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USACE / NAVFAC / AFCEC **UFGS-22 31 03 (May 2025)**

Preparing Activity: USACE **Superseding**
UFGS-22 31 00 (February 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated April 2025
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DOMESTIC WATER SOFTENERS AND WATER CONDITIONERS

05/25

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SECTION 22 31 03

DOMESTIC WATER SOFTENERS AND WATER CONDITIONERS
05/25

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NOTE: This guide specification covers the requirements for fully automatic and semi-automatic water softening equipment. This guide specification also covers the requirements for template assisted crystallization (TAC) water conditioners.

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 must be submitted as a Criteria Change Request (CCR).

Obtain a water sample for analysis to provide water chemistry results to inform design.

The following items must be shown on the drawings:
1. Equipment type - softening or conditioning.
2. Design and/or maximum flowrate with applicable pressure drops.
3. Inlet Water hardness.
4. Design daily flow in GPD/LPD.
5. Equipment dimensions - height and diameter.

Performance and equipment data information for water conditioning and/or softening equipment in equipment data list or schedule.

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PART 1 GENERAL

1.1 REFERENCES

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

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

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

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

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	(2024) Unified Inch Screw Threads (UN, UNR, and UNJ Thread Form)
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC VIII D1	(2023) 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 B200	(2022) Sodium Chloride
AWWA C110/A21.10	(2021) Ductile-Iron and Gray-Iron Fittings
AWWA C111/A21.11	(2023) 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 D102 (2024) Coating Steel Water-Storage Tanks

ASTM INTERNATIONAL (ASTM)

ASTM A6/A6M (2024b) Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling

ASTM A123/A123M (2024) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A153/A153M (2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

ASTM A666 (2023) 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 B88 (2022) Standard Specification for Seamless Copper Water Tube

ASTM B88M (2020) Standard Specification for Seamless Copper Water Tube (Metric)

ASTM D1126 (2017) Standatrd Test Method for Hardness in Water

ASTM D1785 (2021) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120

ASTM D2241 (2020) 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 (2019; R 2024) Standard Specification for ASTM Hydrometers

ASTM E126 (2019; R 2024) Inspection and Verification of Hydrometers

ASTM F593 (2024) 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

NSF INTERNATIONAL (NSF)

NSF/ANSI 372	(2016) Drinking Water System Components - Lead Content
NSF/ANSI/CAN 61	(2024) Drinking Water System Components - Health Effects

1.2 SUBMITTALS

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

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

****

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. Submittals not having a "G" or "S" classification are 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

Water Softening Equipment

Spare Parts

Field Instructions

Water Conditioning Equipment

SD-06 Test Reports

Water Softening Equipment

Piping

Pre-Installation Water Sample Test; G, [_____]

Post-Installation Water Sample Test; G, [_____]

Water Softener Manufacturer's Start Up Report; G, [_____]

Water Conditioner Manufacturer's Start Up Report; G, [_____]

SD-08 Manufacturer's Instructions

Water Conditioning Equipment Manufacturer's Installation Instructions

Water Softening Equipment Manufacturer's Installation Instructions

Water Softener Manufacturer's Start-up Procedures

Water Conditioning Equipment Manufacturer's Start-up Procedures

Posted Instructions; G, [_____]

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

****

NOTE: Depending on water hardness and flow rates, water softener resin will last 3-5 years. Water softener and water conditioner tanks typically last 10 years.

****

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. Include a complete list of parts and supplies, including[water softener resin][, tanks][, and][water conditioning media], with current unit prices and source of supply, and a list of the parts recommended by the manufacturer to be replaced after [1][3][5][10] 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. Provide tools consisting of high-grade, smooth, forged, alloy, tool steel. Provide lever type grease guns. Deliver tools at the same time as the equipment and hand over on completion of the work.

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. Furnish equipment supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

b. All wetted products (materials in contact with potable water) must comply with NSF/ANSI/CAN 61 and NSF/ANSI 372.

[2.2 TEMPLATE ASSISTED CATALYTIC (TAC) WATER CONDITIONING EQUIPMENT

****

NOTE: Provide a vacuum relief valve if units are designed for fixtures/equipment on floors below the location of the units.

Water Conditioning Equipment Feed Water Operating Requirements.

pH	**6.5-8.5**
Hardness (maximum)[a]	**30 grains (513 mg/L CaCO3)**
Water Pressure	**103 kpa to 689 kpa15 psig to 100 psig**
Temperature	**4 degrees C to 38 degrees C40 degrees F to 100 degrees F**
Free Chlorine (maximum)	**2 ppm maximum**
Iron (maximum)[b]	**0.3 ppm**
Manganese (maximum)[b]	**0.05 ppm**
Copper (maximum)[c]	**1.3 ppm**

Oil/hydrogen Sulfide	**0 pp**
Total Phosphates (maximum)	**3.0 ppm**
Silica (maximum)[d]	**20 ppm**
TDS (maximum)	**1500 mg/1**

[a] Media can control lime scale formation at influent levels up to 1282 mg/l 75 grains per gallon CaCO3. Due to variations in water chemistry, 30 grains per gallon is a recommended hardness maximum due to potential aesthetic issues related to soft scale residue formation outside the plumbing system.

[b] Media needs to be protected from excess levels of certain metals that can easily foul the active surfaces.

If excess levels of metallic ions exist in source water, other treatment technologies will need to be designed in addition to water conditioning or cation exchange may need to be used instead.

[c] New copper piping, upstream of water conditioning equipment need to be passivated for a minimum of 4 weeks prior to placing equipment in service. Provide valved bypass on design to allow this to occur.

[d] Media does not reduce silica scaling. While silica tends to have a less significant effect on scale formation than other minerals, it can act as a binder that makes water spots and scale residue outside the plumbing system difficult to remove. This 20 ppm limitation is for aesthetic purposes. If silica levels are excessive, use of cation exchange softening must be utilized.

Insert the number of units in the battery.

****

Provide water conditioning equipment[battery] consisting of [_____] water conditioning units[installed in parallel]. Provide a complete list of equipment and material, including manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts in water conditioning equipment, and submit water conditioning equipment and Water Conditioning Equipment Manufacturer's Installation Instructions.

2.2.1 Equipment Capacity

Provide[a][single][double][floor][wall] mounted, upflow pressure-type water conditioner[s], with size and performance data indicated on drawings.

[2.2.2 Conditioner Tank

****
NOTE: For floor mounted equipment show scaled equipment on plans for space planning purposes. Tanks are limited in size, with diameters 304.8 mm12 inches to 406.4 mm16 inches and heights 1617.98 mm 63.7 inches to 1747.52 mm68.8 inches.

Floor Mounted water conditioning tanks 355.6 mm14 inches diameter and larger must have a bottom base permanently installed with industrial grade adhesive.

Single Wall Mounted Canisters are limited in size, with top bracket dimensions 203.2 mm8 inches to 250.83 mm9.875 inches wide, 130.175 mm5.125 inches to 203.2 mm8 inches deep, with canister lengths of 342.9 mm13.5 inches to 714.375 mm28.125 inches.

Double Wall Mounted canisters are limited in size, with top bracket 323.85 mm12.75 inches to 454.03 mm 17.875 inches wide, 146.05 mm5.75 inches to 216.54 mm 8.525 inches deep, with canister lengths of 368.3 mm 14.5 inches to 638.175 mm25.125 inches dimensions.
****

****
NOTE: Most water conditioner tanks are constructed with a safety factor of 4x operating pressure. 80 psig is normal maximum operating pressure.
****

Provide water conditioning tank[s] constructed of a polyethylene liner with a continuous roving outer fiberglass reinforced wrapping.[Provide water conditioning tank[s] with a bottom base permanently installed with Industrial grade adhesive.]

Provide tank[s] with[a] [101.6 mm4 inches][63.5 mm2.5 inches][_____] top threaded port for loading media and connection of the plumbing manifolds. Provide tank[s] designed for 2206 [_____] kPa 320 [_____]psig for minimum burst pressure.

]2.2.3 Conditioner Media

Provide media utilizing template-assisted crystallization to convert dissolved bicarbonate related water hardness into inactive non-scale forming nanocrystals. Provide media which operates in an upflow flow mode and does not require backwashing or chemicals for regeneration.

2.2.4 External Manifold

Provide a factory installed manifold on top of the mineral tank to allow for the connection of the inlet and outlet plumbing.

][2.3 WATER SOFTENING EQUIPMENT

****
NOTE: Insert the number of units in the battery.

If only one unit is to be furnished, delete the text of sentence, but maintain the title.

****

Provide water softener[battery] consisting of [_____] water-softener resin tank[s]. Performance specified on drawings must refer to each resin tanks and not to the battery as a whole.[Provide[alternating][progressive] operation[for battery].] Provide a complete list of equipment and material, including manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, and water softening equipment. Submit Water Softening Equipment Manufacturer's Installation Instructions.

2.3.1 Equipment Capacity

****

NOTE: Specify equipment which minimizes pressure drop for design flow rate. If required to provide adequate pressure to water closets or showers, units in parallel or a domestic booster pump must be designed.

****

Provide a [fully automatic][semi-automatic] downflow pressure-type water softener, having performance and equipment as indicated on the drawings.

2.3.2 Resin Mineral 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 must 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 must be provided.

Fiberglass wrapped polyethylene tanks must be specified for flow rates less than 200 gpm. Steel tanks must be specified for flows greater than 12.6 lps200 gpm.

Softener media physically degrades over time. Provide a strainer downstream of resin tanks to remove particulates.

Water softener tanks 355.6 mm14 inches diameter and larger must have a bottom base permanently installed with industrial grade adhesive.

****

[Provide resin mineral tank of buttwelded steel in accordance with ASME BPVC SEC VIII D1. Provide shell designed for a working pressure of [_____] kPa psi. Provide tank[and both sides of false bottom] lined with nontoxic epoxy or rubber in accordance with [AWWA D102][_____]. Furnish coatings for potable water tanks. Provide the upper head of each tank with an access opening [101.6][279.4] mm [4][11] inches by [152.4][381.0] mm [6][15] inches or larger. Provide lower side shell of each tank with an access opening [101.6][_____] by [152.4][_____] mm [4][_____] by [6][_____] inches or larger. Provide tank [angle leg][skid] supports of

cast-iron or steel.]

****
NOTE: Most resin tanks are constructed with a safety factor of 4x operating pressure. 80 psig is normal maximum operating pressure.
****

[[Provide resin mineral tanks, of a polyethylene liner with a continuous roving outer fiberglass reinforced wrapping.][Provide water softening tanks with a bottom base permanently installed with industrial grade adhesive.] Provide tank with a [152.4][_____] mm[6][_____] inches top flange [101.6][63.5][_____] mm[2.5][4][_____] inches top threaded port for loading media and connection of the control valve. Provide tank designed for [2206][_____] kPa [320][_____] psig for minimum burst pressure. Provide tanks with a bottom base permanently installed with industrial grade adhesive.]

2.3.3 Underdrain System

****
NOTE: First three sections relate to steel resin tanks which depend on manufacturer specific constructions. The last paragraph relates to fiberglass wrapped in polyethylene resin tanks.

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.
****

Provide a system within the softener tank for collecting softened water and distributing backwash water. Provide[header-lateral-distributor head][deflector-plate][false bottom][or][internal distribution system] type system. Provide an underdrain system that distributes the backwash water uniformly over the entire filter area, and at such velocities that prevents the channeling of the filter bed.

[2.3.3.1 Header-Lateral-Distributor Head Type

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

Provide header-lateral-distributor head type consisting 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. Provide support for system by[a steel plate or steel angles in accordance with 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 must permit the loss of the exchange material during the filtering cycle, provide a gravel bed with the system. Provide stainless steel bolts and attaching hardware conforming with ASTM F593. Provide headers and laterals consisting of[all red brass, in accordance

with ASTM B43][or][polyvinyl chloride, in accordance with ASTM D1785 or ASTM D2241]. Provide strainer heads and strainers manufactured of materials compatible with the header-lateral system, and [brass][or][stainless steel]. Laterals and strainer heads, after being placed, must not protrude into the header or laterals.

][2.3.3.2 Deflector-Plate Type

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

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

][2.3.3.3 False Bottom Type

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

Furnish false bottom type consisting of a false bottom with attached strainers. Provide strainers and fasteners that are [brass][or][stainless steel]. Design system to eliminate the need for a supporting gravel bed.

][2.3.3.4 Internal Distribution System

****
NOTE: The lower distributor must be a hub and lateral design a single point design for mineral tanks 609.6 mm 24 in diameter and below.
****

Provide the internal distributor system already installed in the water softener mineral tank[s]. Provide the upper distribution system with a [slotted screen][perforated pipe] type diffuser. Provide a [slot][perforation] cross section which promotes a self-cleaning characteristic of the [slot][perforation]. Provide [slot][perforation] size which does not allow the resin to pass through and become present in the systems effluent water.[Provide lateral type screen with an internal perforated pipe core to evenly distribute water flow across the entire lateral to prevent resin bed channeling.] Provide the internal distributor system screens made of abrasion resistant 20 percent glass filled polypropylene. Provide a distributor tube connecting the internal distribution system to the system control valve must be made of polyvinyl chloride.

][2.3.4 Gravel Bed

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

****

Place the supporting bed above the underdrain systems of[each] resin tank[s]. Provide gravel that is free from clay, loam, dirt, and calcareous or other foreign materials and free of flat or elongated particles. Properly graduate gravel bed 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. Do not provide gravel bed less than 230 mm 9 inches in depth. Add a 75 mm3 inch layer of ilmenite or garnet sand to the gravel bed where the void size of the top layer of gravel is greater than the smallest particle size of the exchange material.

Provide the gravel under-bedding with a flint media and wash to rid it of fines to prevent clogging of the lower distributor system. Furnish enough gravel to completely cover the lower distributor in the mineral tank[s].

]2.3.5 Soft Water Collector and Backwash Distributor

Provide the backwash distributor and soft water collector with a hub-radial design and require only assembly of the riser pipe upon installation. Provide radials designed with a higher density of [slots][holes] at the outer ends to provide adequate distribution and collection of water away from the center of the tank. Provide internal piping material constructed of [PVC] [and][or] [ABS plastic].

2.3.6 Exchange Material

****

NOTE: Exchange media is determined by the manufacturer.

If the turbidity of the water exceeds 1 nethlometric turbidity unit (NTU), the water must be treated prior to softening.

Use a minimum flow rate of 1 gpm per cubic foot and 4 gpm per square foot to determine resin bed depth and diameter.

Use a maximum flow rate in liter per second per square meter gpm per square foot to determine resin bed depth and diameters.

In multiple-unit softening systems, the above flow rates may be exceeded for short periods of time if a progressive system is designed to allow continuous operation. The backwash rate of flow must 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 must 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 be deposited 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:

1. WATER SOFTENER CAPACITY AND RATES

Leakage	Salt Dosage		Resin Working Exchange Capacity
mg/L	kg/cu ft lb/cu ft	kg/1,000 mg 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

Leakage rates are less than 1 grain per gallon (GPG).

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

For the following constituents, determine the maximum limits of influent water for media compatibility:
a. Total Solids
b. Total Dissolved solids
c. Calcium
d. Sodium and Potassium
e. Total Iron
f. Ferric Iron
g. Ferrous Iron
h. Manganese
i. Copper
j. Silica
k. Sulphate
l. Chlorides
m. Nitrates
n. Alkalinity

o. Methyl Orange as Calcium Carbonate
p. Phenolphthalein as Calcium Carbonate
q. Total hardness as Calcium Carbonate
r. Carbonate hardness as Calcium Carbonate
s. Noncarbonate hardness as Calcium Carbonate
t. Free Carbon Dioxide Calcium Carbonate
u. Turbidity in Nethlometric Turbidity units
v. Color by Platinum standard comparison
w. Residual Chlorine
x. Dissolved Oxygen
y. Conductivity pH

The Ion exchange resin must be cation exchange resin specially designed for drinking water treatment and Water Quality Association (WQA), certified to NSF/ANSI standard 61 and 372. The Ion exchange resin must be composed of polystyrene crosslinking that offers excellent bead integrity, high resistance to bead fracture or osmotic shock, and very low extractables.

Choose a resin which meets the requirements of FDA regulation CFR Section 21, §173.25.

Choose resin with maximum grain capacity per cubic foot to be 30,000 grains as CaCO3 when regenerated with 15 lbs of sodium chloride and 20,000 grains as CaCO3 when regenerated with 6 lbs of sodium chloride.

Bed depth less than 750 mm 30 inches is not permitted. Minimum freeboard above exchanger bed less than 50 percent of bed depth is not acceptable.

****

Provide strongly acidic gel-type cation exchange resin specially designed for drinking water treatment and WQA certified in accordance with NSF/ANSI/CAN 61 and NSF/ANSI 372. The ion exchange resin must be composed of polystyrene with a minimum of 8 percent divinylbenzene crosslinking. Provide resin with maximum grain capacity per cubic foot of resin of 30,000 grains as CaCO3 when regenerated with 15 lbs of sodium chloride and 20,000 grains as CaCO3 when regenerated with 6 lbs of sodium chloride. The pH stability of the resin must be 0-14. Temperature stability of the resin must be up to 121 degrees C250 degrees F.

][2.4 BRINE APPLICATION SYSTEM

****

NOTE: Local brine tanks are the standard, low salt consumption, type of system. For systems requiring more salt and/or inadequate space for salt storage, remote brine tanks can be used.

****

Provide combination sodium chloride storage and brine measuring tank with cover and sized to hold [_____] kglbs of sodium chloride and have the dimensions of [_____] mminches diameter x [_____] mminches tall. Provide tank of rotationally molded rigid polyethylene and equipped with an elevated sodium chloride plate for the collection of brine and must have a chamber to house a brine valve assembly. Provide the brine valve assembly

to include an automatic air eliminator and safety float shut-off valve. Provide valve which opens automatically, to educt brine, close to prevent the entrance of air after the brine has been drawn, and permit refill of the tank with the correct amount of water. Provide brine dosage controlled by the softener control valve. Provide system designed to allow proper refilling regardless of the sodium chloride level in the tank.

****

NOTE: Where two tanks are furnished, one tank located near the resin tank(s), which is typically located exterior to the building, must serve as a remote bulk brine tank and the other as a local brine tank. Single tank units must serve as a combined salt saturator and brine tank.

****

Provide a brine application system, comprising [one][two] tanks, for each installation. Provide sufficient sodium chloride storage for three regeneration cycles or 24-hour operation, whichever is greater.

[2.4.1 Tanks

[Provide local brine tank from [steel in accordance with ASTM A6/A6M no less than 4.8 mm 3/16 inch thick, lined with enamel][fiber glass filament-wound reinforced plastic construction, in accordance with ASTM D3299]. Provide each tank with an underdrain system manufactured from [polyvinyl chloride in accordance with ASTM D1785 or ASTM D2241][or][red brass in accordance with ASTM B43] and provided with a layer of graded gravel or screens for filtering the brine. Furnish screens manufactured from [polyvinyl chloride,][brass,][or][stainless steel]. Equip local tank with a water inlet valve [float-operated][or][solenoid-operated]. Provide solenoid valve 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]. Mount water inlet valves and switches externally. Provide floats and probes mounted [internally][externally], so that the stored sodium chloride does not interfere with their operation. Fabricate all devices in contact with or subject to splashing of brine solution from [red brass][bronze][or][polyvinyl chloride].

][Provide a local brine tank made of high-density polyethylene for making a brine solution for the water softener to use during a regeneration cycle and for sodium chloride storage. Provide the brine tank with an overflow connection, lid, aircheck, and brine well. The brine tank must be sized to hold enough sodium chloride for [4][_____] regenerations at [20][30][_____] kglbs of sodium chloride pcf of resin.

][Provide remote [above][below] ground brine tank manufactured from [single][double] wall [high density polyethylene][fiber glass filament wound reinforced plastic] with [[_____] lb[s] sodium chloride][and][[_____] gallon[s] brine] storage capacity. Provide [salt][brine] fill port must be [2][_____]-[_____]mminches [locking] manhole for sodium chloride [[_____]mminches cam-lock for liquid] fill. Provide brine production to be as [on demand][[_____]litersgallons[_____] minutes].[Provide tank water fill designed to be distributed evenly across tank and equipped with a distribution system collecting brine evenly across the entire tank with a [slotted][perforated] schedule [40][80] PVC piping system, and provide with [a layer of graded gravel][screens] for filtering the brine.]

]
]2.4.2 Hydraulic System

Provide a [hydraulic ejector][or][motor-driven centrifugal pump] of all bronze construction with valves, piping, and connections for lifting brine from the brine or combined tank. Provide [ejector][and][motor-driven pump] with sufficient capacity to permit a 2 to 1 variation in the concentrated brine rate of flow.[Equip hydraulic ejector system with a manual rate-set valve and a check valve on the suction side of the ejector. Provide the suction side of the ejector system with a device to prevent the entrance of air into the system, where the brine tank or combination tank is emptied during each regeneration period. Provide hydraulic ejector system capable of automatically flushing out the dilute brine piping system or completion of the brine cycle.][Equip hydraulic pumping system with a manual rate-set valve, a check valve, and a brine measuring meter on the discharge of the pump. Provide brine measuring meter that is electrically interlocked with the pump starter so that after the discharge of a set quantity of brine, the pump motor shuts down. Provide set point to be infinitely adjustable over a 2 to 1 range. Use a mixing tee to mix dilution water with the concentrated brine. Provide water inflow control to the mixing tee by means of a manual rate-set valve. Provide automatic flush out of the dilute brine piping system on completion of the brine regeneration cycle.] Protect the dilution water supply from inflow of brine by means of back flow prevention device.

][2.5 SOFTENER CONTROLS

2.5.1 Valves

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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.
****

Provide valves which transfer water and brine solution to and from the resin tank by a single-unit multiple-port valve[package-type valve nest for [automatic][semiautomatic][manual] operation]. Provide valve mechanism design such that gradually increasing flows must be attained as ports are opened and initial surges and sudden inrushes of water or brine are avoided. Indicate each step of the operation using a dial pointer.

2.5.1.1 Multiple-Port Valve

Provide the system control valve to control all functions of the water softener regeneration and service cycles. Provide motor driven cycle positioning which is slow in actuation, and does not cause pressure surges or water hammer. Provide the system control valve furnished with a fully programmable microprocessor-based controller with an LCD screen. Provide a system in which the operating data from the system is stored within the controller and displayed on the screen. Provide system with operating data which includes[peak flow rate][, totalizing meter][, gallons remaining in softening cycle][, use since last regeneration][, regeneration interval][, and error history log]. Provide a control valve with a multi-color LED display to indicate the position of the system. Provide LED display which displays conditions of[in service][, regeneration][, standby position][, and error conditions].[Provide valve supplied with a normally open and normally closed dry contact for

interface with the building control system.] Provide controller, related wiring, and positioning motors must be housed within a water-resistant gasket sealed enclosure.

Provide control valve supplied with a meter capable of tracking gallons higher and lower than the system is capable of processing so that it is not a flow restriction at high flow rates or not sensitive to low flow rates.

[Provide valve that is able to be monitored by the Building Automated System in accordance with Section 25 08 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION][and][Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.]

2.5.1.2 Drain Line Flow Controller

Provide a drain line flow controller to regulate the flow of water to drain during a regeneration cycle. Provide flow controller constructed of a [Schedule 80 PVC nipple][or][brass coupling with an orifice plate in the middle. Pressure sensitive rubber flow restrictors must be installed in the orifice plate and not be able to wash out of the plate and must allow the consistent passage of water with pressure fluctuations between 30 to 100 psi.]

2.5.2 Operation

Control of softener regeneration must be[fully automatic initiated by a control switch][semiautomatic initiated manually by a pushbutton in response to an alarm with switch] connected to[an automatic hardness tester]. Use [fully automatic][semiautomatic] controls that permit regeneration to proceed automatically with no manual assistance other than replenishment of sodium chloride storage.[Provide controls connected to building emergency power for continued operation in the event of power failure.] Provide an interlocking system to prevent regeneration of more than one unit at a time.

]2.6 ELECTRICAL WORK

Perform electrical work in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices.

2.7 BOLTS, NUTS, AND FASTENERS

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

2.8 AUXILIARY EQUIPMENT

[2.8.1 Automatic Hardness Tester

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

NOTE: Water softener media will become degraded fouled over time, losing softening capacity and efficiency. An automatic hardness meter will enable monitoring over time and indicate the need for media replacement.

Downstream hardness must not exceed 34 mg/l 2 gpm.
****

Provide a hardness tester for automatically testing the hardness of the water in the soft-water line leading from each softener unit. Provide wall mounted automatic hardness tester that is capable of carrying out intermittent tests on the softened water and of giving visual warning that the residual hardness present exceeds a predetermined limit. Equip tester with necessary wiring and capability for montoring by the Building Automated System in accordance with[Section 25 08 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION][and][Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.] [an alarm device to give notice] when the hardness of the water delivered by the softener unit exceeds [_____] mg/1.

][2.8.2 Piping

****
NOTE: For units requiring field fabrication. As specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE.
****

Fabricate pipe smaller than 100 mm 4 inches in diameter, excluding the underdrain and brine collection systems, from L type copper [tubing][pipe] ASTM B88MASTM B88 with [solder][braze][press fit] joint fittings. Pipe 100 mm 4 inches in diameter and larger must 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. Use pipe hangers and supports conforming to MSS SP-58 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. Fabricate pipe hanger and supports from steel and space no more than 2.14 to 2.74 m 7 to 9 feet as applicable.

][2.8.3 Valves and Unions

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

]2.8.4 Gauges and Cocks

Furnish pressure gauges and sampling cocks 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, valves, and fitting assembly, and to sample the hard and soft water. Provide a sampling cock on the brine system which to permit sampling of the dilute brine solution. Gauges must 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 must be of brass, ground key, lever handle, faucet type.

2.8.5 Water and Brine Testing Equipment

Provide a complete water-testing set recommended by the manufacturer with the softener. Include complete instructions for conducting tests for hardness in accordance with AWWA 10084. Provide 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.

2.9 FACTORY PAINTING

Provide factory painting conforming 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

Install in accordance with the manufacturer's installation procedures. Any recommendations in the installation instructions must be considered mandatory.

3.2.1 Posted Instructions

Provide posted instructions, including equipment layout, wiring and control diagrams, piping, valves and control sequences, and typed condensed operation instructions. The condensed operation instructions must include preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system. The posted instructions must be framed under glass or laminated plastic and be posted where indicated by the Contracting Officer.

3.2.2 Manufacturer's Installation Instructions

For [Water Softening Equipment Manufacturer's Installation Instructions][Water Conditioning Equipment Manufacturer's Installation Instructions] provide manufacturer's standard catalog data, at least [5][_____] weeks prior to the purchase of a particular component, highlighted to show features such as materials, dimensions, options, performance and efficiency. Data must include the manufacturer's recommended installation instructions and procedures. Data must be adequate to demonstrate

compliance with contract requirements. Provide information a minimum of 30 days prior to equipment installation.

3.2.3 Softener and Brine Tanks

Anchor softener and brine tanks to a concrete mat. Provide anchor brackets, anchor rods or straps 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, protect strainer heads and strainers while concrete or gravel fill is being placed.]

3.2.4 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. Carefully inspect all material 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. Repair or replace valves and other equipment which do not operate easily or are otherwise defective.

3.2.5 Piping

Install piping to accurate lines and grades and, where possible, parallel to building walls. Where temporary supports are used, they must be sufficiently rigid to prevent shifting or distortion of the pipe. Make provision for expansion where necessary. All piping must pitch toward low points and make provision for draining these low points. Use a sufficient number of unions or flanges to allow for the dismantling of all water piping, valves, and equipment. Perform installation of piping including cleaning, cutting, threading and jointing, in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE. Provide adequate supports of piping and equipment at [water softener][and][water conditioning equipment] tank to not stress tank connections. Connections must not support the weight of the piping and equipment.[Provide upstream copper pipe passivation as required by water conditioning equipment manufacturer.]

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 [water softener][and][water conditioning] equipment specified. Supervise the installion, adjusting, and testing of equipment.

3.3.2 Field Training

Conduct a training course for operating staff as designated by the Contracting Officer. The training period, for a total of [_____] hours of normal working time, must start after the system is functionally completed but prior to final acceptance tests. Submit field instructions prior to posting. Post framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, where directed. Post the framed instructions before acceptance testing of the systems.

3.4 OPERATING AND MAINTENANCE INSTRUCTIONS

For [water conditioning equipment][and][water softening equipment] submit [6][_____] complete copies of Operating and Maintenance Instructions outlining the step-by-step procedures required for system startup, operation and shutdown. Include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operation features. Include maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Include simplified wiring, layout, and control diagrams of the system as installed.

3.5 TESTING AND PERFORMANCE

Collect and perform a Pre-Installation Water Sample Test to establish existing water chemistry baseline. Collect and perform a Post-Installation Water Sample Test to demonstrate the performance of the [water softener][and][water conditioning equipment].

After installation of the [water softener][and][water conditioning equipment], conduct the manufacturer's recommend field testing in compliance with the approved test plan. Furnish a factory trained field representative authorized by and to represent the equipment manufacturer at the complete execution of the field acceptance testing. If any deficiencies are revealed during any tests, correct such deficiencies and reconduct the tests.

[3.5.1 Water Softeners

****
NOTE: The approximate constant flow rate in liters per second gpm for operating capacity test will be inserted in the blank spaces provided.
****

Provide a Water Softener Manufacturer's Start-up Procedures. Procedures, at a minimum, must include running each softener to exhaustion and regenerate it to full capacity in accordance with manufacturer's instructions before test is started. Put softener 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 must be wasted to the sewer if necessary to maintain the required flow rate. Determine the total grains of equivalent calcium carbonate removed by testing the hard water at such intervals that must give a representative calcium carbonate content. Testing must be in accordance with ASTM D1126. Sodium Chloride used must be in accordance with AWWA B200.

a. After each run, regenerate the unit using sodium chloride 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 softwater, take samples of the water every 2.5 minutes, read the meter, and record the reading. Titrate samples for chlorides and consider zero soft-water production 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, take a quart sample of the softened water and test.

b. Use the test results in determining the capacity and performance of the softener. Take a sample of hard-water and test in a similar manner. Make a complete log of each test run, giving the following data: date, time or readings, total water softened, and pounds of sodium chloride used per regeneration. Collect all samples in clean, glass-stoppered bottles. Thoroughly rinse bottles with water being sampled, and plainly mark all samples for identification.

c. Supply the sodium chloride required for regeneration of the exchange material after each of the above test runs. Under actual operating conditions the exchange material must not be washed out of the apparatus, the turbidity and color of the soft water must not exceed the turbidity and color of the hard water, and during any softening run, slugs of dirty or turbid water must 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 must remain open and a stream of softened water must 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 sodium chloride used for regeneration exceeding [_____] kg pounds per 65 g 1,000 grains hardness of equivalent calcium carbonate removed is not permitted.

d. Provide a Water Softener Manufacturer's Start up Report with results of testing performed.

][3.5.2 Water Conditioners

****
NOTE: The approximate constant flow rate in liters per second gpm for operating capacity test will be inserted in the blank spaces provided.
****

[Provide Water Conditioning Equipment Manufacturer's Start-up Procedures. Procedures, at minimum must include after upstream piping has been passivated,][R][r]un each water conditioner in accordance with manufacturer's instructions before test is started. During capacity test, the conditioned water must be wasted to the sewer if necessary to maintain the required flow rate.

a. Use the test results in determining the performance of the water conditioner. Take a sample of upstream water and test in a similar manner. Make a complete log of each test run, giving the following data: date, time or readings, total water conditioned. Collect all samples in clean, glass-stoppered bottles. Thoroughly rinse bottles with water being sampled, and plainly mark all samples for identification.

b. Under actual operating conditions the conditioning media must not be washed out of the apparatus, the turbidity and color of the conditioned water must not exceed the turbidity and color of the hard water, and during any conditioning run, slugs of dirty or turbid water must not be delivered regardless of the change of demand rate up to the maximum on the apparatus. During the specified test of the water conditioner, the effluent sampling cock must remain open and a stream of conditioned water must be run through a rubber hose, discharging at the bottom of a wide mouth, 3 liter1 gallon glass jar or bottle set

against a white background so that the color and turbidity may be under observation at all times.

c. Provide a Water Conditioner Manufacturer's Start up Report with results of testing performed.

]3.5.3 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. Indicate test pressures in the process pipe schedule shown. Test joints of air lines 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 the Contractor.

3.6 FIELD PAINTING

Paint equipment which did not receive a factory finish in accordance with Section 09 90 00 PAINTS AND COATINGS. Thoroughly clean factory painted items requiring touching up in the field of all foreign material and prime and topcoat with the manufacturer's standard factory finish.

-- End of Section --