vacuum. Provide alarm actuators for low chlorine gas pressure and high chlorine gas pressure, unless the chlorine-feeding machine is direct-cylinder mounted. [Also, provide a solution water low pressure alarm actuator.]

2.2.13 Pumps

Provide a pump for each chlorine-feeding machine when the minimum water pressure specified is below that required for satisfactory operation of

the machine. Provide hydraulically operated or electric motor-drive pumps. The electric motor will be rated for [_____]-volt, [_____]-phase, [_____]-Hz ac, and a maximum speed of [_____] rpm. Equip the pump with a suitable starter in accordance with the type of control specified.

2.3 EVAPORATORS

****

NOTE: Delete this paragraph in its entirety for installations where chlorine withdrawal rates will not exceed chlorine gasification rate.

****

Evaporators are required whenever gas withdrawal rates exceed the rate at which liquid chlorine gasifies at the operating temperature. Provide water immersed tank heat-exchanger evaporators suitable for evaporating liquid chlorine complete with controls and devices for a complete operating system including: Vaporizing chamber, electric water heaters, water temperature thermostat and indicator, high and low water temperature alarm actuators, water-level gauge, automatic make-up water control system, low water alarm actuator, chlorine gas temperature, and pressure gauges, [make-up water visual flow-indicator], ammonia-type flanged connections for chlorine inlet and outlet, drain and vent line connections, and cathodic protection system with ammeter. Provide parts which are subject to contact with chlorine made of materials resistant to the action of chlorine at pressure and concentrations that could be encountered. Construction is to be as simply as practicable to provide reliable service and to be readily accessible for inspection, cleaning, adjustment, repair and replacement.

2.3.1 Capacity

Provide evaporators with a capacity to convert [_____] kgpounds per day of liquid chlorine into gaseous state.

2.3.2 Vaporizing Chamber

Provide a vaporizing chamber constructed of steel and designed to conform to ASME BPVC SEC VIII D1. Test the chamber hydrostatically at 5.5 MPa800 psig minimum. Protect the gas chamber and water bath tank from cathodic corrosion. Provide insulated, galvanized tank to conform to ASTM A153/A153M.

2.3.3 Water Heaters

Design the water heaters for operation on a 3-phase, 60-Hz current of the voltage indicated. Include a vapor-sealed magnetic contactor for handling the current to the heaters. The holding coil is to be rated for single-phase, 60-Hz current.

2.3.4 Switchover System

Supply a liquid chlorine automatic switchover system to automatically change to reserve supply when the on-line liquid chlorine supply runs out.

2.3.5 Pressure-Relief System

Equip each evaporator with a chlorine pressure relief system located downstream of the gas outletwith the following features:

a. Rupture disk with 1.7 MPa250 psig minimum rating.

b. Pressure switch protected by a diaphragm seal and actuated at 137.9 kPa 20 psig.

c. Self-reseating pressure relief valve with manufacturer's standard pressure rating, set for a pressure compatible with the respective rupture disk rating figure.

2.4 PIPING

2.4.1 Water Piping

Provide galvanized steel water piping conforming to ASTM A53/A53M or provide copper tubing conforming to ASTM B88M ASTM B88. Malleable-iron unions and fittings for installation of steel pipe are to conform to ASME B16.3.

2.4.2 Chlorine Piping

Provide chlorine solution piping smaller than 40 mm1-1/2 inches in diameter made of [PVC pipe conforming to ASTM D1785 or CPVC pipe conforming to ASTM F441/F441M] [rubber hose]. Provide piping of 40 mm 1-1/2 inches in diameter or larger made of [plastic pipe] [rubber hose] [rubber-lined] [plastic-lined steel pipe]. Line steel pipe smaller than 150 mm6 inches with plastic lining not less than 3.2 mm1/8 inch thick; and for steel pipe larger than 150 mm6 inches, it cannot be less than 4.8 mm 3/16 inch thick. Provide plastic fittings for plastic pipe with [flanged] [threaded] joints. Provide joints for rubber hose that use a clamp-type mechanical coupling. Provide lined steel pipe that is [threaded] [flanged integral with the pipe] [forged-steel flanges screwed to the pipe barrel]. Provide fittings for steel pipe which are [flanged conforming to ASME B16.1 or ASME B16.5] [forged-steel threaded conforming to ASME B16.11] and are compatible with lined steel pipe.

2.4.2.1 Piping for Dry Chlorine

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NOTE: Selection of chlorine-gas piping is dependent on the service for which the system is designed. The designer will consult the Chlorine Manual and CI Pamphlet 6, Piping Systems for Dry Chlorine for applicable piping system.
****

Ensure piping for dry chlorine conforms to CI Pamphlet 1 and CI Pamphlet 6. [Ensure steel pipe 19 through 40 mm3/4 through 1-1/2 inches in diameter conforms to [ASTM A106/A106M, Schedule 80, Grade A or B][or][ASTM A587]. Ensure steel pipe over 40 mm1-1/2 inches in diameter conforms to ASTM A53/A53M, Schedule [40][80], Grade [E][or][S]. Fittings for steel pipe are to conform to CI Pamphlet 6]. [Provide seamless copper tubing conforming to ASTM B88MASTM B88 in the annealed state with Type K wall thickness or heavier. Provide fittings for copper tubing in accordance with CI Pamphlet 6.] If moisture may be present, provide piping smaller than 40 mm1-1/2 inches in diameter made of [polyvinylidene fluoride][polyvinylidene fluoride lined steel pipe]; if piping is larger than 40 mm1-1/2 inches in diameter, provide polyvinylidene fluoride lined steel pipe. For piping for dry or moist chlorine gas under vacuum provide

chlorinated polyvinyl chloride piping.

2.4.2.2 Piping for Liquid Chlorine

Specify piping for liquid chlorine free of moisture the same as for dry chlorine gas under pressure. Whenever a portion of the liquid chlorine piping can be isolated between two closed valves, protect that portion with a liquid chlorine expansion chamber.

2.4.3 Cylinder Connections

Use cylinder connections made of flexible metal tubing of required size cadmium-plated copper. Install flexible cylinder connector assembly with lead-gasketed, naval-bronze fittings.

2.5 ELECTRICAL WORK

Provide electric motor-driven equipment, and wiring per Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Ratings will be as indicated. Provide motor starters complete with thermal-overload protection and other appurtenances necessary for motor controls specified. Provide mannual or automatic control and protective or signal devices required for controls and devices. Prewire all electrical connections at junction terminal boxes and at contactor-starter unit enclosures.

PART 3 EXECUTION

3.1 INSTALLATION

Submit detail drawings containing complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Show on the drawings proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

3.1.1 Chlorine-Feeding Equipment

Install the chlorine feeding machines, [the evaporators] and all equipment appurtenances in accordance with CI Pamphlet 1 and CI Pamphlet 6 so as to provide a complete and integrated system in accordance with the instructions of the manufacturer [and under the direct supervision of the manufacturer's representative].

3.1.2 Pipe, Tubing, Hangers, and Supports

Install pipes and tubes in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

3.2 FIELD QUALITY CONTROL

3.2.1 Tests

After installation of the chlorine-feeding machine [and evaporators] is complete, perform an operating test at design system flow rates and pressures to assure that the chlorine-feeding installation operates properly. Test all piping hydrostatically and for leaks. No leaks are allowed in piping. If any deficiencies are revealed during any tests, correct such deficiencies and reconduct the tests.

Submit test report 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. Indicate in each test report the final position of controls.

3.2.2 Manufacturer Field Service

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

3.3 Field Painting

Paint equipment which did not receive a factory finish as specified in Section 09 90 00 PAINTS AND COATINGS. Follow manufacturers' recommendations for number of coats, primer and paint type and thickness. Thoroughly clean factory painted items requiring touching up in the field of all foreign material and prime and topcoat with the manufacturer's standard factory finish (provided it does not discolor in the presence of hydrogen sulfide fumes, high water vapor atmosphere, alkaline water vapor, and concentrated chlorine (oxidizing) condition)s. Provide coating that is not less than 0.05 mm1.78 mils thick.

3.4 CLOSEOUT ACTIVITIES

3.4.1 Training

Conduct a field training course for designated operating staff members conducted by the manufacturer's representative and provided for a total period of [8][16][_____] hours of normal working time. Start after the system is functionally complete but prior to final acceptance tests. Cover all of the items contained in the operating and maintenance instructions during field training.

3.4.2 Operating Manuals

Submit complete copies of operating manuals outlining the step-by-step procedures required for system startup, operation and shutdown. Include in the manuals the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features.

3.4.3 Maintenance Manuals

Submit complete copies of maintenance manuals listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Include in the instructions gas pipe layout, liquid chlorine pipe layout, dilution liquid pipe layout, equipment layout, and simplified wiring and control diagrams of the system as installed.

3.4.4 Framed Instructions

Post framed instructions, containing wiring and control diagrams, where directed. Post operating instructions as discussed in the Operating and Maintenance Manual. Post the framed instructions before acceptance testing of the systems.

-- End of Section --