
USACE / NAVFAC / AFCESA / NASA UFGS-43 32 76 (January 2008)

Preparing Activity: USACE Superseding
UFGS-43 32 76 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2012

SECTION TABLE OF CONTENTS

DIVISION 43 - PROCESS GAS AND LIQUID HANDLING, PURIFICATION, AND STORAGE
EQUIPMENT

SECTION 43 32 76

CHLORINE-FEEDING MACHINES (AUTOMATIC, SEMIAUTOMATIC AND MANUAL)

01/08

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 SUBMITTALS
- 1.3 DELIVERY, STORAGE, AND HANDLING
- 1.4 MAINTENANCE, EXTRA MATERIALS AND TOOLS
 - 1.4.1 Auxiliary Equipment and Spare Parts
 - 1.4.2 Special Tools

PART 2 PRODUCTS

- 2.1 GENERAL REQUIREMENTS
 - 2.1.1 Standard Products
 - 2.1.2 Nameplates
 - 2.1.3 Miscellaneous Supports
 - 2.1.4 Submittal Data
- 2.2 CHLORINE-FEEDING MACHINE
 - 2.2.1 Capacity
 - 2.2.2 Chlorinator Controls
 - 2.2.3 Cylinder Connections
 - 2.2.4 Switchover Valves
 - 2.2.5 Chlorine Pressure Gauges
 - 2.2.6 Chlorine Pressure-Reducing Valves
 - 2.2.7 Vacuum and Chlorine Relief
 - 2.2.8 Chlorine-Metering Devices
 - 2.2.9 Injectors
 - 2.2.10 Alarm Actuators
 - 2.2.11 Pumps
- 2.3 EVAPORATORS
 - 2.3.1 Capacity
 - 2.3.2 Vaporizing Chamber
 - 2.3.3 Water Heaters
 - 2.3.4 Switchover System
 - 2.3.5 Pressure-Relief System
- 2.4 PIPING

- 2.4.1 Water Piping
- 2.4.2 Chlorine Piping
 - 2.4.2.1 Piping for Dry Chlorine
 - 2.4.2.2 Piping for Liquid Chlorine
- 2.4.3 Cylinder Connections
- 2.5 ELECTRICAL WORK
- 2.6 FACTORY PAINTING

PART 3 EXECUTION

- 3.1 EXAMINATION
- 3.2 INSTALLATION
 - 3.2.1 Chlorine-Feeding Equipment
 - 3.2.2 Pipe, Tubing, Hangers, and Supports
- 3.3 MANUFACTURER'S FIELD SERVICE
- 3.4 FRAMED INSTRUCTIONS
- 3.5 TESTING
- 3.6 FIELD PAINTING
- 3.7 CLOSEOUT ACTIVITIES
 - 3.7.1 Operating Manuals
 - 3.7.2 Maintenance Manuals
 - 3.7.3 Field Training

-- End of Section Table of Contents --

USACE / NAVFAC / AFCEA / NASA UFGS-43 32 76 (January 2008)

Preparing Activity: USACE Superseding
UFGS-43 32 76 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2012

SECTION 43 32 76

CHLORINE-FEEDING MACHINES (AUTOMATIC, SEMIAUTOMATIC AND MANUAL) 01/08

NOTE: This guide specification covers the requirements for chlorine feeding machines 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 items(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 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.

ASME INTERNATIONAL (ASME)

| | |
|-----------------------|---|
| ASME B16.1 | (2010) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250 |
| ASME B16.11 | (2011) Forged Fittings, Socket-Welding and Threaded |
| ASME B16.3 | (2011) Malleable Iron Threaded Fittings, Classes 150 and 300 |
| ASME B16.5 | (2009) Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard |
| ASME BPVC SEC VIII D1 | (2010) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1 |

ASTM INTERNATIONAL (ASTM)

| | |
|-----------------|--|
| ASTM A106/A106M | (2011) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service |
| ASTM A153/A153M | (2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A53/A53M | (2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A587 | (1996; R 2005) Standard Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry |
| ASTM B88 | (2009) Standard Specification for Seamless Copper Water Tube |
| ASTM B88M | (2005; R 2011) Standard Specification for Seamless Copper Water Tube (Metric) |
| ASTM D1785 | (2012) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120 |
| ASTM F441/F441M | (2009) 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

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.

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

SD-02 Shop Drawings

Installation[; G][; G, [____]]

SD-03 Product Data

Material and Equipment
Framed Instructions

SD-06 Test Reports

Testing

SD-10 Operation and Maintenance Data

Closeout Activities

1.3 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.

1.4 MAINTENANCE, EXTRA MATERIALS AND TOOLS

1.4.1 Auxiliary Equipment and Spare Parts

NOTE: Remove items not required in the project.

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 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.

1.4.2 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 GENERAL REQUIREMENTS

2.1.1 Standard Products

Provide material and equipment 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. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.1.2 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.

2.1.3 Miscellaneous Supports

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.

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. 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. 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.

2.2 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.

2.2.1 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.

2.2.2 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.]

2.2.3 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.

2.2.4 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.

2.2.5 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.

2.2.6 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.

2.2.7 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.

2.2.8 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.

2.2.9 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].

2.2.10 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.]

2.2.11 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.

2.3 EVAPORATORS

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

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.

2.3.1 Capacity

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

2.3.2 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 A153/A153M and insulated.

2.3.3 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.

2.3.4 Switchover System

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

2.3.5 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.

2.4 PIPING

2.4.1 Water Piping

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

2.4.2 Chlorine Piping

Chlorine solution piping smaller than 40 mm 1-1/2 inches in diameter shall be [PVC pipe conforming to ASTM D1785 or CPVC pipe conforming to ASTM F441/F441M] [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].

2.4.2.1 Piping for Dry Chlorine

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.

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 A106/A106M, Schedule 80, Grade A or B] [or] [ASTM A587]. Steel pipe over 40 mm 1-1/2 inches in diameter shall conform to ASTM A53/A53M, 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 B88M ASTM B88 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.

2.4.2.2 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.

2.4.3 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.

2.5 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.

2.6 FACTORY PAINTING

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

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 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.

3.2.1 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].

3.2.2 Pipe, Tubing, Hangers, and Supports

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

3.3 MANUFACTURER'S FIELD SERVICE

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.

3.4 FRAMED INSTRUCTIONS

Post framed operating instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, 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 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.

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

3.6 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.

3.7 CLOSEOUT ACTIVITIES

3.7.1 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.

3.7.2 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.

3.7.3 Field Training

Conduct a field training course for designated operating staff members. Training shall be conducted by the manufacturer's representative and 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 --