**UNIFIED FACILITIES GUIDE SPECIFICATIONS**

**References are in agreement with UMRL dated January 2021**
**********

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SECTION 22 31 00

WATER SOFTENERS, CATION-EXCHANGE (SODIUM CYCLE)

**02/09**

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SECTION 22 31 00

WATER SOFTENERS, CATION-EXCHANGE (SODIUM CYCLE)
**02/09**

**********
**NOTE: This guide specification covers the requirements for fully automatic, semi-automatic, and manual water softening equipment.**

**Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

**Remove information and requirements not required in respective project, whether or not brackets are present.**

**Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).**
**********

PART 1 GENERAL

1.1 REFERENCES

**********
**NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.**

**Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.**

**References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.**
**********

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

| | |
|---|---|
| ASME B1.1 | (2003; R 2018) Unified Inch Screw Threads (UN and UNR Thread Form) |
| ASME B16.3 | (2016) Malleable Iron Threaded Fittings, Classes 150 and 300 |
| ASME B16.39 | (2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300 |
| ASME B40.100 | (2013) Pressure Gauges and Gauge Attachments |
| ASME BPVC SEC VIII D1 | (2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1 |

AMERICAN WATER WORKS ASSOCIATION (AWWA)

| | |
|---|---|
| AWWA 10084 | (2017) Standard Methods for the Examination of Water and Wastewater |
| AWWA C110/A21.10 | (2012) Ductile-Iron and Gray-Iron Fittings for Water |
| AWWA C111/A21.11 | (2017) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings |
| AWWA C115/A21.15 | (2020) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges |
| AWWA C700 | (2015) Cold-Water Meters - Displacement Type, Metal Alloy Main Case |
| AWWA C701 | (2015) Cold-Water Meters - Turbine Type for Customer Service |
| AWWA D102 | (2017) Coating Steel Water-Storage Tanks |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A6/A6M | (2017a) Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling |
| ASTM A53/A53M | (2020) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, |

| | |
|---|---|
| | Welded and Seamless |
| ASTM A123/A123M | (2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A153/A153M | (2016a) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A666 | (2015) Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar |
| ASTM B43 | (2020) Standard Specification for Seamless Red Brass Pipe, Standard Sizes |
| ASTM D1785 | (2015; E 2018) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120 |
| ASTM D2241 | (2015) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series) |
| ASTM D3299 | (2010) Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks |
| ASTM E100 | (2017) Standard Specification for ASTM Hydrometers |
| ASTM E126 | (2013a) Inspection and Verification of Hydrometers |
| ASTM F593 | (2017) Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs |

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

| | |
|---|---|
| MSS SP-58 | (2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation |
| MSS SP-70 | (2011) Gray Iron Gate Valves, Flanged and Threaded Ends |
| MSS SP-80 | (2019) Bronze Gate, Globe, Angle and Check Valves |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA ICS 1 | (2000; R 2015) Standard for Industrial Control and Systems: General Requirements |
| NEMA MG 1 | (2018) Motors and Generators |

NSF INTERNATIONAL (NSF)

| | |
|---|---|
| NSF/ANSI 61 | (2020) Drinking Water System Components - Health Effects |

1.2 SUBMITTALS

**********
**NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.**

**For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.**

**The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.**

**Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.**
**********

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation

SD-03 Product Data

Softening Equipment
Spare Parts

Field Instructions

SD-06 Test Reports

Softening Equipment
Piping

SD-10 Operation and Maintenance Data

Operating and Maintenance Instructions; G[, [_____]]

1.3 DELIVERY, STORAGE, AND HANDLING

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

1.4 EXTRA MATERIALS

a. Submit spare parts data for each different item of material and equipment, 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.

b. Provide, for each type of equipment furnished, special tools necessary for adjustment, operation, maintenance, and disassembly; a grease gun or other lubricating device for each type of grease required; and 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 STANDARD PRODUCTS

a. 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.

b. Pumps and motors 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 SOFTENING EQUIPMENT

**********
**NOTE: Insert the number of units in the battery. If only one unit is to be furnished, delete the text of paragraph, but maintain the title.**
**********

Softener battery shall consist of [_____] water-softener units.

Performance specified shall refer to each unit and not to the battery as a whole. Submit a complete list of equipment and material, including manufacturer's descriptive and technical literature; performance charts and curves; catalog cuts; and installation instructions.

2.2.1 Equipment Capacity

Each unit shall be a [fully automatic] [semi-automatic] [manual] downflow pressure-type water softener, having a capacity to soften [_____] liters gallons of water with a maximum influent total hardness of [_____] milligrams per liter (mg/L) during the interval between successive regenerations, to a maximum effluent total hardness of [_____] mg/L. Intervals between successive generations shall be [_____] hours.

2.2.2 Softener Tank

**********
**NOTE: For tanks less than 900 mm 36 inches in diameter, access openings 101.6 mm by 152.4 mm 4 inches by 6 inches or larger will be provided in upper head of tank; for tanks 900 mm 36 inches in diameter and larger, access opening 279.4 mm by 381.0 mm 11 inches by 15 inches will be provided.**
**********

Softener tank shall be a minimum of [_____] mm inches in diameter by [_____] mm inches straight shell (tangent line to tangent line). Tank shall be of buttwelded steel construction conforming to the ASME BPVC SEC VIII D1. Shell shall be designed for a working pressure of [_____] kPa psi. Tank [and both sides of false bottom] shall be lined with nontoxic epoxy or rubber conforming to [AWWA D102] [_____]. Coatings for potable water tanks shall also conform to NSF/ANSI 61. The upper head of each tank shall be provided with an access opening [101.6] [279.4] mm [4] [11] inches by [152.4] [381.0] mm [6] [15] inches or larger. Lower side shell of each tank shall be provided with an access opening 101.6 by 152.4 mm 4 by 6 inches or larger. Tank shall have [angle leg] [skid] supports of cast-iron or steel.

2.2.3 Underdrain System

**********
**NOTE: Delete the inapplicable underdrain system and remove brackets. The header-lateral-distributor head type will be used in all tanks 900 mm 36 inches in diameter or larger. Tanks smaller than 900 mm 36 inches in diameter will be equipped with either deflector-plate or false-bottom type collector system.**
**********

A system shall be provided within the softener tank for collecting softened water and distributing backwash water. The system shall be [header-lateral-distributor head] [deflector-plate] [or] [false bottom] type. Underdrain system shall distribute the backwash water uniformly over the entire filter area, and at such velocities that will prevent the channeling of the filter bed.

2.2.3.1 Header-Lateral-Distributor Head Type

**********
**NOTE: Delete entire paragraph for tanks smaller than 900 mm 36 inches in diameter.**
**********

Header-lateral-distributor head type shall consist of a central manifold or header, connected to laterals provided with strainer heads or strainers with openings placed radially so as to discharge horizontally or downward. System shall be supported by [a steel plate or steel angles conforming to ASTM A666 with [rubber] [or] [nontoxic epoxy] linings] [or by] [concrete fill] [or] [gravel bed] [or] [directly on the bottom of the tank]. Where the system will permit the loss of the exchange material during the filtering cycle, the system shall be provided with a gravel bed. All bolts and attaching hardware shall be stainless steel, conforming with ASTM F593. Headers and laterals shall be [all red brass, conforming to ASTM B43] [or] [polyvinyl chloride, conforming to ASTM D1785 or ASTM D2241]. Strainer heads and strainers shall be manufactured of materials compatible with the header-lateral system, and shall be [brass] [or] [stainless steel]. Laterals and strainer heads, after being placed, shall not protrude into the header or laterals.

2.2.3.2 Deflector-Plate Type

**********
**NOTE: Delete this paragraph for tanks 900 mm 36 inches in diameter or more.**
**********

Deflector-plate type shall be [cast-iron] [or] [steel], and [rubber] [or] [nontoxic epoxy] lined, fastened to the bottom of the tank, and arranged for discharge through radial slots. Pipe connection for softened water outlet or backwash inlet shall be on the underside between the deflector and the tank bottom. Deflector-plate type collector system shall be provided with a gravel bed.

2.2.3.3 False Bottom Type

**********
**NOTE: Delete this paragraph for tanks 900 mm 36 inches in diameter or more.**
**********

False bottom type shall consist of a false bottom with attached strainers. Strainers and fasteners shall be [brass] [or] [stainless steel]. System shall be designed to eliminate the need for a supporting gravel bed.

2.2.4 Gravel Bed

**********
**NOTE: Delete this paragraph if a gravel supporting bed is not required.**
**********

Supporting bed shall be placed above the underdrain systems. Gravel shall be free from clay, loam, dirt, and calcareous or other foreign materials and shall be free of flat or elongated particles. Gravel bed shall be properly graduated to distribute the backwash water, to prevent loss of

exchange materials, and to prevent migration of the material in the gravel bed during operation and backwashing. Gravel bed shall not be less than 230 mm 9 inches in depth. Where the void size of the top layer of gravel is greater than the smallest particle size of the exchange material, a 75 mm 3 inch layer of ilmenite or garnet sand shall be added to the gravel bed.

2.2.5 Exchange Material

**********

**NOTE: The proper data will be inserted in all the blank spaces. In order to specify the type of exchange material required and thereby determine the size of the units of the softener system, an analysis of the water to be softened will be obtained giving the following information.**

**If the turbidity of the water exceeds 1 nethlometric turbidity unit, the water will be treated prior to softening. The following values are recommended for specifying the exchange material.**

| TABLE 1. PHYSICAL PROPERTIES STYRENE RESINS | | | |
|---|---|---|---|
| Approximate shipping weight, kg/cu ft lb per cu ft | Effective size (mm) | Maximum uniformity coefficient | Size screen not more than 1 percent shall pass |
| 801-881 50-55 | 0.45-0.60 | 2.0 | 50 |

**The maximum flow rate in liter per second per square meter gpm per square foot based on an application rate of 4.4 liter per second per cubic meter 2 gpm per cubic foot for various depths of bed are given in TABLE 2.**

| TABLE 2. MAXIMUM FLOW RATES | | | | |
|---|---|---|---|---|
| | Depth of bed in mm inches | | | |
| | 762.0 30 | 914.4 36 | 1066.8 42 | 1143.0 (45) |
| Maximum flow rate, L/s per sq m gpm/square foot | 3.4 5 | 4.1 6 | 4.8 7 | 5.4 8 |

**In multiple-unit softening systems, the above flow rates may be increased by 40 percent for short periods of time to allow continuous operation while regenerating the individual softeners. The backwash rate of flow will be sufficient to give at least 25 percent bed expansion for all exchange materials. Rinse rates will not exceed the above flow rates. Minimum freeboard above exchanger bed will be 50 percent of bed depth.**

Normally styrene resinous exchange materials that contain 8 to 8.5 percent divinylbenzene, by weight, are satisfactory for use in softening most waters. Since this type of resin is indicated to have chemical stability over pH ranges from 0 to 14 and temperatures up to 121 degrees C 250 degrees F, pH and temperature will not usually be, by themselves, a factor in selecting the exchange material.

Iron and manganese can constitute a problem because they either deposit iron on the resins or reduce the capacity of the exchange material to soften the water. Iron in the ferrous state will be generally removed, while iron in the ferric state will be deposited on the grains. Ferric compounds are insoluble over a pH range of about 3 to 8, and since most water supplies lie within this pH range, they will deposit on ion exchange material. Manganese, on the other hand is insoluble at a pH of 9 or greater and, therefore, is not usually precipitated on the ion exchange material. To prevent the deposition of iron, the water may be prefiltered before softening, or where possible, the source of the oxidizing agent should be removed. Since this specification recommends a turbidity of one or less, in many cases prefiltration will be required, and this will also aid in reducing the iron deposition problem. Continuous application of iron bearing waters to the softening unit will foul the resins in time and require periodic cleaning. The cleaning process requires the removal of the resin from the softening tank. As an alternative, a cleaner additive may be added to the brine rinsing solution.

Where oxidizing agents such as chlorine or oxygen are present, the cross linking agent (divinylbenzene) may be broken down which results in an increase in pressure drop, a loss of volume capacity, and more frequent replacement of the resin material. The effect of oxidizing agents will be increased with higher temperatures. One method of correcting this problem is to select an exchange material that has a higher cross linkage. Where oxidizing agents are present, the exchange material supplier should be contacted for specific recommendations.

The sodium cycle softening process substitutes sodium for calcium and magnesium, and accordingly the sodium content of the finished water supply is increased. Regulations proposed by the United States Environmental Protection Agency limit the sodium content of water to be used for potable purposes to 20 mg/1. Many states have adopted this standard and some require notification to users, where the sodium concentration exceeds the allowable limit. Applicable State regulations should be confirmed. One method of controlling the sodium content of the water supply is to provide a side

**stream of unsoftened water, which may when mixed with the softened water, produce a water supply of acceptable hardness and sodium content.**

**To determine the working exchange capacity of a resin, the following information should be available:**

**a. The total dissolved solids in the influent water.**

**b. The acceptable hardness in the effluent water.**

**The first step is to determine the salt dosage required to obtain the desired level of hardness at the known total dissolved solids content in the influent water. The second step is to determine the working exchange capacity of a particular resin at the selected salt dosage and known total dissolved solids content in the influent water. Parameters for undertaking this analysis should be secured from the manufacturer of the particular resin under consideration.**

**Typical application hardness leakage rates, salt dosages, and resin working exchange capacities for softening water having 510 mg/1 of total dissolved solids (as calcium carbonate) are as follows:**

| Leakage | Salt Dosage | | Resin Working Exchange Capacity |
|---|---|---|---|
| mg/L | kg/cu ft lb/cu ft | kg/1,000 mg<br>lb/1,000 gr | mg/cu m gr/cu ft |
| 0.6 | 240 15 | 3.5 0.5 | 69 30,000 |
| 1.4 | 160 10 | 2.8 0.4 | 57 25,000 |
| 4.0 | 96 6 | 2.1 0.3 | 46 20,000 |

**Above working exchange capacities are for standard 8 percent to 10 percent divinylbenzene polystyrene resins used in water softeners.**

**********

| Component | Concentration (mg/L) |
|---|---|
| Total Solids | [_____] |
| Total Dissolved Solids | [_____] |
| Calcium | [_____] |
| Sodium and Potassium | [_____] |
| Total Iron | [_____] |

| Component | Concentration (mg/L) |
|---|---|
| Ferric Iron | [_____] |
| Ferrous Iron | [_____] |
| Manganese | [_____] |
| Copper | [_____] |
| Silica | [_____] |
| Sulphate | [_____] |
| Chlorides | [_____] |
| Nitrates | [_____] |
| Alkalinity | [_____] |
| Methyl Orange as Calcium Carbonate | [_____] |
| Phenolphthalein as Calcium Carbonate | [_____] |
| Total Hardness as Calcium Carbonate | [_____] |
| Carbonate Hardness as Calcium Carbonate | [_____] |
| Noncarbonate Hardness as Calcium Carbonate | [_____] |
| Free Carbon Dioxide Calcium Carbonate | [_____] |
| Turbidity in Nethlometric Turbidity units | [_____] |
| Color by Platinum Standard Comparison | [_____] |
| Residual Chlorine | [_____] |
| Dissolved Oxygen | [_____] |
| Conductivity pH | [_____] |

Exchange material shall be of styrene-resinous type, washed, processed, graded, and suitable for water softening purposes. All granules shall be clean and hard, and the material shall be free from defects that affect the serviceability and appearance of the finished product. Exchange material shall not require dosing or the adding of any chemical mixture or solution to the water to be or to the water used for backwashing or regeneration other than sodium chloride, except for a cleaner additive recommended by the Exchange Material Manufacturer. Material shall conform to the following:

a. Working exchange capacity not less than [_____] g/cubic meter grains pcf.

b. Approximate shipping weight of [_____] kg/cubic foot pcf, backwashed and drained volume.

c. Effective size not less than [_____] millimeters.

d. Uniformity coefficient not greater than 2.0.

e. Not more than 1 percent by weight to pass 50-mesh US standard screen.

Bed depth shall not be less than 750 mm 30 inches. Application rate shall not exceed 4.5 L per second/cubic meter 2 gpm per cubic foot of exchange material. Minimum freeboard above exchanger bed shall be not less than 50 percent of bed depth.

## 2.3 BRINE APPLICATION SYSTEM

A brine application system, comprising one or two tanks, shall be provided for each installation. Where two tanks are furnished, one tank shall serve as a salt saturator tank, and the other as a brine tank. Single tank units shall serve as a combined salt saturator and brine tank. Minimum capacity of the system shall be such as to provide sufficient salt storage for three regeneration cycles or 24-hour operation, whichever is greater.

### 2.3.1 Tanks

Each saturator, brine or combined-purpose tank shall be fabricated from steel conforming to ASTM A6/A6M not less than 4.8 mm 3/16 inch thick, lined with enamel, or of fiber glass filament-wound reinforced plastic construction, conforming to ASTM D3299. Comply with EPA requirements in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING. Each tank shall be equipped with an underdrain system manufactured from [polyvinyl chloride conforming to ASTM D1785 or ASTM D2241] [or] [red brass conforming to ASTM B43] and provided with a layer of graded gravel or screens for filtering the brine. Screens shall be manufactured from [polyvinyl chloride,] [brass,] [or] [stainless steel]. Saturator tank or combined-purpose tank shall be equipped with a water inlet valve [float-operated] [or] [solenoid-operated. Solenoid-operated valve shall be activated by a [probe] [or] [a float-operated switch] [or] [a timer together with a float switch to automatically shut off the incoming supply in the event of failure of the timing mechanism]]. Water inlet valves and switches shall be mounted externally. Floats and probes may be mounted internally or externally, in such a manner that the stored salt shall not interfere with their operation. All devices in contact with or subject to splashing of brine solution shall be fabricated from [red brass] [bronze] [or] [polyvinyl chloride].

### 2.3.2 Hydraulic System

A [hydraulic ejector] [or] [motor-driven centrifugal pump] of all bronze construction with valves, piping, and connections shall be provided for lifting brine from the brine or combined tank. [Ejector] [and] [motor-driven pump] shall have sufficient capacity to permit a 2 to 1 variation in the concentrated brine rate of flow. [Hydraulic ejector system shall be equipped with a manual rate-set valve and a check valve on the suction side of the ejector. Where the brine tank or combination tank is emptied during each regeneration period, the suction side of the ejector system shall be provided with a device to prevent the entrance of

air into the system. Hydraulic ejector system shall be capable of automatically flushing out the dilute brine piping system or completion of the brine cycle.] [Hydraulic pumping system shall be equipped with a manual rate-set valve, a check valve, and a brine measuring meter on the discharge of the pump. Brine measuring meter shall be electrically interlocked with the pump starter so that after the discharge of a set quantity of brine, the pump motor shall shut down. Set point shall be infinitely adjustable over a 2 to 1 range. Dilution water shall be mixed with the concentrated brine through use of a mixing tee. Water inflow to the mixing tee shall be controlled by means of a manual rate-set valve. System shall be capable of automatically flushing out the dilute brine piping system on completion of the brine regeneration cycle.] The dilution water supply shall be protected from inflow of brine by means of back flow prevention device.

## 2.4 CONTROLS

### 2.4.1 Valves

**********

**NOTE: The inapplicable types of operation will be deleted. The multiport valve and the package-type valve nest are suitable for all three types of operation.**

**********

Transfer of water and brine solution to and from the water softener shall be accomplished by a single-unit multiple-port valve or by a package-type valve nest for [automatic] [semiautomatic] [manual] operation. Design of the valve mechanisms shall be such that gradually increasing flows will be attained as ports are opened and initial surges and sudden inrushes of water or brine are avoided. A dial pointer shall indicate each step of the operation.

#### 2.4.1.1 Multiple-Port Valve

Multiple-port valve shall consist of an assembly of nonsticking, nonleaking, water-lubricated valve ports that connect to the hard-water inlet, soft-water outlet, backwash inlet and outlet, and brine inlet, all enclosed in a single casing. Design shall permit the various steps of operation service, backwash, brine flow, and rinse to be accomplished by the rotation of a shaft that drives the mechanism causing the opening and closing of ports in correct sequence.

#### 2.4.1.2 Package-Type Valve

Package-type valve nest shall consist of a pilot valve connected with fittings as may be required to each one of a nest of valves hydraulically or pneumatically operated. Nest of valves shall have connections to hard-water inlet, soft-water outlet, backwash inlet and outlet, and brine inlet.

### 2.4.2 Operation

Control of softener regeneration shall be [fully automatic initiated by a control switch] [semiautomatic initiated manually by a pushbutton in response to an alarm with switch] [manual with operation initiated manually in response to an alarm with switch] connected to [a water meter] [an automatic hardness tester]. [Use of [fully automatic] [semiautomatic]

controls shall permit regeneration to proceed automatically with no manual assistance other than replenishment of salt storage. Controls shall be subject to convenient and accurate manual adjustment and shall be designed for manual operation in the event of failure of the electrical equipment. An interlocking system shall be provided to prevent regeneration of more than one unit at a time.] [Backwash, brine injection, displacement, rinsing, and return to service shall be controlled manually by the operator by turning the multiport valve or pilot valve. A manual-reset electric alarm timer shall be provided for timing the several regeneration cycles.]

## 2.5 ELECTRICAL WORK

[Electrical motor-driven equipment specified shall be provided complete with motors [motor starters] and controls.] [Motor starters shall be provided complete with properly sized thermal overload protection and other appurtenances necessary for the motor specified.] Electrical work shall be as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices, shall be provided.

## 2.6 BOLTS, NUTS, AND FASTENERS

All bolts, anchor bolts, nuts, washers, plates, bolt sleeves, and all other types of supports necessary for the installation of the equipment shall be furnished with the equipment and shall be galvanized unless otherwise indicated. Expansion bolts shall have malleable-iron and lead composition elements. Unless otherwise specified, stud, tap, and machine bolts shall be of refined bar iron. All threads shall conform to ASME B1.1. Bolts, anchor bolts, nuts, and washers specified to be galvanized, shall be zinc coated, after being threaded, by the hot-dip process in conformity with ASTM A123/A123M or ASTM A153/A153M. Bolts, anchor bolts, nuts, and washers specified to be stainless steel shall be Type 316 stainless steel. Where indicated, specified, or required, anchor bolts shall be provided with square plates at least 101.6 by 101.6 by 9.5 mm 4 by 4 by 3/8 inch or shall have square heads and washers and be set in the concrete forms with suitable pipe sleeves.

## 2.7 AUXILIARY EQUIPMENT

### 2.7.1 Water Meter

**********

**NOTE: If a control switch is not connected to the meter, the sentence in brackets will be removed.**

**********

Each softener shall be provided with a displacement or turbine-type water meter reading in U.S. gallons, and shall conform to AWWA C700 or AWWA C701 as appropriate. [Meter shall be equipped with necessary wiring and electric controls for automatic regeneration when the softener has delivered [_____] gallons of water.] Meter shall be equipped with necessary wiring and an alarm device to give notice when the unit has delivered [_____] gallons of water. Meter shall be installed in the soft-water line from the softener unit, and shall be so located as to be readily accessible for reading and setting. Meter contacts shall be infinitely adjustable over the range of the meter to permit setting to suit actual hardness of the water being treated.

2.7.2 Automatic Hardness Tester

**********
**NOTE: If an automatic hardness tester is not required, this paragraph will be deleted.**
**********

A hardness tester for automatically testing the hardness of the water shall be installed in the soft-water line leading from each softener unit. Automatic hardness tester shall be wall mounted and shall be capable of carrying out intermittent tests on the softened water and of giving visual warning that the residual hardness present exceeds a predetermined limit. Tester shall be equipped with necessary wiring and [electrical controls for automatic regeneration] [an alarm device to give notice] when the hardness of the water delivered by the softener unit exceeds [_____] mg/1.

2.7.3 Electric Motors

**********
**NOTE: Delete the entire paragraph if an electric motor is not required.**
**********

Motors shall be single-phase, suitable for operation on 115-volt, single-phase, 60 cycle, alternating current conforming to NEMA MG 1. Each motor shall be designed for operation in a 40-degree C ambient temperature. Motor controls shall conform to NEMA ICS 1.

2.7.4 Piping

Pipe smaller than 100 mm 4 inches in diameter, excluding the underdrain and brine collection systems, shall be fabricated from galvanized steel conforming to ASTM A53/A53M with malleable-iron fittings conforming to ASME B16.3. Pipe 100 mm 4 inches in diameter and larger shall be flanged ductile-iron conforming to AWWA C115/A21.15 with ductile-iron fittings conforming to AWWA C110/A21.10 and AWWA C111/A21.11. Pipe hangers and supports conforming to MSS SP-58 shall be used on all 40 mm 1-1/2 inch diameter or smaller pipe with runs longer than 2.14 m 7 feet, and on all 50 mm 2 inch diameter or larger pipe with runs longer than 2.74 m 9 feet. The pipe hanger and supports shall be fabricated from steel and shall be spaced not more than 2.14 to 2.74 m 7 to 9 feet as applicable.

2.7.5 Valves and Unions

Gate valves smaller than 100 mm 4 inches shall be bronze with screwed ends, conforming to MSS SP-80 and valves 100 mm 4 inches or larger shall be iron body with flanged ends, conforming to MSS SP-70. Valves shall open counterclockwise, and the operating wheel shall have an arrow, cast in the metal, indicating the direction of opening. Unions shall conform to ASME B16.39.

2.7.6 Gauges and Cocks

Pressure gauges and sampling cocks shall be furnished on each softener unit connected to the hard-water inlet and soft-water outlet to indicate the pressure loss through the softener and its pipe, valve, and fitting assembly, and to sample the hard and soft water. A sampling cock shall also be provided on the brine system which will permit sampling of the

dilute brine solution. Gauges shall be precision type with bronze Bourdon tube and phenolic case and an accuracy of plus or minus 1/2 percent conforming to ASME B40.100. Sampling cocks shall be of brass, ground key, lever handle, faucet type.

### 2.7.7 Water and Brine Testing Equipment

A complete water-testing set recommended by the manufacturer shall be provided with the softener. The set shall include complete instructions for conducting tests for hardness in accordance with AWWA 10084. Two Baume hydrometers conforming to ASTM E100 and ASTM E126, and calibrated for the range necessary for testing saturated brine solution and three glass cylinders of heat-resistant glass to hold sufficient brine for testing shall also be provided.

## 2.8 FACTORY PAINTING

Factory painting shall conform to manufacturer's standard factory finish for the intended service.

# PART 3 EXECUTION

## 3.1 EXAMINATION

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

## 3.2 INSTALLATION

Submit drawings showing 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.

### 3.2.1 Softener and Brine Tanks

Softener and brine tanks shall be anchored to a concrete mat. Anchor brackets, anchor rods or straps shall be provided to hold the tank to the anchors in the mat. [Where concrete or gravel fill is provided for support of the header-lateral-distributor head, strainer heads and strainers shall be protected while concrete or gravel fill is being placed.]

### 3.2.2 Valves

Install valves as nearly as possible in the position indicated consistent with convenience of operating the hand wheel. Carefully erect and support all valves in their respective position free from all distortion and strain on appurtenances during handling and installation. All material shall be carefully inspected for defects in workmanship and material, and debris and foreign material cleaned out of valve openings and seats, all operating mechanisms operated to check their proper functioning, and all nuts and bolts checked for tightness. Valves and other equipment which do not operate easily or are otherwise defective shall be repaired or replaced.

### 3.2.3 Pumps

Pump and motor shall be mounted on a common monoblock. The monoblock shall be anchored to a concrete mat. Anchor brackets, anchor rods, or straps shall be provided to hold the monoblock to the anchors in the mat.

### 3.2.4 Piping

Install piping to accurate lines and grades and, where possible, parallel to building walls. Where temporary supports are used, they shall be sufficiently rigid to prevent shifting or distortion of the pipe. Provision shall be made for expansion where necessary. All piping shall pitch toward low points, and provision shall be made for draining these low points. A sufficient number of unions or flanges shall be used to allow for the dismantling of all water pipe, valves, and equipment. Installation of piping including cleaning, cutting, threading and jointing, shall be in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

## 3.3 MANUFACTURER'S SERVICES

### 3.3.1 Manufacturer's Representative

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

### 3.3.2 Field Training

Conduct training course for operating staff as designated by the Contracting Officer. The training period, for a total of [_____] hours of normal working time, shall start after the system is functionally completed but prior to final acceptance tests. Submit proposed diagrams, field instructions, and other sheets, prior to posting. Framed 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 above for the wiring and control diagrams and posted beside the diagrams. The framed instructions shall be posted before acceptance testing of the systems. The field instructions shall cover all of the items contained in the Operating and Maintenance Instructions. Submit [6] [_____] complete copies of operating instructions outlining the step-by-step procedures required for system startup, operation and shutdown. The instructions shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operation features. Submit [6] [_____] complete copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. The instructions shall include simplified wiring, layout, and control diagrams of the system as installed.

## 3.4 TESTING AND PERFORMANCE

After installation of the water softener, operating tests shall be carried out to assure that the water softener system operates properly. If any deficiencies are revealed during any tests, such deficiencies shall be

corrected and the tests reconducted.

3.4.1 Softeners

**********

**NOTE: The approximate constant flow rate in liters per second gpm for operating capacity test will be inserted in the blank spaces provided. For some softener units, the tests may be modified if required by the type and operating conditions. This is particularly necessary where high capacity exchange materials are used and the hardness is such that complete tests would require abnormal extended periods of time. In such cases this paragraph will be suitably rewritten.**

**********

Run each softener to exhaustion and regenerate it to full capacity in accordance with manufacturer's instructions before test is started. Softener shall be put through a complete cycle of operation at a constant flow rate of approximately [_____] L/second gpm for capacity test. During capacity test, the softened water shall be wasted to the sewer if necessary to maintain the required flow rate. Total grains of equivalent calcium carbonate removed shall be determined by test of the hard water at such intervals as will give a representative calcium carbonate content.

a. After each run, the unit shall be regenerated using salt brine delivered from the measuring tank in the amount called for by operating instructions. Near the end of the brine rinse and beginning of production of zero soft-water, samples of the water shall be taken every 2.5 minutes, the meter read, and the reading recorded. Samples shall be titrated for chlorides, and zero soft-water production shall be considered to begin when chlorides, as chloride radicals, are not in excess of 20 milligrams per liter above the chloride content of the hard-water. When the required number of liters gallons of hard water of specified hardness have been run through the softener, a quart sample shall be taken of the softened water and tested.

b. Results of the test shall be used in determining the capacity and performance of the softener. A sample of hard-water shall be taken and tested in a similar manner. A complete log of each test run shall be made, giving the following data: date, time or readings, total water softened, and pounds of salt used per regeneration. All samples shall be collected in clean, glass-stoppered bottles. Bottles shall be thoroughly rinsed with water being sampled, and all samples shall be plainly marked for identification.

c. Supply the salt required for regeneration of the exchange material after each of the above test runs. Under actual operating conditions the exchange material shall not be washed out of the apparatus, the turbidity and color of the soft water shall not exceed the turbidity and color of the hard water, and during any softening run, slugs of dirty or turbid water shall not be delivered regardless of the change of demand rate up to the maximum on the apparatus. During the specified test of the softener, the soft-water sampling cock shall remain open and a stream of softened water shall be run through a rubber hose, discharging at the bottom of a wide mouth, 3 liter 1 gallon glass jar or bottle set against a white background so that the color and turbidity may be under observation at all times. Amount of

salt used for regeneration shall not exceed [_____] kg pounds per 65 g 1,000 grains hardness of equivalent calcium carbonate removed.

### 3.4.2 Piping

After installation, test all pipelines for watertightness. For these tests furnish testing plugs or caps, all necessary pressure pumps, pipe connections, gauges, other equipment, and all labor required. Test pressures shall be indicated in the process pipe schedule shown. Test of joints of air lines shall be made using a soapy water solution to detect leaks. The obtaining of water, electric power and other utility items as well as the disposal of water drainage are also the responsibilities of Contractor. 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. Each test report shall indicate the final position of controls.

## 3.5 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 top-coated with the manufacturer's standard factory finish.

-- End of Section --