
USACE / NAVFAC / AFCEA / NASA UFGS-43 32 69 (April 2006)

Preparing Activity: USACE Superseding
UFGS-43 32 69 (April 2005)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated October 2010

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SECTION 43 32 69

CHEMICAL FEED SYSTEMS

04/06

NOTE: This guide specification covers the requirements for chemicals and controlled volume pumps and appurtenances.

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.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z400.1 (2004) Hazardous Industrial Chemicals -
Material Safety Data Sheets - Preparation

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA B201 (2008) Soda Ash

AWWA B300 (2010) Hypochlorites

AWWA B302 (2005) Ammonium Sulfate

AWWA B303 (2000; R 2005; R 2010) Sodium Chlorite

AWWA B402 (2006) Ferrous Sulfate

AWWA B403 (2009) Aluminum Sulfate - Liquid, Ground,
or Lump

AWWA B404 (2008) Liquid Sodium Silicate

AWWA B405 (2006) Sodium Aluminate

AWWA B406 (2006) Ferric Sulfate

AWWA B407 (2005) Liquid Ferric Chloride

AWWA B408 (2010) Liquid Polyaluminum Chloride

AWWA B451 (2004; R 2010)
Poly(Diallyldimethylammonium Chloride)

AWWA B452 (2006; Addenda 2007) EPI-DMA Polyamines

AWWA B453 (2006; Addenda 2007) Polyacrylomide

AWWA B501 (2008) Sodium Hydroxide (Caustic Soda)

AWWA B502 (2005) Sodium Polyphosphate, Glassy
(Sodium Hexametaphosphate)

AWWA B503 (2005) Sodium Tripolyphosphate

AWWA B504 (2005) Monosodium Phosphate, Anhydrous

AWWA B505 (2005) Disodium Phosphate, Anhydrous

AWWA B511 (2010) Standard for Potassium Hydroxide

AWWA B550 (2010) Standard for Calcium Chloride

AWWA B600 (2005) Powdered Activated Carbon

AWWA B601	(2005) Sodium Metabisulfite
AWWA B602	(2008) Copper Sulfate
AWWA B603	(2010) Permanganates
AWWA B701	(2006) Sodium Fluoride
AWWA B702	(2006) Sodium Fluorosilicate
AWWA B703	(2006; Addenda A 2008) Fluorosilicic Acid

ASME INTERNATIONAL (ASME)

ASME A13.1	(2007) Scheme for the Identification of Piping Systems
ASME B16.1	(2005) Gray Iron Threaded Fittings; Classes 25, 125 and 250
ASME B16.11	(2009) Forged Fittings, Socket-Welding and Threaded
ASME B16.5	(2009) Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard

ASTM INTERNATIONAL (ASTM)

ASTM D 1785	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D 1998	(2006) Polyethylene Upright Storage Tanks
ASTM D 3299	(2010) Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks
ASTM D 5421	(2005) Contact Molded "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Flanges
ASTM E 1067	(2007) Acoustic Emission Examination of Fiberglass Reinforced Plastic Resin (FRP) Tanks/Vessels
ASTM F 441/F 441M	(2009) Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80

HYDRAULIC INSTITUTE (HI)

HI 7.1-7.5	(2002) Controlled Volume Metering Pumps
HI 9.1-9.5	(2000) Pumps - General Guidelines for Types, Applications, Definitions, Sound Measurements and Documentation

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 1	(2000; R 2005; R 2008) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; Add/Errata 2000; Errata 2006; R 2005; Errata 2008) Standard for Controllers, Contactors, and Overload Relays Rated 600 V

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 37	(2010; TIA 10-1) Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines
NFPA 70	(2011) National Electrical Code

NSF INTERNATIONAL (NSF)

NSF/ANSI 60	(2009a) Drinking Water Treatment Chemicals - Health Effects
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PLUMBING-HEATING-COOLING CONTRACTORS NATIONAL ASSOCIATION (PHCC)

NAPHCC NSPC	(2009) National Standard Plumbing Code
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UNDERWRITERS LABORATORIES (UL)

UL 50	(2007) Enclosures for Electrical Equipment, Non-environmental Considerations
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1.2 SYSTEM DESCRIPTION

Provide a **chemical feed system** consisting of a chemical supply storage tank from which the chemical solution is pumped through piping or tubing, as appropriate, to the point of application. Include with each chemical feed system controlled volume pumps, tanks, mixers, gauges, back pressure regulators, strainers, pressure relief valves, sight glasses and flow metering devices, check valves, and hand valves.

1.2.1 Design Requirements

Design and fabrication of the pumps shall be in accordance with **HI 7.1-7.5** and **HI 9.1-9.5** except as modified herein. Pump stands and platforms shall be adequate to support the pumping system.

1.2.2 Performance Requirements

Capacity and design of the chemical feed systems and accessories shall be suitable for 24-hour full load service in ambient, non freezing conditions.

1.3 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. 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.

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 piping, wiring, schematic, flow 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 installation, maintenance and operation.

SD-03 Product Data

Chemical Feed System[; G][; G, [____]]

Manufacturer's descriptive and technical literature, catalog cuts, performance charts, and pump curves. List of materials, list of equipment, including a complete list of parts and supplies

with current unit prices and source of supply. List of special tools for each type of equipment furnished including special tools necessary for adjustment, operation, maintenance, and disassembly.

Material Safety Data Sheets

Material safety data sheets, as specified.

Framed Instructions

Installation instructions and framed instructions.

Auxiliary Equipment and Spare Parts

List of parts recommended by the manufacturer to be replaced after [1] [and] [3] [year] [years] service.

SD-06 Test Reports

Factory Test Report

A copy of the ASTM E 1067 test report with each fiberglass tank.

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

SD-07 Certificates

Chemicals

[Two] [_____] copies of certification stating that each chemical supplied meets the specified requirements.

SD-10 Operation and Maintenance Data

Operating and Maintenance Instructions

[Six] [_____] complete copies of operating instructions outlining the step-by-step procedures required for system startup, operation and shutdown. Include in the instructions the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Also include in the instructions as-built drawings of the piping layout, equipment layout, simplified wiring and control diagrams of the system as installed, and flow diagrams.

[Six] [_____] complete copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and trouble-shooting guides.

1.4 DELIVERY, STORAGE, AND HANDLING

Protect material and equipment delivered and placed in storage from the weather, excessive humidity and excessive temperature variation, dirt,

dust, or other contaminants.

1.5 EXTRA MATERIALS

NOTE: Include items needed for future maintenance
and repair, items that might be difficult to obtain
because of color or pattern match, or spare parts
needed to ensure continued operation of critical
equipment.

Concurrent with delivery and installation of the specified equipment,
furnish auxiliary equipment and spare parts as follows:

- a. Spare parts for each different item of material and equipment specified including all of the parts recommended by the manufacturer to be replaced after [1] [and] [3] [year] [years] service.
- b. For each machine: one extra of each part used that is made from glass, hard rubber, or clear plastic; one extra set of solution-hose connections; one extra set of diaphragms, two filler plug seal washers; two ball checks; two seats; two complete sets of all gaskets; one spare diaphragm for each back pressure regulator; one hydraulic plunger assembly for each different size metering pump; one of each type of material back pressure regulator, with three spare springs and fluorocarbon resin diaphragms for each; one spare diaphragm and air valve for pulsation dampener.
- c. For each different size of direct current motor one SCR circuit board with 12 drive motor fuses and 12 SCR controller fuses; overload replacement elements for each size and type of motor.
- d. One set of special tools for each type of equipment including calibration devices, and instruments required for adjustment, calibration, disassembly, operation, and maintenance of the equipment.
- e. One residual-chlorine comparator employing permanent color standards and 13- or 26-millimeter viewing depth sample tubes, with corrosion-resistant case, color disk reading from 0.0 to 1 part per million, and sufficient DPD tablets for 100 tests.
- f. Two pairs of safety goggles and/or face shields, two chemical resistant aprons, and two pairs of chemical resistant gloves in one or more wall mounted steel cases.
- g. One assembly tool for tubular diaphragm.
- h. One lever type grease gun or other lubricating device for each type of grease required.
- i. One or more steel tool cases mounted on the wall in a convenient location complete with flat key locks, two keys, and clips or hooks to hold each special tool.
- j. [_____].

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

NOTE: Review the materials recommendations of EM
1110-1-4008 Liquid Process Piping, Appendix B.

2.1.1 Standard Products

Provide materials 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

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 CHEMICALS

NOTE: Consider the environmental consequences of each chemical, including disposal of precipitated solids and other wastes. Chemicals need not be required to meet AWWA or NSF specifications for waste water applications, use other available industrial/commercial standards.

Submit [Material Safety Data Sheets](#) in conformance with [ANSI Z400.1](#) for each chemical. A [30] [90] [_____] day supply at the maximum pumping rate for each feeder or pair of duplexed feeders shall be provided. Chemicals shall conform to the following:

2.2.1 Acids

Hydrochloric (muratic acid), sulphuric (sulfuric acid).

2.2.2 Adsorption Agents

[AWWA B600](#) powdered activated carbon.

2.2.3 Bases

[AWWA B501](#) caustic soda, [AWWA B511](#) potassium hydroxide, [AWWA B201](#) soda ash (sodium carbonate).

2.2.4 Biocides

Glutaraldehyde; Tolcide(R); [AWWA B602](#) copper sulfate.

2.2.5 Coagulant Aids

Anionic polyelectrolytes, cationic polyelectrolytes.

2.2.6 Disinfecting Agents

AWWA B302 ammonium sulfate, AWWA B300 hypochlorites.

2.2.7 Miscellaneous

AWWA B451 poly(diallyldimethylammonium chloride), AWWA B452 EPI-DMA polyamines, AWWA B453 polyacrylamide, AWWA B550 calcium chloride, AWWA B405 sodium aluminate, AWWA B601 sodium metabisulfite (Sodium Pyrosulfite), AWWA B303 sodium chlorite, AWWA B404 liquid sodium silicate, AWWA B504 monosodium phosphate, anhydrous, AWWA B408 polyaluminum chloride, AWWA B505 disodium phosphate, anhydrous.

2.2.8 Oxidants

[50] [35] [_____] % NSF/ANSI 60 hydrogen peroxide solution, AWWA B603 potassium permanganate [potassium permanganate may be supplied in powder form for onsite preparation] at the discretion of the Contracting Officer.

2.2.9 Precipitants

[_____] .

2.2.10 Primary Coagulants

AWWA B403 aluminum sulfate, AWWA B407 liquid ferric chloride, AWWA B406 ferric sulfate, AWWA B402 ferrous sulfate.

2.2.11 Prophylaxis

AWWA B703 hydrofluosilicic acid, AWWA B701 sodium fluoride, AWWA B702 sodium silicofluoride.

2.2.12 Sequestrants

AWWA B502 sodium polyphosphate, glassy (sodium hexametaphosphate), AWWA B503 sodium tripolyphosphate.

2.3 CONTROLLED VOLUME PUMPS

NOTE: See HI 7.1-7.5 to determine the optimum type of metering pumps with capacities between 0.04 liters per hour (0.011 gph) and 10,000 liters per hour (2500 gph). Materials for each pump shall be as recommended in Table 9.3 of HI 9.1-9.5 for the material to be pumped. If the system backpressure is not at least 5 psi (0.35 bar) greater than the suction pressure, a backpressure valve must be installed in the discharge piping to prevent flowthrough (downhill pumping) which contributes to pump failure and undesired flow at pump shutdown. System backpressure must not exceed the rated discharge pressure of the pump.

Pumps shall be controlled volume pumps as defined by HI 7.1-7.5. Each pump shall be capable of delivering chemical solution at any rate from the minimum flow rate to the maximum flow rate and shall be capable of continuous operation at rated capacity. Accuracy shall be plus or minus 2 percent over a 100 to 1 range from the required maximum capacity to the minimum pumping rate. Net positive suction head required shall not exceed 90 percent of the net positive suction head available, as installed. Construction shall be as simple as practicable to provide equipment isolation, bypass and reliable service and to be readily accessible for inspection, cleaning, adjustment, repairs, and replacements.

2.3.1 Acid Feed System

The following shall be provided for [hydrochloric] [sulfuric] [_____] acid solution delivery.

- a. Concentration: Minimum [_____] percent; maximum [_____] percent.
- b. Number of pumps: [_____].
- c. Type of pump: [Packed plunger] [Packed piston] [Mechanically or hydraulically coupled diaphragm].
- d. Configuration: [Simplex] [Duplex] [Multiplex].
- e. Controls: [Automatic] [Semiautomatic] [Manual] rate adjustment.
- f. Feed/flow rate: Minimum [_____] L/hour gph; maximum [_____] L/hour gph.
- g. Back pressure at point of injection: [_____] kPa psig. Back pressure regulating valve shall be installed on the pump discharge and shall be factory adjusted to crack open at [_____] kPa psig. Regulators shall be of [polyvinyl chloride] [or] [_____] construction with [fluorocarbon resin] [or] [chlorosulphonated polyethylene] diaphragms.
- h. Suction valve cartridge: [Single] [Double] [Slurry type] ball check.
- i. Discharge valve cartridge: [Single] [Double] [Slurry type] ball check.
- j. Materials of construction allowed for wetted parts: [Type [304L] [316] [316L] stainless steel,] [PVC,] [hypalon] [nylon,] [fluorocarbon resin,] [chlorosulfonated polyethylene,] [hard rubber,] [_____].

2.3.2 Adsorption Agent Feed Systems

The following shall be provided for [powdered activated carbon] [_____] slurry delivery.

- a. Concentration: Minimum [_____] percent; maximum [_____] percent.
- b. Number of pumps: [_____].
- c. Type of pump: [Packed plunger] [Packed piston] [Mechanically or hydraulically coupled diaphragm].

- d. Configuration: [Simplex] [Duplex] [Multiplex].
- e. Controls: [Automatic] [Semiautomatic] [Manual] rate adjustment.
- f. Feed/flow rate: Minimum [_____] L/hour gph; maximum [_____] L/hour gph.
- g. Back pressure at point of injection: [_____] kPa psig. Back pressure regulating valve shall be installed on the pump discharge and shall be factory adjusted to crack open at [_____] kPa psig. Regulators shall be of [polyvinyl chloride] [or] [_____] construction with [fluorocarbon resin] [or] [chlorosulphonated polyethylene] diaphragms.
- h. Suction valve cartridge: [Single] [Double] [Slurry type] ball check.
- i. Discharge valve cartridge: [Single] [Double] [Slurry type] ball check.
- j. Materials of construction allowed for wetted parts: [Type [304L] [316] [316L] stainless steel,] [PVC,] [hypalon] [nylon,] [fluorocarbon resin,] [chlorosulfonated polyethylene,] [hard rubber,] [_____] .

2.3.3 Base Feed System

The following shall be provided for [sodium carbonate (soda ash)] [sodium hydroxide (caustic soda)] [_____] solution delivery.

- a. Concentration: Minimum [_____] percent; maximum [_____] percent.
- b. Number of pumps: [_____] .
- c. Type of pump: [Packed plunger] [Packed piston] [Mechanically or hydraulically coupled diaphragm] .
- d. Configuration: [Simplex] [Duplex] [Multiplex] .
- e. Controls: [Automatic] [Semiautomatic] [Manual] rate adjustment.
- f. Feed/flow rate: Minimum [_____] L/hour gph; maximum [_____] L/hour gph.
- g. Back pressure at point of injection: [_____] kPa psig. Back pressure regulating valve shall be installed on the pump discharge and shall be factory adjusted to crack open at [_____] kPa psig. Regulators shall be of [polyvinyl chloride] [or] [_____] construction with [fluorocarbon resin] [or] [chlorosulphonated polyethylene] diaphragms.
- h. Suction valve cartridge: [Single] [Double] [Slurry type] ball check.
- i. Discharge valve cartridge: [Single] [Double] [Slurry type] ball check.
- j. Materials of construction allowed for wetted parts: [Type [304L] [316] [316L] stainless steel,] [PVC,] [hypalon] [nylon,] [fluorocarbon

resin,] [chlorosulfonated polyethylene,] [hard rubber,] [____].

2.3.4 Biocide Feed System

The following shall be provided for [copper sulfate] [____] solution delivery.

- a. Concentration: Minimum [____] percent; maximum [____] percent.
- b. Number of pumps: [____].
- c. Type of pump: [Packed plunger] [Packed piston] [Mechanically or hydraulically coupled diaphragm].
- d. Configuration: [Simplex] [Duplex] [Multiplex].
- e. Controls: [Automatic] [Semiautomatic] [Manual] rate adjustment.
- f. Feed/flow rate: Minimum [____] L/hour gph; maximum [____] L/hour gph.
- g. Back pressure at point of injection: [____] kPa psig. Back pressure regulating valve shall be installed on the pump discharge and shall be factory adjusted to crack open at [____] kPa psig. Regulators shall be of [polyvinyl chloride] [or] [____] construction with [fluorocarbon resin] [or] [chlorosulphonated polyethylene] diaphragms.
- h. Suction valve cartridge: [Single] [Double] [Slurry type] ball check.
- i. Discharge valve cartridge: [Single] [Double] [Slurry type] ball check.
- j. Materials of construction allowed for wetted parts: [Type [304L] [316] [316L] stainless steel,] [PVC,] [hypalon] [nylon,] [fluorocarbon resin,] [chlorosulfonated polyethylene,] [hard rubber,] [____].

2.3.5 Coagulant Aid Feed System

The following shall be provided for [polyelectrolyte] [____] [solution] [slurry] delivery.

- a. Concentration: Minimum [____] percent; maximum [____] percent.
- b. Number of pumps: [____].
- c. Type of pump: [Packed plunger] [Packed piston] [Mechanically or hydraulically coupled diaphragm].
- d. Configuration: [Simplex] [Duplex] [Multiplex].
- e. Controls: [Automatic] [Semiautomatic] [Manual] rate adjustment.
- f. Feed/flow rate: Minimum [____] L/hour gph; maximum [____] L/hour gph.
- g. Back pressure at point of injection: [____] kPa psig. Back pressure regulating valve shall be installed on the pump discharge and

shall be factory adjusted to crack open at [_____] kPa psig. Regulators shall be of [polyvinyl chloride] [or] [_____] construction with [fluorocarbon resin] [or] [chlorosulphonated polyethylene] diaphragms.

h. Suction valve cartridge: [Single] [Double] [Slurry type] ball check.

i. Discharge valve cartridge: [Single] [Double] [Slurry type] ball check.

j. Materials of construction allowed for wetted parts: [Type [304L] [316] [316L] stainless steel,] [PVC,] [hypalon] [nylon,] [fluorocarbon resin,] [chlorosulfonated polyethylene,] [hard rubber,] [_____] .

2.3.6 Disinfecting Agent Feed Systems

The following shall be provided for [ammonium sulfate] [hypochlorite] [_____] solution delivery.

a. Concentration: Minimum [_____] percent; maximum [_____] percent.

b. Number of pumps: [_____] .

c. Type of pump: [Packed plunger] [Packed piston] [Mechanically or hydraulically coupled diaphragm] .

d. Configuration: [Simplex] [Duplex] [Multiplex] .

e. Controls: [Automatic] [Semiautomatic] [Manual] rate adjustment.

f. Feed/flow rate: Minimum [_____] L/hour gph; maximum [_____] L/hour gph.

g. Back pressure at point of injection: [_____] kPa psig. Back pressure regulating valve shall be installed on the pump discharge and shall be factory adjusted to crack open at [_____] kPa psig. Regulators shall be of [polyvinyl chloride] [or] [_____] construction with [fluorocarbon resin] [or] [chlorosulphonated polyethylene] diaphragms.

h. Suction valve cartridge: [Single] [Double] [Slurry type] ball check.

i. Discharge valve cartridge: [Single] [Double] [Slurry type] ball check.

j. Materials of construction allowed for wetted parts: [Type [304L] [316] [316L] stainless steel,] [PVC,] [hypalon] [nylon,] [fluorocarbon resin,] [chlorosulfonated polyethylene,] [hard rubber,] [_____] .

2.3.7 Miscellaneous Feed System

The following shall be provided for [poly(diallyldimethylammonium chloride)] [calcium chloride] [sodium aluminate] [sodium metabisulfite (sodium pyrosulfite)] [sodium chlorite] [sodium silicate] [monosodium phosphate] [disodium phosphate] [_____] [solution] [slurry] delivery.

a. Concentration: Minimum [_____] percent; maximum [_____] percent.

- b. Number of pumps: [____].
- c. Type of pump: [Packed plunger] [Packed piston] [Mechanically or hydraulically coupled diaphragm].
- d. Configuration: [Simplex] [Duplex] [Multiplex].
- e. Controls: [Automatic] [Semiautomatic] [Manual] rate adjustment.
- f. Feed/flow rate: Minimum [____] L/hour gph; maximum [____] L/hour gph.
- g. Back pressure at point of injection: [____] kPa psig. Back pressure regulating valve shall be installed on the pump discharge and shall be factory adjusted to crack open at [____] kPa psig. Regulators shall be of [polyvinyl chloride] [or] [____] construction with [fluorocarbon resin] [or] [chlorosulphonated polyethylene] diaphragms.
- h. Suction valve cartridge: [Single] [Double] [Slurry type] ball check.
- i. Discharge valve cartridge: [Single] [Double] [Slurry type] ball check.
- j. Materials of construction allowed for wetted parts: [Type [304L] [316] [316L] stainless steel,] [PVC,] [hypalon] [nylon,] [fluorocarbon resin,] [chlorosulfonated polyethylene,] [hard rubber,] [____].

2.3.8 Oxidant Feed System

The following shall be provided for [potassium permanganate] [hydrogen peroxide] [____] solution delivery.

- a. Concentration: Minimum [____] percent; maximum [____] percent.
- b. Number of pumps: [____].
- c. Type of pump: [Packed plunger] [Packed piston] [Mechanically or hydraulically coupled diaphragm].
- d. Configuration: [Simplex] [Duplex] [Multiplex].
- e. Controls: [Automatic] [Semiautomatic] [Manual] rate adjustment.
- f. Feed/flow rate: Minimum [____] L/hour gph; maximum [____] L/hour gph.
- g. Back pressure at point of injection: [____] kPa psig. Back pressure regulating valve shall be installed on the pump discharge and shall be factory adjusted to crack open at [____] kPa psig. Regulators shall be of [polyvinyl chloride] [or] [____] construction with [fluorocarbon resin] [or] [chlorosulphonated polyethylene] diaphragms.
- h. Suction valve cartridge: [Single] [Double] [Slurry type] ball check.

- i. Discharge valve cartridge: [Single] [Double] [Slurry type] ball check.
- j. Materials of construction allowed for wetted parts: [Type [304L] [316] [316L] stainless steel,] [PVC,] [hypalon] [nylon,] [fluorocarbon resin,] [chlorosulfonated polyethylene,] [hard rubber,] [____].

2.3.9 Precipitant Feed System

The following shall be provided for [____] solution delivery.

- a. Concentration: Minimum [____] percent; maximum [____] percent.
- b. Number of pumps: [____].
- c. Type of pump: [Packed plunger] [Packed piston] [Mechanically or hydraulically coupled diaphragm].
- d. Configuration: [Simplex] [Duplex] [Multiplex].
- e. Controls: [Automatic] [Semiautomatic] [Manual] rate adjustment.
- f. Feed/flow rate: Minimum [____] L/hour gph; maximum [____] L/hour gph.
- g. Back pressure at point of injection: [____] kPa psig. Back pressure regulating valve shall be installed on the pump discharge and shall be factory adjusted to crack open at [____] kPa psig. Regulators shall be of [polyvinyl chloride] [or] [____] construction with [fluorocarbon resin] [or] [chlorosulphonated polyethylene] diaphragms.
- h. Suction valve cartridge: [Single] [Double] [Slurry type] ball check.
- i. Discharge valve cartridge: [Single] [Double] [Slurry type] ball check.
- j. Materials of construction allowed for wetted parts: [Type [304L] [316] [316L] stainless steel,] [PVC,] [hypalon] [nylon,] [fluorocarbon resin,] [chlorosulfonated polyethylene,] [hard rubber,] [____].

2.3.10 Primary Coagulant Feed System

The following shall be provided for [aluminum sulfate] [ferric chloride] [ferric sulfate] [ferrous sulfate] [____] solution delivery.

- a. Concentration: Minimum [____] percent; maximum [____] percent.
- b. Number of pumps: [____].
- c. Type of pump: [Packed plunger] [Packed piston] [Mechanically or hydraulically coupled diaphragm].
- d. Configuration: [Simplex] [Duplex] [Multiplex].
- e. Controls: [Automatic] [Semiautomatic] [Manual] rate adjustment.
- f. Feed/flow rate: Minimum [____] L/hour gph; maximum [____] L/hour gph.

gph.

g. Back pressure at point of injection: [_____] kPa psig. Back pressure regulating valve shall be installed on the pump discharge and shall be factory adjusted to crack open at [_____] kPa psig. Regulators shall be of [polyvinyl chloride] [or] [_____] construction with [fluorocarbon resin] [or] [chlorosulphonated polyethylene] diaphragms.

h. Suction valve cartridge: [Single] [Double] [Slurry type] ball check.

i. Discharge valve cartridge: [Single] [Double] [Slurry type] ball check.

j. Materials of construction allowed for wetted parts: [Type [304L] [316] [316L] stainless steel,] [PVC,] [hypalon] [nylon,] [fluorocarbon resin,] [chlorosulfonated polyethylene,] [hard rubber,] [_____] .

2.3.11 Prophylaxis Feed System

The following shall be provided for [hydrofluosilicic acid] [sodium fluoride] [sodium silicofluoride] [_____] solution delivery.

a. Concentration: Minimum [_____] percent; maximum [_____] percent.

b. Number of pumps: [_____] .

c. Type of pump: [Packed plunger] [Packed piston] [Mechanically or hydraulically coupled diaphragm] .

d. Configuration: [Simplex] [Duplex] [Multiplex] .

e. Controls: [Automatic] [Semiautomatic] [Manual] rate adjustment.

f. Feed/flow rate: Minimum [_____] L/hour gph; maximum [_____] L/hour gph.

g. Back pressure at point of injection: [_____] kPa psig. Back pressure regulating valve shall be installed on the pump discharge and shall be factory adjusted to crack open at [_____] kPa psig. Regulators shall be of [polyvinyl chloride] [or] [_____] construction with [fluorocarbon resin] [or] [chlorosulphonated polyethylene] diaphragms.

h. Suction valve cartridge: [Single] [Double] [Slurry type] ball check.

i. Discharge valve cartridge: [Single] [Double] [Slurry type] ball check.

j. Materials of construction allowed for wetted parts: [Type [304L] [316] [316L] stainless steel,] [PVC,] [hypalon] [nylon,] [fluorocarbon resin,] [chlorosulfonated polyethylene,] [hard rubber,] [_____] .

2.3.12 Sequestrant Feed Systems

The following shall be provided for [sodium polyphosphate, glassy (sodium hexametaphosphate)] [sodium tripolyphosphate] [_____] solution delivery.

- a. Concentration: Minimum [_____] percent; maximum [_____] percent.
- b. Number of pumps: [_____].
- c. Type of pump: [Packed plunger] [Packed piston] [Mechanically or hydraulically coupled diaphragm].
- d. Configuration: [Simplex] [Duplex] [Multiplex].
- e. Controls: [Automatic] [Semiautomatic] [Manual] rate adjustment.
- f. Feed/flow rate: Minimum [_____] L/hour gph; maximum [_____] L/hour gph.
- g. Back pressure at point of injection: [_____] kPa psig. Back pressure regulating valve shall be installed on the pump discharge and shall be factory adjusted to crack open at [_____] kPa psig. Regulators shall be of [polyvinyl chloride] [or] [_____] construction with [fluorocarbon resin] [or] [chlorosulphonated polyethylene] diaphragms.
- h. Suction valve cartridge: [Single] [Double] [Slurry type] ball check.
- i. Discharge valve cartridge: [Single] [Double] [Slurry type] ball check.
- j. Materials of construction allowed for wetted parts: [Type [304L] [316] [316L] stainless steel,] [PVC,] [hypalon] [nylon,] [fluorocarbon resin,] [chlorosulfonated polyethylene,] [hard rubber,] [_____].

2.4 CONTROLS

NOTE: Proportional control is appropriate for variable flow systems. Batch systems should have manual, pH, ORP, or timer control. Constant pumping rate systems should respond to pump operation or a flow switch, if the pumps are remote from the feed system.

The chemical metering equipment shall be provided with the appurtenances and accessories, as required, for flow capacity adjustment. Manual range adjustment shall be provided on all systems.

2.4.1 Automatic Control

Automatic control shall have the capability to vary feed rate based on signals from a [flow], [oxidation-reduction potential (ORP)], [or] [pH] meter or controller.

2.4.1.1 Flow meter and Controller

The chemical dosage shall vary in proportion to the measured flow with the dosage per flow unit manually adjustable.

2.4.1.2 Oxidation-Reduction Potential Probe

Oxidation-reduction potential probe shall be located where indicated on the drawings. Chemical feed rate shall be variable in response to the deviation from set point.

2.4.1.3 pH Probe

pH probe shall be located where indicated on the drawings. Chemical feed rate shall be variable in response to the deviation from set point.

2.4.2 Semiautomatic Control

Semiautomatic control shall have the capability to automatically start and stop the chemical metering equipments. The pump start and stop shall respond to [flow switch] [or] [pump operation] [or] [timer] status. Flow switch for semiautomatic operation shall be installed in the pipe line upstream of chemical injectors.

2.4.3 Manual Control

Nonautomatic control shall have the capability for starting or stopping the chemical metering equipment and adjustment of the solution feed rate by the operator. Semicontinuous operation shall be provided for where intermittent dosages may be desired (for example control of biocide addition where periodic (shock) treatment is sufficient or preferred).

2.5 DRIVES FOR CONTROLLED VOLUME PUMPS

NOTE: Alternating current motors are preferred where a reliable power supply is accessible. Water power drives are feasible only when the take off can be located at a point with significantly higher pressure than the injection pressure.

The metering pumps shall be supplied with and driven by [water pressure] [alternating current electric motor] [direct current electric motor] [plant air] [gasoline engine] drives.

2.5.1 Water Pressure Drive

Appropriate pressure regulation devices shall be provided for water pressure drives operated off system water pressures.

2.5.2 Electric Motor Drive

Electric motor shall be of sufficient capacity to operate the chemical metering equipment under all operating conditions without exceeding their rated nameplate current or power, or their specified temperature limits. The motors shall have starting characteristics and ruggedness necessary under the actual conditions of operations or clean-up procedures used in the areas where they will be located. Alternating current motors with power rating of 248.6 W 1/3 hp or less shall be 115 volts, single-phase, 60-Hz service; motors with power rating in excess of 248.6 W 1/3 hp shall be 460 volts, three-phase, 60-Hz service. Electrical features of direct current motors, including the ratings of the motors, shall be compatible with the capabilities and ratings of the rectifier controllers with which

they are used.

2.5.3 Gasoline Engine Drive

Gasoline engines shall develop sufficient horsepower to operate the chemical metering equipment continuously under the maximum operation conditions without overheating or overloading when operating at a speed not to exceed [_____] rpm. The engines shall be of the 4-cycle, vertical, single cylinder, high tension magneto, air cooled type. The engine shall be connected to the pump or mechanical device by V-belts and shall be fully guarded.

2.6 CALIBRATION STANDPIPES

Chemical chemical metering equipment shall be provided with a calibration standpipe for measuring pump output. The standpipe shall allow convenient observation of the change of fluid level for at least 1/2 minute at full stroke and maximum speed settings, and shall be Schedule 80, clear PVC pipe conforming to [ASTM D 1785](#) with Schedule 80 fittings equipped with a flanged connection to the pump manifold and an end cap fitted with a PVC vacuum breaker and ball valve for air venting. The standpipe shall have a clear, observable length of at least [\[300 mm 12 inches\]](#) [_____] and shall be permanently calibrated in [liters gallons](#) and fractions thereof, to allow reading of the fluid contents with an accuracy of [1] [_____] percent.

2.7 VALVES

2.7.1 Metering Pump Valves

The metering pump shall be equipped with adjustable internal vacuum and pressure relief valve, hydraulic oil refill valve, and automatic air bleed valve. The relief valve shall be adjustable over the full pressure range of the pump and shall be preset at the factory.

2.7.2 Suction and Discharge Valves

Suction and discharge valve cartridges shall be fitted with ball checks that open to full pipe diameter.

2.7.3 Back Pressure Valve

Back pressure regulating valve shall be installed on the pump discharge and factory adjusted to crack open at the indicated pressure. Diaphragms shall be spring opposed with loading pressures adjustable by means of a screw in the top works.

2.7.4 Pulsation Dampeners

NOTE: The pulsation dampener should always be installed as close to the pumps as possible in order to reduce the length of pipe in which pulsating flow occurs. A pulsation dampener is a pneumatically charged diaphragm within a chamber that stores energy carried in the acceleration of the pumped fluid. On the discharge side it will protect sensitive equipment from pulsating flow spikes, and will translate pulsating flow to near linear flow by reducing the peak flow and pressure generated by the

metering pump. When a pulsating dampener is used on the suction side of a metering pump, it will improve suction pressure conditions by reducing pressure losses associated with the acceleration of the fluid.

Pulsation dampeners shall be suitably sized for the displacement of each pump. Pulsation dampeners shall have a diaphragm separating the upper chamber from the lower chamber. The upper chamber shall be charged with compressed air to 50 percent of the expected line pressure. The diaphragm shall be of molded construction and shall prevent the air charge from being dissolved in the process fluid. The lower chamber shall be [plastic] [or] [lined with inert plastic material] to prevent corrosion by the process fluid. The upper chamber shall be equipped with a tire valve type charging valve and air pressure gauge. An air line and air hose with pressure regulator and hand-operated, lever-type valve suitable for charging the pulsation dampers shall also be provided.

2.8 SOLUTION TANKS

Tanks shall be fully resistant to the effects of the full-strength and fully diluted solution concentrations. Tanks shall be pressure rated for 1.5 times the weight of solution at full capacity. Each tank shall have the capacity listed and shall be equipped with a fill nozzle, vent, discharge, level instrument, drain, and two spare connections. Tanks shall be reinforced to withstand all forces when full of solution. Tanks shall be completely shop fabricated with no field assembly permitted. Drain connections shall provide complete drainage of the tank. All gaskets shall be fluorocarbon elastomer; nuts and bolts shall be Type 316 stainless steel; and steel supports shall be either stainless or epoxy coated. Each tank shall be furnished with a calibrated side wall strip to indicate volume. A permanent plastic sign indicating the tank contents shall be attached to the front of each tank. Tanks smaller than 900 mm 36 inches in diameter shall be fitted with removable lids. Tanks larger than 900 mm 36 inches in diameter shall be fitted with 600 mm 24 inch manways. Polyethylene tanks shall be manufactured in accordance with ASTM D 1998. Fiberglass tanks shall be manufactured in accordance with ASTM D 3299 with flanged openings in accordance with ASTM D 5421. Steel tanks shall be lined with [ceramic], [rubber] or [plastic], as indicated herein. Tanks designated to be double walled or provided with secondary containment shall be provided with containment separate from the containment provided for other tanks to prevent reaction within the contained area. Dissolving baskets and tank mixers shall be provided as indicated and shall be sized to provide initial mixing and to maintain suspensions. Floating seals shall be provided as indicated.

2.8.1 Acid Tank

Tank shall be [hydrochloric] [sulfuric] acid solution resistant and comply with the following:

- a. Number of tanks: [____].
- b. Minimum tank capacity: [____] liters gal.
- c. Sign shall read: "DANGER - [HYDROCHLORIC] [SULFURIC] ACID SOLUTION."
- d. Mixer: [Constant] [Variable] speed [____] rpm, maximum.

- e. Dissolving basket: [____].
- f. Floating seal: [____].
- g. Containment: Double wall/secondary containment.

2.8.2 Adsorption Agent Tank

Tank shall be [powdered activated carbon] [____] slurry resistant and comply with the following:

- a. Number of tanks: [____].
- b. Minimum tank capacity: [____] **liters gal.**
- c. Sign shall read: [____].
- d. Mixer: [Constant] [Variable] speed [____] rpm, maximum.
- e. Dissolving basket: [____].
- f. Floating seal: [____].
- g. Containment: Double wall/secondary containment.

2.8.3 Base Tank

Tank shall be [sodium hydroxide (caustic soda)] [____] solution resistant and shall comply with the following:

- a. Number of tanks: [____].
- b. Minimum tank capacity: [____] **liters gal.**
- c. Sign shall read: "DANGER - ALKALI (SODIUM HYDROXIDE) SOLUTION."
- d. Mixer: [Constant] [Variable] speed [____] rpm, maximum.
- e. Dissolving basket: [____].
- f. Floating seal: [____].
- g. Containment: Double wall/secondary containment.

2.8.4 Biocide Tank

Tank shall be [copper sulfate] [Tolcide(R)] [Glutaraldehyde] [____] solution resistant and shall comply with the following:

- a. Number of tanks: [____].
- b. Minimum tank capacity: [____] **liters gal.**
- c. Sign shall read: [____].
- d. Mixer: [Constant] [Variable] speed [____] rpm, maximum.
- e. Dissolving basket: [____].

- f. Floating seal: [____].
- g. Containment: Double wall/secondary containment.

2.8.5 Coagulant Aid Tank

NOTE: Polyelectrolytes degrade with storage.

Tank shall be [polyelectrolyte] [____] solution resistant and shall comply with the following:

- a. Number of tanks: [____].
- b. Minimum tank capacity: [____] liters gal.
- c. Sign shall read: "CAUTION - [POLYELECTROLYTE SOLUTION - SLIP HAZARD] [____]."
- d. Mixer: [Constant] [Variable] speed [____] rpm, maximum.
- e. Dissolving basket: [____].
- f. Floating seal: [____].
- g. Containment: Double wall/secondary containment.

2.8.6 Disinfecting Agent Tank

Tank shall be [ammonium sulfate] [hypochlorite] solution resistant and shall comply with the following:

- a. Number of tanks: [____].
- b. Minimum tank capacity: [____] liters gal.
- c. Sign shall read: "[____]."
- d. Mixer: [Constant] [Variable] speed [____] rpm, maximum.
- e. Dissolving basket: [____].
- f. Floating seal: [____].
- g. Containment: Double wall/secondary containment.

2.8.7 Miscellaneous Tanks

Tanks shall be [poly(diallyldimethylammonium chloride)] [calcium chloride] [sodium aluminate] [sodium metabisulfite (sodium pyrosulfite)] [sodium chlorite] [sodium silicate] [monosodium phosphate] [disodium phosphate] solution resistant and shall comply with the following:

- a. Number of tanks: [____].
- b. Minimum tank capacity: [____] liters gal.

- c. Sign shall read: [____].
- d. Mixer: [Constant] [Variable] speed [____] rpm, maximum.
- e. Dissolving basket: [____].
- f. Floating seal: [____].
- g. Containment: Double wall/secondary containment.

2.8.8 Oxidant Tank

Tank shall be [hydrogen peroxide] [potassium permanganate] solution resistant and shall comply with the following:

- a. Number of tanks: [____].
- b. Minimum tank capacity: [____] liters gal.
- c. Sign shall read: ["DANGER - STRONG OXIDIZER"] [____].
- d. Mixer: [Constant] [Variable] speed [____] rpm, maximum.
- e. Dissolving basket: [____].
- f. Floating seal: [____].
- g. Containment: Double wall/secondary containment.

2.8.9 Precipitant Tank

Tank shall be [____] solution resistant and shall comply with the following:

- a. Number of tanks: [____].
- b. Minimum tank capacity: [____] liters gal.
- c. Sign shall read: [____].
- d. Mixer: [Constant] [Variable] speed [____] rpm, maximum.
- e. Dissolving basket: [____].
- f. Floating seal: [____].
- g. Containment: Double wall/secondary containment.

2.8.10 Primary Coagulant Tank

Tank shall be [aluminum sulfate] [ferric chloride] [ferric sulfate] [ferrous sulfate] solution resistant and shall comply with the following:

- a. Number of tanks: [____].
- b. Minimum tank capacity: [____] liters gal.
- c. Sign shall read: [____].

- d. Mixer: [Constant] [Variable] speed [_____] rpm, maximum.
- e. Dissolving basket: [_____] .
- f. Floating seal: [_____] .
- g. Containment: Double wall/secondary containment.

2.8.11 Prophylaxis Tank

Tank shall be [hydrofluosilicic acid] [sodium fluoride] [sodium silicofluoride] solution resistant and shall comply with the following:

- a. Number of tanks: [_____] .
- b. Minimum tank capacity: [_____] **liters gal.**
- c. Sign shall read: [_____] .
- d. Mixer: [Constant] [Variable] speed [_____] rpm, maximum.
- e. Dissolving basket: [_____] .
- f. Floating seal: [_____] .
- g. Containment: Double wall/secondary containment.

2.8.12 Sequestrant Tank

NOTE: Polyelectrolytes degrade with storage.

Tank shall be [sodium polyphosphate, glassy (sodium hexametaphosphate)] [sodium tripolyphosphate] solution resistant and shall comply with the following:

- a. Number of tanks: [_____] .
- b. Minimum tank capacity: [_____] **liters gal.**
- c. Sign shall read: "CAUTION - [SODIUM HEXAMETAPHOSPHATE] [SODIUM TRIPOLYPHOSPHATE] SOLUTION - SLIP HAZARD."
- d. Mixer: [Constant] [Variable] speed [_____] rpm, maximum.
- e. Dissolving basket: [_____] .
- f. Floating seal: [_____] .
- g. Containment: Double wall/secondary containment.

2.9 PRESSURE GAUGES

Gauges shall be diaphragm type with Bourdon tube and diaphragm compartments filled completely with oil, and shall be made of materials suitable for the application. Diaphragm seals shall be installed at each gauge connection to isolate gauges from corrosion, sludge or other hazards of the process fluid. Seal material shall be compatible with the oil in the gauge and the

process fluid.

2.10 INJECTORS

Injectors for chemical solution shall be introduced into the pipeline mains by means of a [hard rubber] [or] [plastic] injection nozzle, or by means of a suitable diffuser tube inserted through a corporation cock. The device for introducing the solution into a pressure main shall be constructed in such a way that accidental breakage of discharge hose or tubing will not cause water to escape from the pipeline, and will allow disassembling of the unit without leakage.

2.11 PIPING

2.11.1 Backflow Preventer

Backflow prevention devices or air gaps shall be provided on tank fill lines in accordance with NAPHCC NSPC.

2.11.2 Chemical Solution Piping

**NOTE: Select materials in accordance with EM
1110-1-4008 Liquid Process Piping.**

Provisions shall be incorporated to allow solution piping to be conveniently and safely bled of trapped air and minimize infiltration of air bubbles. Chemical solution piping shall be in accordance with Section 40 05 13 PIPELINES, LIQUID PROCESS PIPING.

2.11.2.1 Smaller than 40 mm 1-1/2 inch Diameter

Chemical solution piping smaller than 40 mm 1-1/2 inch diameter shall be [PVC pipe conforming to ASTM D 1785 or CPVC pipe conforming to ASTM F 441/F 441M] [[_____] tubing] [or] [rubber hose]. 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.

2.11.2.2 Piping 40 mm 1-1/2 inch Diameter or Greater

Chemical solution piping of 40 mm 1-1/2 inch diameter or larger shall be [rubber-lined] [or] [plastic-lined] steel pipe. Steel pipe shall have [threads] [or] [flanges integral with the pipe] [or] [forged-steel flanges screwed to the pipe barrel].

2.11.3 Pipe Lining

Linings for steel pipe smaller than 150 mm 6 inches shall be not less than 4.8 mm 3/16 inch thick. Linings shall be continuous and free of holidays.

2.11.4 Pipe Fittings

Pipe 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].

2.11.5 Plumbing

Water piping, drain, waste and vent piping shall be in accordance with

Section 22 00 00 PLUMBING, GENERAL PURPOSE.

2.12 ELECTRICAL WORK

**NOTE: Coordinate hazard areas with Section 26 20 00
INTERIOR DISTRIBUTION SYSTEM and the drawings.**

Electric motor-driven equipment shall be provided complete with motor, motor starter, and controls. Electrical equipment and wiring shall be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Hazard classifications indicated on the drawings shall be implemented in accordance with NFPA 70.

2.12.1 Motor Starters

Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary for the motor control specified.

2.12.2 Control and Protective Devices

Manual or automatic control and protective or signal devices required for the operation and any control wiring required for controls and devices shall be provided. Motor controls shall conform to NEMA ICS 1 or NEMA ICS 2. Equipment shall be prewired to the maximum practicable extent. Control cabinets shall conform to the requirements of UL 50, NEMA 250, [Type 4,] [Type 7,] [or] [Type 12].

2.13 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 or Type 316 stainless steel.

2.14 FACTORY PAINTING

Factory painting shall conform to 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 1.75 mils thick.

2.15 FACTORY TEST REPORT

Factory examination of fiberglass tanks shall be in accordance with ASTM E 1067 prior to shipping. A copy of the corresponding test report shall be furnished with each tank.

PART 3 EXECUTION

3.1 FIELD MEASUREMENTS

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

3.2 INSTALLATION

3.2.1 Chemical Feeding Equipment

Controlled volume pumps, equipment, and appurtenances shall be installed to provide a complete and integrated system in accordance with the instruction of the manufacturer and under the direct supervision of the manufacturer's representative.

3.2.2 Gasoline Engines

Gasoline engines shall be installed in accordance with NFPA 37.

3.2.3 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 FIELD PAINTING

Factory painted items requiring touching up in the field shall be thoroughly cleaned of all foreign material and shall be primed and top-coated 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. Equipment which did not receive a factory finish shall be painted as specified in Section 09 90 00 PAINTS AND COATINGS. Coating shall be not less than 0.05 mm 1.75 mils thick. Piping identification shall be as specified in [ASME A13.1] [Section 09 90 00 PAINTS AND COATINGS. Pipe carrying materials not listed in Section 09 90 00 PAINTS AND COATINGS shall be marked in accordance with ASME A13.1.]

3.4 FRAMED INSTRUCTIONS

Post framed instructions, containing wiring and control diagrams, where directed. Condensed operating instructions shall be posted as specified above. The framed instructions shall be posted before acceptance testing of the systems.

3.5 FIELD TESTING

After installation of each controlled volume pump, operating tests shall be carried out to assure that the chemical metering installation operates properly. If any deficiencies are revealed during any tests, such deficiencies shall be corrected and the tests shall be reconducted. Reports of all tests shall be submitted prior to final acceptance of the installation.

3.5.1 Tanks

Tanks shall be cleaned of loose debris and dried prior to testing. Tanks shall be field tested for leaks or damage in shipment. The tanks shall be hydrostatically tested to [_____] kPa psig or 1.5 times the system operating pressure, whichever is greater, to detect large leaks and then with the specified chemical to detect small leaks. Tanks shall be tested with each solution for a period of 24 hours at which time no visible leakage shall be evident. Supply all pipes, hoses, pumps, water, power and other equipment required to convey the test liquids and to carry out the tests. Damage or leaks in tanks shall be repaired or tanks shall be

replaced. Damaged ceramic tanks shall be replaced.

3.5.2 Controlled Volume Pumps

Pumps shall be tested to demonstrate that the pumps are capable of operating without vibration or leakage. Testing shall be performed at the maximum design flow rate and at half the design flow rate. Testing shall be demonstrated while controlled and operated in all feasible modes with the pumps operated singly and in unison. The response of each pump shall be plotted on curves for the various operating pressures encountered and the results shall be compared to the curves shown on the manufacturer's published pump data. If control characteristic curves are not available at the time of testing, the pump manufacturer's service engineer shall generate such curves for each pump. Pump curves shall graphically depict the pump displacement at 25, 50, 75, and 100 percent of motor speed for SCR equipped pumps, and at 25, 50, 75, and 100 percent of maximum stroke position for all pumps. Curves shall be generated only for the specified back pressure.

3.5.3 Time, Volume and Pumping Pressure

Pumps shall be tested by filling [the standpipe] [a portable calibrated standpipe furnished by the Contractor] with chemical and measuring the outage, with all other equipment valved off. The time, volume and pumping pressures shall be recorded.

3.5.4 Test Pressure

NOTE: To establish that full service can be provided, fill in the blank with the numerical value of the pressures that can be expected during normal operation of the system.

Tests shall be carried out at [_____] and [_____] kPa **psig**. Back pressure valves shall be manually controlled for this testing, and shall be reset as necessary after testing. The time to deliver a given quantity of chemical at a given stroke and speed setting shall be the same at all pressures.

3.5.5 Flow

Pumps shall be tested to demonstrate zero **L/second** **gpm** flow at a zero stroke or speed setting. Failure to meet this test will be cause for rejection.

3.5.6 Synchronization

The pumps shall be operated for a period of 4 hours to demonstrate that the double diaphragm systems do not lose their synchronization. Loss of synchronization shall also be cause for rejection and the pump shall be repaired or replaced as necessary. Repaired or replaced equipment shall be fully retested.

3.5.7 Chemical Waste

NOTE: In selection of chemicals, consider the environmental consequences, including disposal of

precipitated solids and other wastes. Select the most appropriate options and edit to fit the situation for drinking water or waste water treatment systems.

Chemicals wasted during testing procedures shall be neutralized to achieve a pH value between 6.5 and 9.5 and a chlorine concentration of not more than 1 percent (10,000 mg/L). All chemicals wasted during testing procedures shall be [routed to the sanitary sewer] [routed through the treatment process] at a rate that the process can assimilate without upset.

3.6 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

Conduct a field training course for designated operating, maintenance and supervisory 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 --