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USACE / NAVFAC / AFCEA / NASA UFGS-43 32 76 (April 2006)  
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Preparing Activity: USACE Replacing without Change  
UFGS-11241 (August 2004)

## UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 9 October 2006

Latest change indicated by CHG tags

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CHLORINE-FEEDING MACHINES (AUTOMATIC, SEMIAUTOMATIC AND MANUAL)

04/06

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### SECTION 43 32 76

#### CHLORINE-FEEDING MACHINES (AUTOMATIC, SEMIAUTOMATIC AND MANUAL) 04/06

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

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

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## 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 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.

ASME INTERNATIONAL (ASME)

ASME B16.1	(1998) Cast Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.11	(2005) Forged Fittings, Socket-Welding and Threaded
ASME B16.3	(1998) Malleable Iron Threaded Fittings
ASME B16.5	(2003) Pipe Flanges and Flanged Fittings
ASME BPVC SEC VIII D1	(2004) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage

ASTM INTERNATIONAL (ASTM)

ASTM A 106/A 106M	(2004b) Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A 153/A 153M	(2005) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 53/A 53M	(2004a) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 587	(1996; R 2001) Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry
ASTM B 88	(2003) Seamless Copper Water Tube
ASTM B 88M	(2003) Seamless Copper Water Tube (Metric)
ASTM D 1785	(2005) Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM F 441/F 441M	(2002) Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80

CHLORINE INSTITUTE (CI)

CI Pamphlet 1	(1997) Chlorine Manual
CI Pamphlet 6	(2005) Piping Systems for Dry Chlorine

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 to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" 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.

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" 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.] The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation[; G][; G, [\_\_\_\_]]

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. 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.

SD-03 Product Data

## Material and Equipment

A complete list of equipment and material, including manufacturer's descriptive data and technical literature, performance charts and curves, catalog cuts, and installation instructions. Spare parts data for each different item of material and equipment specified, after approval of the detail drawings and not later than [\_\_\_\_\_] months prior to the date of beneficial occupancy. Data shall include 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.

Diagrams, instructions, and other sheets, proposed for posting.

## SD-06 Test Reports

### Testing

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.

## SD-10 Operation and Maintenance Data

### Operating and Maintenance Instructions

[Six] [\_\_\_\_\_] complete copies of operating manuals outlining the step-by-step procedures required for system startup, operation and shutdown. The manuals shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. [Six] [\_\_\_\_\_] complete copies of maintenance manuals listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. The instructions shall include gas pipe layout, liquid chlorine pipe layout, dilution liquid pipe layout, equipment layout, and simplified wiring and control diagrams of the system as installed.

## 1.3 GENERAL REQUIREMENTS

### 1.3.1 Standard Products

Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the 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.

### 1.3.2 Nameplates

Major equipment items 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.

### 1.3.3 Verification of Dimensions

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

### 1.4 DELIVERY AND STORAGE

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

### 1.5 MAINTENANCE, EXTRA MATERIALS AND TOOLS

#### 1.5.1 Auxiliary Equipment and Spare Parts

\*\*\*\*\*  
**NOTE: Remove items not required in the project.**  
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Auxiliary equipment and spare parts shall be furnished 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 mL 4 ounce bottle of ammonia.
- g. Stationary metal platform scale without wheels, with a capacity of [\_\_\_\_\_] chloride containers of [\_\_\_\_\_] kg pounds size and of the [dial] [beam] type.
- h. [[\_\_\_\_\_] air-purifying respirators, with cartridges conforming to 30 CFR 72; Subpart 710.] [[\_\_\_\_\_] self-contained air breathing units.]
- i. [\_\_\_\_\_] 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. The residual chlorine comparators shall meet EPA requirements.
- j. [\_\_\_\_\_] emergency repair kit for chlorine cylinders.
- k. [\_\_\_\_\_] emergency repair kit for chlorine [\_\_\_\_\_] metric ton ton containers.

#### 1.5.2 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. Tools shall be high-grade, smooth, forged, alloy tool steel. Grease guns shall be lever type. Tools shall be delivered at the same time as the equipment and handed over on completion of the work.

## PART 2 PRODUCTS

### 2.1 CHLORINE-FEEDING MACHINE

The machine shall be designed for the treatment of [water] [or] [sewage] by the application of chlorine [solution] [gas] against a [positive] [negative] head of [\_\_\_\_\_] mm feet using the facility's [clarified sewage effluent] [or] [water supply] system for operation of the machines under a variation in pressure from [\_\_\_\_\_] minimum to [\_\_\_\_\_] maximum kPa psi. The chlorine-feeding system shall consist 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. Each chlorine-feeding machine shall be provided with means for [direct cylinder mounting] [wall mounting] [floor mounting on a panel or in a cabinet] and shall be designed so that the chlorine gas feed rate control is under [a vacuum] [pressure] when the machine is in operation. [Chlorine gas shall be mixed with liquid after being measured through the meter.] The chlorine feeding machine shall function accurately regardless of normal variations in pressure in the chlorine cylinders [and in the liquid pressure operating the machines].

In case of failure of the chlorine supply, the machine shall be the type that is automatically protected against flooding or damage so that under operating conditions it will not be possible for water to get back into the chlorine inlet line or dry-gas control parts. Parts subject to contact with chlorine shall be made of materials resistant to the action of chlorine at the pressures and concentrations that could be encountered. Construction shall be as simple as practicable to provide reliable service and to be readily accessible for inspection, cleaning, adjustment, repairs, and replacements.

#### 2.1.1 Capacity

Each chlorine-feeding machine shall be capable of delivering chlorine from a minimum of [\_\_\_\_\_] kg pounds to a maximum of [\_\_\_\_\_] kg pounds in 24 hours and shall be capable of continuous operation at rated capacity.

#### 2.1.2 Chlorinator Controls

Each chlorine-feeding machine shall be of the [fully automatic] [semiautomatic] [program control] [manually-adjusted] type. [Fully automatic machines shall be capable of receiving standard 4-20 mA control signals.] [Fully automatic controls shall 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. The controls shall require no manual attention other than adjustment of the required chlorine residual.] [Semiautomatic controls shall 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 shall consist of a device with accessories to change the chlorine feed rate of the machine automatically according to a predetermined cycle.] [Manual controls shall consist of adjustment and indicating devices for regulating the chlorine dosage manually. Manually adjusted types shall be capable of receiving standard 4-20 mA control signals by the addition of an automatic control device.]

#### 2.1.3 Cylinder Connections

Cylinder connections shall be provided for attaching standard chlorine cylinders to the chlorine-feeding machines. Connections shall include flexible metal tubing, an auxiliary valve for each chlorine cylinder, a manifold for connecting [\_\_\_\_\_] cylinders to each chlorine-feeding machine, and other necessary fittings, unless the machine is direct cylinder-mounted.

#### 2.1.4 Switchover Valves

Two or more mechanically operated or loss of chlorine supply-operated automatic gas switchover valves to automatically regulate chlorine gas [pressure] [vacuum] shall be supplied and installed [in the gas header] [directly on the chlorine cylinders]. The switchover valves shall be of suitable size and shall be equipped with filters [and traps]. The switchover [pressure] [vacuum] shall be factory set.

#### 2.1.5 Chlorine Pressure Gauges

Chlorine pressure gauges when supplied, shall be of the diaphragm type with the Bourdon tube and diaphragm compartments filled completely with suitable oil. The gauge on the line from the chlorine tank shall be constructed to indicate accurately the pressure of chlorine gas as supplied from the gas tank to the chlorine feeder.

#### 2.1.6 Chlorine Pressure-Reducing Valves

Chlorine pressure-reducing valves shall function to 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.

#### 2.1.7 Vacuum and Chlorine Relief

Vacuum and chlorine relief shall be provided 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 will seal off the system when excessive vacuum is present may be substituted for the vacuum relief valve.

#### 2.1.8 Chlorine-Metering Devices

Chlorine-metering devices in sufficient number shall be furnished to cover properly the range specified. The chlorine feed rate control system shall maintain the feed rate within 4 percent of the indicated rate.

### 2.1.9 Injectors

Injectors shall be provided with the chlorine-feeding machines to receive all chlorine and solution water and to discharge the resulting solution to the points of application. The chlorine solution shall be introduced 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].

### 2.1.10 Alarm Actuators

Each chlorine-feeding machine shall be equipped with alarm actuators to indicate loss of vacuum and excess vacuum. Alarm actuators shall be provided for low chlorine gas pressure and high chlorine gas pressure, unless the chlorine-feeding machine is direct-cylinder mounted. [There shall also be a solution water low pressure alarm actuator.]

### 2.1.11 Pumps

A pump shall be provided for each chlorine-feeding machine when the minimum water pressure specified is below that required for satisfactory operation of the machine. The pump shall be hydraulically operated or electric motor-driven. The electric motor shall be rated for [\_\_\_\_\_] -volt, [\_\_\_\_\_] -phase, [\_\_\_\_\_] -Hz ac, and a maximum speed of [\_\_\_\_\_] rpm. The pump shall be equipped with a suitable starter in accordance with the type of control specified.

## 2.2 EVAPORATORS

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**NOTE: Delete this paragraph in its entirety for  
installations where chlorine withdrawal rates will  
not exceed chlorine gasification rate.**  
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Evaporators will be required whenever gas withdrawal rates would exceed the rate at which liquid chlorine gasifies at the operating temperature. Evaporators shall be water immersed tank heat-exchanger type specifically designed to evaporate liquid chlorine. The evaporators shall be 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. Parts subject to contact with chlorine shall be made of materials resistant to the action of chlorine at pressure and concentrations that could be encountered. Construction shall be as simple as practicable to provide reliable service and to be readily accessible for inspection, cleaning, adjustment, repair and replacement.

### 2.2.1 Capacity

Evaporators shall have a capacity to convert [\_\_\_\_\_] kg pounds per day of liquid chlorine into gaseous state.

### 2.2.2 Vaporizing Chamber

The vaporizing chamber shall be constructed of steel and shall be designed to conform to [ASME BPVC SEC VIII D1](#). The chamber shall be hydrostatically tested at [5.5 MPa 800 psig](#) minimum. The gas chamber and water bath tank shall be cathodically protected. The tank shall be galvanized to conform to [ASTM A 153/A 153M](#) and insulated.

### 2.2.3 Water Heaters

The water heaters shall be designed for operation on a 3-phase, 60-Hz current of the voltage indicated. A vapor-sealed magnetic contactor shall be included for handling the current to the heaters. The holding coil shall be suitable for single-phase, 60-Hz current.

### 2.2.4 Switchover System

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

### 2.2.5 Pressure-Relief System

Each evaporator shall also be equipped with a chlorine pressure relief system located downstream of the gas outlet. The relief system shall have the following features:

- a. Rupture disk with [1.7 MPa 250 psig](#) minimum rating.
- b. Pressure switch protected by a diaphragm seal and actuated at [137.9 kPa 20 psig](#).
- c. Self-seating pressure relief valve with manufacturer's standard pressure rating, set for a pressure compatible with the respective rupture disk rating figure.

## 2.3 PIPING

### 2.3.1 Water Piping

Water piping shall be galvanized steel conforming to [ASTM A 53/A 53M](#) or copper tubing conforming to [ASTM B 88M ASTM B 88](#). Malleable-iron unions and fittings for installation of steel pipe shall conform to [ASME B16.3](#).

### 2.3.2 Chlorine Piping

Chlorine solution piping smaller than [40 mm 1-1/2 inches](#) in diameter shall be [PVC pipe conforming to [ASTM D 1785](#) or CPVC pipe conforming to [ASTM F 441/F 441M](#)] [or] [rubber hose]. Piping of [40 mm 1-1/2 inches](#) in diameter or larger shall be [plastic pipe] [or] [rubber hose] [rubber-lined] [or] [plastic-lined] [steel pipe]. Linings for steel pipe smaller than [150 mm 6 inches](#) shall be not less than [3.2 mm 1/8 inch](#) thick, and for steel pipe larger than [150 mm 6 inches](#), it shall be not less than [4.8 mm 3/16 inch](#) thick. Fittings for plastic pipe shall be of plastic with [flanged] [or] [threaded] joints. Joints for rubber hose shall be made using a clamp-type mechanical coupling. Steel pipe shall have [threaded] [or] [flanged integral with the pipe] [or] [forged-steel flanges screwed to the pipe barrel]. Fittings for steel pipe shall be [flanged conforming to [ASME B16.1](#) or [ASME B16.5](#)] [or] [forged-steel threaded conforming to [ASME B16.11](#)].

#### 2.3.2.1 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 must consult the Chlorine Manual and CI  
Pamphlet 6, Piping Systems for Dry Chlorine for  
applicable piping system.  
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Piping for dry chlorine shall conform to CI Pamphlet 1 and CI Pamphlet 6.  
[Steel pipe 19 through 40 mm 3/4 through 1-1/2 inches in diameter shall  
conform to [ASTM A 106/A 106M, Schedule 80, Grade A or B] [or] [ASTM A 587  
]. Steel pipe over 40 mm 1-1/2 inches in diameter shall conform to  
ASTM A 53/A 53M, Schedule [40] [80], Grade [E] [or] [S]. Fittings for  
steel pipe shall conform to CI Pamphlet 6]. [Copper tubing shall be  
seamless conforming to ASTM B 88M ASTM B 88 in the annealed state with Type  
K wall thickness or heavier. Fittings for copper tubing shall be in  
accordance with CI Pamphlet 6.] If moisture may be present, piping smaller  
than 40 mm 1-1/2 inches in diameter shall be [polyvinylidene fluoride]  
[polyvinylidene fluoride lined steel pipe]; piping larger than 40 mm 1-1/2  
inches in diameter shall be polyvinylidene fluoride lined steel pipe.  
Piping for dry or moist chlorine gas under vacuum shall be chlorinated  
polyvinyl chloride.

#### 2.3.2.2 Piping for Liquid Chlorine

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

#### 2.3.3 Cylinder Connections

Cylinder connections shall be flexible metal tubing of required size  
cadmium-plated copper. Flexible cylinder connector assembly shall be  
installed with lead-gasketed, naval-bronze fittings.

#### 2.4 ELECTRICAL WORK

Electric motor-driven equipment, and wiring shall be in accordance with  
Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Ratings shall be as  
indicated. Motor starters shall be provided complete with thermal-overload  
protection and other appurtenances necessary for motor controls specified.  
Manual or automatic control and protective or signal devices required for  
controls and devices shall be provided. All electrical connections at  
junction terminal boxes and at contactor-starter unit enclosures shall be  
prewired.

#### 2.5 EQUIPMENT APPURTENANCES

Bolts, nuts, anchors, washers, and all other types of supports necessary  
for the installation of the equipment shall be galvanized steel, cadmium  
plated steel, or Type 316 stainless steel.

## PART 3 EXECUTION

### 3.1 INSTALLATION

#### 3.1.1 Chlorine-Feeding Equipment

The chlorine feeding machines, [the evaporators] and all equipment appurtenances shall be installed 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

The installation of pipes and tubes shall be in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

### 3.2 TESTING

After installation of the chlorine-feeding machine [and evaporators] is complete, operating tests shall be carried out to assure that the chlorine-feeding installation operates properly. All piping shall be tested hydrostatically and for leaks. If any deficiencies are revealed during any tests, such deficiencies shall be corrected and the tests shall be reconducted.

### 3.3 PAINTING

#### 3.3.1 Factory Painting

Factory painting shall conform to manufacturer's standard factory finish.

#### 3.3.2 Field Painting

Equipment which did not receive a factory finish shall be painted as specified in Section 09 90 00 PAINTS AND COATINGS. Factory painted items requiring touching up in the field, shall be thoroughly cleaned of all foreign material and shall be primed and topcoated 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) conditions. Coating shall be not less than 0.05 mm 1.78 mils thick.

### 3.4 FRAMED INSTRUCTIONS

Framed operating instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, shall be posted where directed. 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 shall be prepared in typed form, framed as specified and posted beside the diagrams. The framed instructions shall be posted before acceptance testing of the systems.

### 3.5 MANUFACTURER'S FIELD SERVICE

#### 3.5.1 Manufacturer's Supervision

Services of a manufacturer's representative who is experienced in the

installation, adjustment, and operation of the equipment specified shall be provided. The representative shall supervise the installation, adjustment, and testing of the equipment.

#### 3.5.2 Field Training

A field training course shall be provided for designated operating 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 instructions](#).

-- End of Section --