

SECTION 232500 - HVAC WATER TREATMENT

TIPS:

To view non-printing **Editor's Notes** that provide guidance for editing, click on Masterworks/Single-File Formatting/Toggle/Editor's Notes.

To read **detailed research, technical information about products and materials, and coordination checklists**, click on Masterworks/Supporting Information.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes the following HVAC water-treatment systems:

1. Manual and automatic chemical-feed equipment and controls.
2. Ozone-generator biocide equipment and controls.
3. Stainless-steel pipes and fittings.
4. UV-irradiation unit, biocide equipment, and controls.
5. Chemical treatment test equipment.
6. Chemicals.
7. HVAC makeup-water softeners.
8. RO equipment for HVAC makeup water.
9. Water filtration equipment.

1.3 DEFINITIONS

- A. EEPROM: Electrically erasable, programmable read-only memory.
- B. RO: Reverse osmosis.
- C. TSS: Total suspended solids are solid materials, including organic and inorganic, that are suspended in the water. These solids may include silt, plankton, and industrial wastes.

1.4 ACTION SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for the following products:

1. Bypass feeders.
 2. Water meters.
 3. Inhibitor injection timers.
 4. pH controllers.
 5. TSS controllers.
 6. Biocide feeder timers.
 7. Chemical solution tanks.
 8. Injection pumps.
 9. Ozone generators.
 10. UV-irradiation units.
 11. Chemical test equipment.
 12. Chemical material safety data sheets.
 13. Water softeners.
 14. RO units.
 15. Multimedia filters.
 16. Self-cleaning strainers.
 17. Replaceable bag- or cartridge-type filters.
 18. Centrifugal separators.
- B. Shop Drawings: Pretreatment and chemical[, and **ozone-generator biocide**][, and **UV-irradiation biocide**] treatment equipment showing tanks, maintenance space required, and piping connections to HVAC systems.
- C. 1. Include plans, elevations, sections, and attachment details.
1. Include diagrams for power and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For **[water softeners]** **[RO equipment]** **[water filtration units]** and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
- B. Water Analysis Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider.
- C. Field quality-control reports.
- D. Other Informational Submittals:
1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in "Performance Requirements" Article.
 2. Water Analysis: Illustrate water quality available at Project site.
 3. Passivation Confirmation Report: Verify passivation of galvanized-steel surfaces, and confirm this observation in a letter to Architect.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For sensors, injection pumps, **[water softeners,]** **[RO equipment,]** **[water filtration units,]** and controllers to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)

2.2 PERFORMANCE REQUIREMENTS

- A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or to the environment.
- B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.
- C. Closed hydronic systems, including **[hot-water heating]** **[chilled water]** **[dual-temperature water]** **[and]** **[glycol cooling]**, shall have the following water qualities:
 - 1. pH: Maintain a value within **[9.0 to 10.5]** **<Insert range>**.
 - 2. "P" Alkalinity: Maintain a value within **[100 to 500]** **<Insert range>** ppm.
 - 3. Boron: Maintain a value within **[100 to 200]** **<Insert range>** ppm.
 - 4. Chemical Oxygen Demand: Maintain a maximum value of **[100]** **<Insert number>** ppm.
 - 5. Soluble Copper: Maintain a maximum value of **[0.20]** **<Insert number>** ppm.
 - 6. TSS: Maintain a maximum value of **[10]** **<Insert number>** ppm.
 - 7. Ammonia: Maintain a maximum value of **[20]** **<Insert number>** ppm.
 - 8. Free Caustic Alkalinity: Maintain a maximum value of **[20]** **<Insert number>** ppm.
 - 9. Microbiological Limits:
 - a. Total Aerobic Plate Count: Maintain a maximum value of **[1000]** **<Insert number>** organisms/mL.
 - b. Total Anaerobic Plate Count: Maintain a maximum value of **[100]** **<Insert number>** organisms/mL.
 - c. Nitrate Reducers: Maintain a maximum value of **[100]** **<Insert number>** organisms/mL.

- d. Sulfate Reducers: Maintain a maximum value of [zero] <Insert number> organisms/mL.
- e. Iron Bacteria: Maintain a maximum value of [zero] <Insert number> organisms/mL.

10. <Insert other requirements if necessary>.

D. Steam Boiler and Steam Condensate:

1. Steam Condensate:

- a. pH: Maintain a value within [7.8 to 8.4] <Insert range>.
- b. Total Alkalinity: Maintain a value within [5 to 50] <Insert range> ppm.
- c. Chemical Oxygen Demand: Maintain a maximum value of [15] <Insert number> ppm.
- d. Soluble Copper: Maintain a maximum value of [0.20] <Insert number> ppm.
- e. TSS: Maintain a maximum value of [10] <Insert number> ppm.
- f. Ammonia: Maintain a maximum value of [20] <Insert number> ppm.
- g. Total Hardness: Maintain a maximum value of [2] <Insert number> ppm.
- h. <Insert other requirements if necessary>.

2. Steam boiler operating at 15 psig (104 kPa) and less shall have the following water qualities:

- a. "OH" Alkalinity: Maintain a value within [200 to 400] <Insert range> ppm.
- b. TSS: Maintain a value within [600 to 3000] <Insert range> ppm.
- c. <Insert other requirements if necessary>.

3. Steam boiler operating at more than 15 psig (104 kPa) shall have the following water qualities:

- a. "OH" Alkalinity: Maintain a value within [200 to 400] <Insert range> ppm.
- b. TSS: Maintain a value within [600 to 1200] <Insert range> ppm to maximum 30 times RO water TSS.
- c. <Insert other requirements if necessary>.

E. Open hydronic systems, including [condenser] [fluid-cooler spray] water, shall have the following water qualities:

- 1. pH: Maintain a value within [8.0 to 9.1] <Insert range>.
- 2. "P" Alkalinity: Maintain a maximum value of [100] <Insert number> ppm.
- 3. Chemical Oxygen Demand: Maintain a maximum value of [100] <Insert number> ppm.
- 4. Soluble Copper: Maintain a maximum value of [0.20] <Insert number> ppm.
- 5. TSS: Maintain a maximum value of [10] <Insert number> ppm.
- 6. Ammonia: Maintain a maximum value of [20] <Insert number> ppm.
- 7. Free "OH" Alkalinity: Maintain a maximum value of [zero] <Insert number> ppm.
- 8. Microbiological Limits:
 - a. Total Aerobic Plate Count: Maintain a maximum value of [10,000] <Insert number> organisms/mL.

- b. Total Anaerobic Plate Count: Maintain a maximum value of [1000] <Insert number> organisms/mL.
 - c. Nitrate Reducers: Maintain a maximum value of [100] <Insert number> organisms/mL.
 - d. Sulfate Reducers: Maintain a maximum value of [zero] <Insert number> organisms/mL.
 - e. Iron Bacteria: Maintain a maximum value of [zero] <Insert number> organisms/mL.
9. Polymer Testable: Maintain a minimum value within [10 to 40] <Insert range>.
10. <Insert other requirements if necessary>.

F. Passivation for Galvanized Steel: For the first 60 days of operation.

- 1. pH: Maintain a value within [7 to 8] <Insert range>.
- 2. Calcium Carbonate Hardness: Maintain a value within [100 to 300] <Insert range> ppm.
- 3. Calcium Carbonate Alkalinity: Maintain a value within [100 to 300] <Insert range> ppm.

2.3 MANUAL CHEMICAL-FEED EQUIPMENT

- A. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch (89-mm) fill opening in the top, and NPS 3/4 (DN 20) bottom inlet and top side outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.
- 1. Capacity: [2 gal. (7.6 L)] [5 gal. (19 L)] <Insert value>.
 - 2. Minimum Working Pressure: [125 psig (860 kPa)] [175 psig (1210 kPa)] <Insert value>.

2.4 AUTOMATIC CHEMICAL-FEED EQUIPMENT

A. Water Meter:

- 1. AWWA C700, oscillating-piston, magnetic-drive, totalization meter.
- 2. Body: Bronze.
- 3. Minimum Working-Pressure Rating: 150 psig (1035 kPa).
- 4. Maximum Pressure Loss at Design Flow: 3 psig (20 kPa).
- 5. Registration: Gallons (Liters) or cubic feet (cubic meters).
- 6. End Connections: Threaded.
- 7. Controls: Flow-control switch with normally open contacts; rated for maximum 10 A, 250-V ac, and that will close at adjustable increments of total flow.

B. Water Meter:

- 1. AWWA C701, turbine-type, totalization meter.
- 2. Body: Bronze.
- 3. Minimum Working-Pressure Rating: 100 psig (690 kPa).
- 4. Maximum Pressure Loss at Design Flow: 3 psig (20 kPa).

5. Registration: Gallons (Liters) or cubic feet (cubic meters).
6. End Connections: Threaded.
7. Controls: Low-voltage signal capable of transmitting 1000 feet (305 m).

C. Water Meter:

1. AWWA C701, turbine-type, totalization meter.
2. Body: [Bronze] [Epoxy-coated cast iron].
3. Minimum Working-Pressure Rating: 150 psig (1035 kPa).
4. Maximum Pressure Loss at Design Flow: 3 psig (20 kPa).
5. Registration: Gallons (Liters) or cubic feet (cubic meters).
6. End Connections: Flanged.
7. Controls: Flow-control switch with normally open contacts; rated for maximum 10 A, 250-V ac, and that will close at adjustable increments of total flow.

D. Inhibitor Injection Timers:

1. Microprocessor-based controller with digital display in NEMA 250, Type 12 enclosure with gasketed and lockable door.[**Interface for start/stop and status indication at central workstation as described in Section 230923 "Direct Digital Control (DDC) System for HVAC."**]
2. Programmable timers with infinite adjustment over full range, and mounted in cabinet with hand-off-auto switches and status lights.
3. Test switch.
4. Hand-off-auto switch for chemical pump.
5. Illuminated legend to indicate feed when pump is activated.
6. Programmable lockout timer with indicator light. Lockout timer to deactivate the pump and activate alarm circuits.
7. Digital display totalizer to measure amount of makeup and bleed-off water from two water meter inputs.

E. pH Controller:

1. Microprocessor-based controller, 1 percent accuracy in a range from zero to 14 units. Incorporate solid-state integrated circuits and digital display in NEMA 250, Type 12 enclosure with gasketed and lockable door.[**Interface for start/stop and status indication at central workstation as described in Section 230923 "Direct Digital Control (DDC) System for HVAC."**]
2. Digital display and touch pad for input.
3. Sensor probe adaptable to sample stream manifold.
4. High, low, and normal pH indication.
5. High or low-pH-alarm-light trip points, field adjustable; with silence switch.
6. Hand-off-auto switch for acid pump.
7. Internal adjustable hysteresis or deadband.

F. TSS Controller:

1. Microprocessor-based controller, 1 percent accuracy in a range from zero to 5000 micromhos. Incorporate solid-state integrated circuits and digital display in NEMA 250, Type 12 enclosure with gasketed and lockable door.[**Interface for start/stop and status**

indication at central workstation as described in Section 230923 "Direct Digital Control (DDC) System for HVAC."]

2. Digital display and touch pad for input.
3. Sensor probe adaptable to sample stream manifold.
4. High, low, and normal conductance indication.
5. High- or low-conductance-alarm-light trip points, field adjustable; with silence switch.
6. Hand-off-auto switch for solenoid bleed-off valve.
7. Bleed-off valve activated indication.
8. Internal adjustable hysteresis or deadband.
9. Bleed Valves:
 - a. Cooling Systems: Forged-brass body, globe pattern, general-purpose solenoid with continuous-duty coil, or motorized valve.
 - b. Steam Boilers: Motorized ball valve, steel body, and TFE seats and seals.

G. Biocide Feeder Timer:

1. Microprocessor-based controller with digital display in NEMA 250, Type 12 enclosure with gasketed and lockable door.[**Interface for start/stop and status indication at central workstation as described in Section 230923 "Direct Digital Control (DDC) System for HVAC."**]
2. 24-hour timer with 14-day skip feature to permit activation any hour of day.
3. Precision, solid-state, bleed-off lockout timer and clock-controlled biocide pump timer. Prebleed and bleed lockout timers.
4. Solid-state alternator to enable use of two formulations.
5. 24-hour display of time of day.
6. 14-day display of day of week.
7. Battery backup so clock is not disturbed by power outages.
8. Hand-off-auto switches for biocide pumps.
9. Biocide A and Biocide B pump running indication.

H. Chemical Solution Tanks:

1. Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with minimum 110 percent containment vessel.
2. Molded cover with recess for mounting pump.
3. Capacity: [**30 gal. (114 L)**] [**50 gal. (189 L)**] [**120 gal. (454 L)**] <Insert value>.

I. Chemical Solution Injection Pumps:

1. Self-priming, positive displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.
2. Adjustable flow rate.
3. Metal and thermoplastic construction.
4. Built-in relief valve.
5. Fully enclosed, continuous-duty, single-phase motor. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- J. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints except ASTM A 269, Type 304, stainless steel for steam boiler injection assemblies.
- K. Injection Assembly:
 - 1. Quill: Minimum **NPS 1/2 (DN 15)** with insertion length sufficient to discharge into at least 25 percent of pipe diameter.
 - 2. Ball Valve: [**Three**] [**Two**]-piece stainless steel, as described in "Stainless-Steel Pipes and Fittings" Article; selected to fit quill.
 - 3. Packing Gland: Mechanical seal on quill of sufficient length to allow quill removal during system operation.
 - 4. Assembly Pressure/Temperature Rating: Minimum **600 psig (4137 kPa)** at **200 deg F (93 deg C)**.

2.5 OZONE-GENERATOR BIOCIDES EQUIPMENT

- A. Corona discharge generator with stainless-steel generating cells and transformer housed in a NEMA 250, Type 4 enclosure. Assembly shall be suitable for continuous duty. Provide site glasses to verify proper operation of generator.
- B. Water-cooled generators shall be provided with cooling water at maximum [**70 deg F (21 deg C)**] <Insert value> and [**35 psig (241 kPa)**] <Insert value>.
- C. Generator vessels exposed to system pressure shall be constructed according to ASME Boiler and Pressure Vessel Code and be equipped with pressure relief valve.
- D. External air compressor or induced airflow through a cleanable prefilter supplies concentrated oxygen through a molecular sieve with **minus 62 deg F (minus 52 deg C)** dew point to avoid the formation of nitric acid.
- E. Microprocessor-based control with software in EEPROM, surge protection, high-temperature cutout, and operational status lights. [**Interface for start/stop and status indication at central workstation as described in Section 230923 "Direct Digital Control (DDC) System for HVAC."**]
- F. Ozone Contactors:
 - 1. Bubble diffusers.
 - 2. Induction injection nozzle.
 - 3. Injectors with static mixers.
- G. Ozone Detector and Alarm Devices:
 - 1. Detector:
 - a. Sensor: Metal dioxide semiconductor.
 - b. Concentration Range: [**0.01 to 0.14**] <Insert range> ppm.
 - c. Accuracy: Plus or minus 20 percent of range.
 - d. Sensitivity: 0.01 ppm.
 - e. Response Time: Maximum 10 seconds.

- f. Operating Temperature: 50 to 100 deg F (10 to 38 deg C).
 - g. Relative Humidity: 20 to 95 percent, noncondensing over the operating temperature range.
- 2. Horns:
 - a. Electric-vibrating-polarized type.
 - b. 24-V dc, with provision for housing the operating mechanism behind a grille.
 - c. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet (3 m) from the horn.
 - d. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- 3. Visible Alarm Devices:
 - a. Xenon strobe lights listed in UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate.
 - b. Rated Light Output: [75] [110] <Insert number> candela.
 - c. Strobe Leads: Factory connected to screw terminals.
- H. Self-Contained Breathing Apparatus: Open-circuit, pressure-demand compressed air includes completely assembled, portable, self-contained devices designed for hazardous breathing environment application.
 - 1. Face Piece: EPDM or silicone rubber construction material, one-size-fits-all with double-sealing edge, stainless-steel speaking diaphragm and lens retainer, five adjustable straps to hold face piece to head (two straps on each side and one on top), exhalation valve in mask, close-fitting nose piece to ensure no CO₂ buildup, and perspiration drain to avoid skin irritation and to prevent eyepiece, spectacle, and lens fogging.
 - 2. Backplate: Orthopedically designed of [chemical and impact-resistant, glass-fiber composite] [aluminum].
 - 3. Harness and Carrier Assembly: Large triangular back pad, backplate, and adjustable waist and shoulder straps. Modular in design, detachable components, and easy to clean and maintain. Shoulder straps padded with flame-resistant material, reinforced with stainless-steel cable, and attached with T-nuts, washers, and screws.
 - 4. Air Cylinder: [30] [45] [60]-minute, low-pressure, air-supply-loaded [fiberglass] [aluminum] [steel] cylinders fitted with quick-fill assembly for refilling and air transfer.
 - 5. Wall-Mounting Cabinet: Leakproof, corrosion-resistant, clear, plastic case.
 - 6. Tested and Certified: By the National Institute for Occupational Safety and Health and by the Mine Safety and Health Administration, according to 42 CFR 84, Subpart H.

2.6 STAINLESS-STEEL PIPES AND FITTINGS

- A. Stainless-Steel Tubing: Comply with ASTM A 269, Type 316.
- B. Stainless-Steel Fittings: Comply with ASTM A 815/A 815M, Type 316, Grade WP-S.
- C. Two-Piece, Full-Port, Stainless-Steel Ball Valves: ASTM A 351/A 351M, Type 316 stainless-steel body; ASTM A 276, Type 316 stainless-steel stem and vented ball, carbon-filled TFE

seats, threaded body design with adjustable stem packing, threaded ends, and **250-psig (1725-kPa)** Steam Working Pressure and **600-psig (4140-kPa)** Cold Working Pressure ratings.

- D. Three-Piece, Full-Port, Stainless-Steel Ball Valves: ASTM A 351/A 351M, Type 316 stainless-steel body; ASTM A 276, Type 316 stainless-steel stem and vented ball, threaded body design with adjustable stem packing, threaded ends, and **150-psig (1035-kPa)** Steam Working Pressure and **600-psig (4140-kPa)** Cold Working Pressure rating.

2.7 UV BIOCIDES EQUIPMENT

- A. Target Irradiation: Minimum 30,000 microwatts x s/sq. cm.
- B. Light Source Vessels:
1. ASTM A 666, Type 304 stainless steel.
 2. Construct for minimum [**150 psig (1035 kPa)**] <Insert value> at [**150 deg F (65 deg C)**] <Insert value> according to ASME Boiler and Pressure Vessel Code, and equipped with pressure relief valve.
 3. Light Source Sleeve: Quartz, with EPDM O-ring seals.
 4. Light Source: Replaceable UV lamp producing minimum target irradiation of 254-nm wavelength light.
- C. Controls: Interlock with pumps to operate when water is circulating.

2.8 CHEMICAL TREATMENT TEST EQUIPMENT

- A. Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounting cabinet for testing pH, TSS, inhibitor, chloride, alkalinity, and hardness; sulfite and testable polymer tests for high-pressure boilers; and oxidizing biocide test for open cooling systems.
- B. Sample Cooler:
1. Tube: Sample.
 - a. Size: **NPS 1/4 (DN 8)** tubing.
 - b. Material: ASTM A 666, Type 316 stainless steel.
 - c. Pressure Rating: Minimum **2000 psig (13 790 kPa)**.
 - d. Temperature Rating: Minimum **850 deg F (454 deg C)**.
 2. Shell: Cooling water.
 - a. Material: ASTM A 666, Type 304 stainless steel.
 - b. Pressure Rating: Minimum **250 psig (1725 kPa)**.
 - c. Temperature Rating: Minimum **450 deg F (232 deg C)**.
 3. Capacities and Characteristics:
 - a. Tube: Sample.
 - 1) Flow Rate: [**0.25 gpm (0.016 L/s)**] <Insert value>.

- 2) Entering Temperature: [400 deg F (204 deg C)] <Insert value>.
- 3) Leaving Temperature: [88 deg F (31 deg C)] <Insert value>.
- 4) Pressure Loss: [6.5 psig (44.8 kPa)] <Insert value>.

b. Shell: Cooling water.

- 1) Flow Rate: [3 gpm (0.19 L/s)] <Insert value>.
- 2) Entering Temperature: [70 deg F (21 deg C)] <Insert value>.
- 3) Pressure Loss: [1.0 psig (6.89 kPa)] <Insert value>.

C. Corrosion Test-Coupon Assembly: Constructed of corrosive-resistant material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.

1. [Two] <Insert number>-station rack for closed-loop systems.
2. [Four] <Insert number>-station rack for open-loop systems.

2.9 CHEMICALS

A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment and that can attain water quality specified in "Performance Requirements" Article.

B. Water Softener Chemicals:

1. Mineral: High-capacity, sulfonated-polystyrene ion-exchange resin that is stable over entire pH range with good resistance to bead fracture from attrition or shock. Resin exchange capacity minimum 30,000 grains/cu. ft. (69 kg/cu. m) of calcium carbonate of resin when regenerated with 15 lb (6.8 kg) of salt.
2. Salt for Brine Tanks: High-purity sodium chloride, free of dirt and foreign material. Rock and granulated forms are unacceptable.

2.10 HVAC MAKEUP-WATER SOFTENER

A. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)

B. Description: Twin mineral tanks and one brine tank, factory mounted on skid.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Fabricate supports and attachments to tanks with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure as recommended in writing by manufacturer.

E. Mineral Tanks:

1. Fabricate and label steel filter tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

2. Fabricate and label Fiber Reinforced Plastic filter tanks to comply with ASME Boiler and Pressure Vessel Code: Section X, if indicated.
 3. Pressure Rating: [100 psig (690 kPa)] [125 psig (860 kPa)] [150 psig (1035 kPa)] <Insert value> minimum.
 4. Wetted Components: Suitable for water temperatures from [40 to at least 100 deg F (5 to at least 38 deg C)] <Insert range>.
 5. Freeboard: 50 percent, minimum, for backwash expansion above the normal resin bed level.
 6. Support Legs or Skirt: Constructed of structural steel, welded, or bonded to tank before testing and labeling.
 7. Finish: Hot-dip galvanized on exterior and interior of tank after fabrication.
 8. Upper Distribution System: Single-point type, fabricated from galvanized-steel pipe and fittings.
 9. Lower Distribution System: Hub and radial-arm or header-lateral type; fabricated from PVC pipe and fittings with individual, fine-slotted, nonclogging polyethylene strainers; arranged for even-flow distribution through resin bed.
- F. Controls: Automatic; factory mounted on mineral tanks and factory wired.
1. Adjustable duration of regeneration steps.
 2. Push-button start and complete manual operation override.
 3. Pointer on pilot-control valve shall indicate cycle of operation.
 4. Means of manual operation of pilot-control valve if power fails.
 5. Main Operating Valves: Industrial, automatic, multiport, diaphragm type with the following features:
 - a. Slow opening and closing, nonslam operation.
 - b. Diaphragm guiding on full perimeter from fully open to fully closed.
 - c. Isolated dissimilar metals within valve.
 - d. Self-adjusting, internal, automatic brine injector that draws brine and rinses at constant rate independent of pressure.
 - e. Float-operated brine valve to automatically measure the correct amount of brine to the softener and refill with fresh water.
 - f. Sampling cocks for soft water.
 6. Flow Control: Automatic control of backwash and flush rates over variations in operating pressures that do not require field adjustments. Equip mineral tanks with automatic-reset-head water meter that electrically activates cycle controller to initiate regeneration at preset total in gallons (liters) and that automatically resets after regeneration to preset total in gallons (liters) for next service run. Include alternator to regenerate one mineral tank with the other in service.
- G. Brine Tank: Combination measuring and wet-salt storing system.
1. Tank and Cover Material: Fiberglass a minimum of 3/16 inch (4.8 mm) thick; or molded polyethylene a minimum of 3/8 inch (9.5 mm) thick.
 2. Brine Valve: Float operated and plastic fitted for automatic control of brine withdrawn and freshwater refill.
 3. Size: Large enough for at least four regenerations at full salting.
- H. Factory-Installed Accessories:

1. Piping, valves, tubing, and drains.
2. Sampling cocks.
3. Main-operating-valve position indicators.
4. Water meters.

I. Water Test Kit: Include in wall-mounting enclosure for water softener.

J. Capacities and Characteristics:

1. Continuous Service Flow Rate: <Insert **gpm (L/s)**> at **15-psig (104-kPa)** pressure loss.
2. Peak Service Flow Rate: <Insert **gpm (L/s)**> at **25-psig (173-kPa)** pressure loss.
3. Water Consumption: <Insert **gal./day (cu. m/day)**>.
4. Water Demand: <Insert **number**> hours/day.
5. Electrical Characteristics:
 - a. Volts: <Insert **value**>.
 - b. Phase: <Insert **value**>.
 - c. Hertz: <Insert **value**>.
 - d. Full-Load Amperes: <Insert **value**>.
 - e. Minimum Circuit Ampacity: <Insert **value**>.
 - f. Maximum Overcurrent Protection: <Insert **amperage**>.
 - g. Interrupting Capacity: <Insert **amperage**>.

2.11 RO EQUIPMENT FOR HVAC MAKEUP WATER

- A. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Description: Factory fabricated and tested with RO membrane elements in housings, high-pressure pumps and motors, controls, valves, and prefilter; mounted on skid.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Fabricate supports and attachments to tanks with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure as recommended in writing by manufacturer.
- E. Skid Assembly: Welded-steel frame coated with epoxy protective finish.
- F. RO Membrane and Housing:
 1. Element: Thin-film composite with U-cup brine seal with minimum 98 percent salt rejection based on 2000-ppm water supplied at **225 psig (1551 kPa)** and **77 deg F (25 deg C)**.
 2. Housing: ASTM A 666, Type 304 stainless steel with PVC end caps held in place with stainless-steel straps.
- G. High-Pressure Pumps and Motors:
 1. Pump:

- a. Vertical, multistage centrifugal operating at 3500 rpm with ASTM A 666, Type 304 stainless-steel casing, shaft, impellers, and inlet and discharge casting.
- b. Bearings shall be tungsten carbide and ceramic.
- c. Cast-iron frame and flanged suction and discharge connections.
- d. Motor: NEMA-standard, C-faced totally enclosed, fan cooled motor supported on the pump-bearing frame. General requirements for motors are specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

H. Controls:

1. Microprocessor-based controller with digital display.
2. Interlock for remote start/stop control.
3. Membrane flush sequence when pumps shut down.
4. Run time indicator.
5. Low-pressure safety cutoff.
6. Panel-mounted gages as follows:
 - a. Product and concentrate.
 - b. Inlet, cartridge filter outlet, RO feed, RO concentrate, and RO product pressures.
 - c. Product conductivity monitor.

I. Valves:

1. Stainless-steel pump, concentrate, and recycle throttling valves rated for minimum 300 psig (2068 kPa).
2. Automatic inlet shutoff valve, diaphragm type; solenoid actuated, normally closed, and constructed of glass-reinforced noryl thermoplastic.
3. PVC valves with EPDM seats and seals for isolation at inlet, and check and sample valves at product and concentrate. Sample valves at cartridge filter outlet, concentrate, and product outlet.

J. Prefilter:

1. Housing: Polypropylene with built-in relief or vent valve.
2. Element: Spun-wound polypropylene.

K. Inlet Water Tempering Valve: Thermostatic water-tempering valve to maintain [77 deg F (25 deg C)] <Insert value> inlet water temperature to RO unit.

L. Activated Carbon Filter:

1. Media Tank: Fiberglass-reinforced polyester rated for minimum 150 psig (1035 kPa) with internal backwash distributor and filtered water collector.
2. Media: 12-by-40-mesh, bituminous coal-based activated carbon.
3. Backwash Valve: Piston-operated control valve with drain-line, flow-control orifice.
4. Backwash Control: Seven-day time clock.

M. Atmospheric Storage Tank:

1. Tank: Polyethylene single piece with closed top and flat bottom with manway in top, 0.2-micron filter vent, inlet, discharge, and drain piping connections, and bulkhead fittings for level controls.
2. Control: Level switches start and stop RO unit. Low-level limit shall stop repressurization pumps and signal an alarm.

N. Repressurization Pumps:

1. Pumps: Two close-coupled, single-stage centrifugal pumps with mechanical seals. Wetted components ASTM A 666, Type 316 stainless steel.
2. Controls: NEMA-4X pump control panel constructed of fiberglass to control pumps, one operating and one standby, with automatic alternator and fail-over control.
3. Motor: Open, drip proof motor supported on the pump-bearing frame. General requirements for motors are specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

O. Water Test Kit: Include in wall-mounting cabinet for RO unit.

P. Capacities and Characteristics:

1. RO Product Flow Rate: <Insert **gpm (L/s)**>.
2. Total Water Flow Rate: <Insert **gpm (L/s)**>.
3. Daily Water Consumption: <Insert **gal./day (cu. m/day)**>.
4. Water Demand: <Insert **number**> hours/day.
5. Storage Tank Size: <Insert **gal. (L)**>.
6. RO Inlet Operating Temperature: [**77 deg F (25 deg C)**] <Insert **value**>.
7. High-Pressure Pump:
 - a. Discharge Pressure: <Insert **psig (kPa)**>.
 - b. Flow Rate: <Insert **gpm (L/s)**>.
 - c. Horsepower: <Insert **value**>.
 - d. Motor Speed: [**3500**] <Insert **number**> rpm.
8. Repressure Pumps:
 - a. Discharge Pressure: <Insert **psig (kPa)**>.
 - b. Flow Rate: <Insert **gpm (L/s)**>.
 - c. Horsepower: <Insert **value**>.
 - d. Motor Speed: [**3500**] <Insert **number**> rpm.
9. Prefilter Design (at Total Water Flow Rate):
 - a. Filter Efficiency: [**98**] <Insert **number**> percent.
 - b. Particle Size: [**5**] <Insert **number**> microns and larger.
 - c. Clean Pressure Loss: [**2 psig (14 kPa)**] <Insert **value**>.
 - d. Replacement Pressure Loss: [**6 psig (41 kPa)**] <Insert **value**>.

10. Electrical Characteristics (Single-Point Connection):

- a. Volts: <Insert value>.
- b. Phase: <Insert value>.
- c. Hertz: <Insert value>.
- d. Full-Load Amperes: <Insert value>.
- e. Minimum Circuit Ampacity: <Insert value>.
- f. Maximum Overcurrent Protection: <Insert amperage>.
- g. Interrupting Capacity: <Insert amperage>.

2.12 FILTRATION EQUIPMENT

A. Multimedia Filters:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Description: Factory-fabricated and -tested, simplex, multimedia filter system of filter tank, media, strainer, circulating pump, piping, and controls for removing particles from water.
 - a. Filter Tank: Corrosion resistant with distribution system and media.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - a. Fabricate and label steel filter tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 - b. Fabricate and label FRP filter tanks to comply with ASME Boiler and Pressure Vessel Code: Section X, if indicated.
 - c. Pipe Connections **NPS 2 (DN 50)** and Smaller: Threaded according to ASME B1.20.1.
 - d. Steel Tank Pipe Connections **NPS 2-1/2 (DN 65)** and Larger: Steel, Class 150 flanges according to ASME B16.5 or grooved according to AWWA C606.
 - e. FRP Tank Pipe Connections **NPS 2-1/2 (DN 65)** and Larger: Type A, integral; **[Designation E, 125-psig (0.862-MPa)] [or] [Designation F, 150-psig (1.034-MPa)]** pressure category flanges of grade same as tank material according to ASTM D 5421.
 - f. Motorized Valves: Flanged or grooved-end, ductile-iron butterfly type with **[EPDM]** <Insert material> valve seat and stem seal; with ASTM B 148 aluminum bronze disc.
 - g. Strainer: Basket type mounted on pump suction.
 - h. Piping: ASTM A 53/A 53M, Type S, F, or E; Grade B, Schedule 40 black steel, with flanged, grooved, or threaded joints and malleable, steel welding, or ductile-iron fittings.
 - i. Piping: **ASTM B 88, Type L (ASTM B 88M, Type B)** copper water tube, copper-alloy solder-joint fittings and brazed, flanged, or grooved joints.
 - j. Safety Valves: Automatic pressure relief.
 - k. Circulating Pump: Overhung impeller, close coupled, single stage, end suction, centrifugal. Comply with UL 778 and with HI 1.1-1.2 and HI 1.3.

- 1) Casing: Radially split, cast iron.
 - 2) Pressure Rating: [125 psig (860 kPa)] [150 psig (1035 kPa)] minimum.
 - 3) Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, closed, and keyed to shaft.
 - 4) Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
 - 5) Seal: Mechanical.
 - 6) Motor: ODP motor supported on the pump-bearing frame. General requirements for motors are specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
- l. Controls: Automatic control of circulating pump and tank backwash; factory wired for single electrical connection.
- 1) Panel: NEMA 250, [Type 4] <Insert type> enclosure with time clock and pressure gages.
 - 2) Pump: Automatic and manual switching; manual switch position bypasses safeties and controls.
 - 3) Backwash: Automatic; with time clock and differential pressure switch.
 - 4) Backwash Valve: Tank mounted with valves interlocked to single actuator.
- m. Support: Skid mounting. [Fabricate supports and base and attachment to tank with reinforcement strong enough to resist filter movement during a seismic event when filter base is anchored to building structure.]
4. Capacities and Characteristics:
- a. Filter Design:
 - 1) Water Flow: <Insert gpm (L/s)>.
 - 2) Clean Pressure Loss: [5 psig (34.5 kPa)] <Insert value>.
 - 3) Maximum Media Flow Rate: [15 gpm/sq. ft. (10.2 L/s per sq. m)] <Insert value>.
 - 4) Filtration Efficiency: [98] <Insert number> percent.
 - 5) Particle-Specific Gravity: [1.8] <Insert number>.
 - 6) Particle Size: [5] [10] [20] [45] <Insert number> microns.
 - b. Filter Tank: With internal distribution piping.
 - 1) Pressure Rating: <Insert psig (kPa)>.
 - 2) Diameter: <Insert inches (mm)>.
 - 3) Inlet and Outlet Size: <Insert NPS (DN)>.
 - 4) Blowdown Piping Outlet Size: <Insert NPS (DN)>.
 - c. Filter Media: <Insert material>.
 - d. Start Backwash Pressure Loss: [13 psig (90 kPa)] <Insert value>.
 - e. Backwash Period: [10] <Insert number> minutes.
 - f. Circulating Pump:
 - 1) Capacity: <Insert gpm (L/s)>.
 - 2) Total Dynamic Head: <Insert feet (kPa)>.
 - 3) Motor Speed: <Insert number> rpm.

- 4) Inlet Size: <Insert **NPS (DN)**>.
- 5) Outlet Size: <Insert **NPS (DN)**>.

g. Pump Motor Size and Electrical Characteristics:

- 1) Horsepower: <Insert value>.
- 2) Volts: [120] [208] [240] [277] [480] <Insert number> V.
- 3) Phase: [Single] [Three].
- 4) Hertz: [60] <Insert number> Hz.

h. Unit Electrical Characteristics:

- 1) Full-Load Amperes: <Insert value>.
- 2) Minimum Circuit Ampacity: <Insert value>.
- 3) Maximum Overcurrent Protection: <Insert amperage>.
- 4) Interrupting Capacity: <Insert amperage>.

B. Self-Cleaning Strainers:

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Description: Factory-fabricated and -tested, ASTM A 126, Class B, cast-iron or steel, self-cleaning strainer system of tank, strainer, backwash arm or cleaning spiral, drive and motor, piping, and controls for removing particles from water.
 - a. Fabricate and label ASTM A 126, Class B, cast-iron or steel strainer tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 - b. Pipe Connections:
 - 1) **NPS 2 (DN 50)** and Smaller: Threaded according to ASME B1.20.1.
 - 2) **NPS 2-1/2 (DN 65)** and Larger: Steel, Class 150 flanges according to ASME B16.5 or grooved according to AWWA C606.
3. Motorized Valves: Flanged or grooved-end, ductile-iron angle type with [EPDM] <Insert material> valve seat and stem seal; with ASTM B 148 aluminum bronze disc.
4. Strainer: ASTM A 666, Type 316 stainless steel.
5. Piping: ASTM A 53/A 53M, Type S, F, or E; Grade B, Schedule 40 black steel, with flanged, grooved, or threaded joints and malleable, steel welding, or ductile-iron fittings.
6. Safety Valves: Automatic pressure relief.
7. Backwash Arm Drive:
 - a. Drive Casing: Cast iron.
 - b. Worm Gears: Immersed in oil.
 - c. Motor: ODP motor supported on the strainer-bearing frame. General requirements for motors are specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
8. Controls: Automatic control of backwash; factory wired for single electrical connection.
 - a. Panel: NEMA 250, [Type 4] <Insert type> enclosure with time clock and pressure gages.

- b. Backwash Arm Drive: Automatic and manual switching; manual switch position bypasses safeties and controls.
 - c. Backwash: Automatic; with time clock and differential pressure switch.
 - d. Backwash Valve: Electric actuator.
- 9. Support: Skid mounting. **[Fabricate supports and base and attachment to tank with reinforcement strong enough to resist strainer movement during a seismic event when strainer base is anchored to building structure.]**
- 10. Capacities and Characteristics:
 - a. Strainer Design:
 - 1) Water Flow: **<Insert gpm (L/s)>**.
 - 2) Clean Pressure Loss: **[5 psig (34.5 kPa)] <Insert value>**.
 - 3) Strainer Mesh: **[40] [60] [80] <Insert number>**.
 - b. Strainer Tank: With internal distribution piping.
 - 1) Material: **[Cast iron] [Steel] <Insert material>**.
 - 2) Pressure Rating: **[150 psig (1034 kPa)] <Insert value>**.
 - 3) Inlet and Outlet Size: **<Insert NPS (DN)>**.
 - 4) Backwash Piping Outlet Size: **<Insert NPS (DN)>**.
 - c. Start Backwash: **[10 psig (69 kPa)] <Insert value>**.
 - d. Backwash Period: **[5] <Insert number>** minutes.
 - e. Drive Motor Size and Electrical Characteristics:
 - 1) Horsepower: **<Insert value>**.
 - 2) Volts: **[120] [208] [240] [277] [480] <Insert number> V**.
 - 3) Phase: **[Single] [Three]**.
 - 4) Hertz: **[60] <Insert number> Hz**.
 - f. Unit Electrical Characteristics:
 - 1) Full-Load Amperes: **<Insert value>**.
 - 2) Minimum Circuit Ampacity: **<Insert value>**.
 - 3) Maximum Overcurrent Protection: **<Insert amperage>**.
 - 4) Interrupting Capacity: **<Insert amperage>**.

C. **[Bag] [Cartridge]-Type Filters:**

- 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- 2. Description: Floor-mounting housing with filter **[bags] [cartridges]** for removing particles from water.
 - a. Housing: Corrosion resistant; designed to separate inlet from outlet and to direct inlet through **[bag] [cartridge]**-type water filter; with **[bag support and]**base, feet, or skirt.
 - 1) Pipe Connections **NPS 2 (DN 50)** and Smaller: Threaded according to ASME B1.20.1.

- 2) Steel Housing Pipe Connections **NPS 2-1/2 (DN 65)** and Larger: Steel, Class 150 flanges according to ASME B16.5 or grooved according to AWWA C606.
 - 3) Plastic Housing Pipe Connections **NPS 2-1/2 (DN 65)** and Larger: **150-psig (1035-kPa)** plastic flanges.
- b. **[Bag] [Cartridge]**: Replaceable; of shape to fit housing.
3. Capacities and Characteristics:
- a. Filter Design:
 - 1) Water Flow Rate: **<Insert gpm (L/s)>**.
 - 2) Filtration Efficiency: **[98] <Insert number>** percent.
 - 3) Particle Size: **[10] [20] <Insert number>** microns and larger.
 - 4) Clean Pressure Loss: **[2 psig (14 kPa)] <Insert value>**.
 - 5) Pressure Loss at Replacement: **[6 psig (41 kPa)] <Insert value>**.
 - b. Housing:
 - 1) Material: **[Carbon steel] [Plastic]**.
 - 2) Pressure Rating: **<Insert psig (kPa)>**.
 - 3) Seal Material: **[Nitrile Rubber] <Insert material>**.
 - 4) Diameter: **<Insert inches (mm)>**.
 - 5) Height or Length: **<Insert inches (mm)>**.
 - 6) Inlet and Outlet Size: **<Insert NPS (DN)>**.
 - 7) Drain Size: **[Not applicable] <Insert NPS (DN)>**.
 - 8) Bag Support Basket Material: **[Stainless steel] <Insert material>**.
 - c. **[Bag] [Cartridge]**:
 - 1) Number Required: **<Insert number>**.
 - 2) Nominal Diameter: **<Insert inches (mm)>**.
 - 3) Nominal Length: **<Insert inches (mm)>**.
 - 4) Media Material: **[Cotton] [Polyester] [Polypropylene] <Insert material>**.

D. Centrifugal Separators:

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Description: Simplex separator housing with baffles and chambers for removing particles from water by centrifugal action and gravity.
3. Housing: With manufacturer's proprietary system of baffles and chambers.
 - a. Construction: Fabricate and label steel separator housing to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 - b. Inlet: Designed with tangential entry to produce centrifugal flow of feedwater.
 - c. Vortex Chamber: Designed for downward vortex flow and gravity separation of particles.
 - d. Collection Chamber: Designed to hold separated particles.
 - e. Outlet: Near top of unit.
 - f. Purge: At bottom of collection chamber.

- g. Pipe Connections **NPS 2 (DN 50)** and Smaller: Threaded according to ASME B1.20.1.
 - h. Pipe Connections **NPS 2-1/2 (DN 65)** and Larger: Steel, Class 150 flanges according to ASME B16.5 or grooved according to AWWA C606. Provide stainless-steel flanges if tank is stainless steel.
4. Motorized Purge Valve: Gate or plug pattern valve.
- a. Motorized Valves: Butterfly-type, flanged or grooved-end, ductile-iron body, with **[EPDM] <Insert material>** valve seat and stem seal; with ASTM B 148 aluminum bronze disc.
 - b. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
5. Strainer: Stainless-steel basket type mounted on pump suction.
6. Piping: ASTM A 53/A 53M, Type S, F, or E; Grade B, Schedule 40 black steel, with flanged, grooved, or threaded joints and malleable, steel welding, or ductile-iron fittings.
7. Piping: **ASTM B 88, Type L (ASTM B 88M, Type B)** copper water tube, copper-alloy solder-joint fittings, and brazed, flanged, or grooved joints.
8. Circulating Pump: Overhung impeller, close coupled, single stage, end suction, centrifugal. Comply with UL 778 and with HI 1.1-1.2 and HI 1.3.
- a. Casing: Radially split, cast iron.
 - b. Pressure Rating: **[125 psig (860 kPa)] [150 psig (1035 kPa)]** minimum.
 - c. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, closed, and keyed to shaft.
 - d. Shaft and Shaft Sleeve: Steel shaft with copper-alloy shaft sleeve.
 - e. Seal: Mechanical.
 - f. Motor: ODP motor supported on the pump-bearing frame. General requirements for motors are specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - g. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
9. Controls: Automatic control of circulating pump and separator purge; factory wired for single electrical connection.
- a. Panel: NEMA 250, **[Type 4] <Insert type>** enclosure.
 - b. Pump: Automatic and manual switching; manual switch position bypasses safeties and controls.
 - c. Separator Purge: Automatic and manual.
 - d. TSS Controller Interlock: Open separator purge valve with bleed-off control.
10. Support: Skid mounting. **[Fabricate supports and base and attachment to separator housing with reinforcement strong enough to resist separator movement during a seismic event when separator base is anchored to building structure.]**
11. Capacities and Characteristics:
- a. Separator Design:

- 1) Water Flow Rate: <Insert **gpm (L/s)**>.
 - 2) Pressure Loss: [**5 psig (34.5 kPa)**] <Insert value>.
 - 3) Separator Efficiency: [**98**] <Insert number> percent.
 - 4) Particle-Specific Gravity: [**1.8**] <Insert number>.
 - 5) Particle Size: [**5**] [**10**] [**20**] [**45**] <Insert number> microns.
- b. Housing:
- 1) Material: [**Steel**] [**Stainless steel**] [**Plastic**] [**Fiberglass**] <Insert material>.
 - 2) Pressure Rating: <Insert **psig (kPa)**>.
 - 3) Diameter: <Insert **inches (mm)**>.
 - 4) Height: <Insert **inches (mm)**>.
 - 5) Inlet and Outlet Size: <Insert **NPS (DN)**>.
 - 6) Purge Size: <Insert **NPS (DN)**>.
- c. Circulating Pump:
- 1) Capacity: <Insert **gpm (L/s)**>.
 - 2) Total Dynamic Head: <Insert **feet (kPa)**>.
 - 3) Motor Speed: <Insert number> rpm.
 - 4) Inlet Size: <Insert **NPS (DN)**>.
 - 5) Outlet Size: <Insert **NPS (DN)**>.
- d. Pump Motor Size and Electrical Characteristics:
- 1) Horsepower: <Insert value>.
 - 2) Volts: [**120**] [**208**] [**240**] [**277**] [**480**] <Insert number> V.
 - 3) Phase: [**Single**] [**Three**].
 - 4) Hertz: [**60**] <Insert number> Hz.
 - 5) Full-Load Amperes: <Insert value>.
 - 6) Minimum Circuit Ampacity: <Insert value>.
 - 7) Maximum Overcurrent Protection: <Insert amperage>.
 - 8) Interrupting Capacity: <Insert amperage>.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

- A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

- A. Install chemical application equipment on concrete bases level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.

- B. Install seismic restraints for equipment and floor-mounting accessories and anchor to building structure. See Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.
- C. Install water-testing equipment on wall near water-chemical-application equipment.
- D. Install interconnecting control wiring for chemical treatment controls and sensors.
- E. Mount sensors and injectors in piping circuits.
- F. Bypass Feeders: Install in closed hydronic systems, including [**hot-water heating**] [**chilled water**] [**dual-temperature water**] [**and**] [**glycol cooling**], and equipped with the following:
 - 1. Install bypass feeder in a bypass circuit around circulating pumps unless otherwise indicated on Drawings.
 - 2. Install water meter in makeup-water supply.
 - 3. Install test-coupon assembly in bypass circuit around circulating pumps unless otherwise indicated on Drawings.
 - 4. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below feeder inlet.
 - 5. Install a swing check on inlet after the isolation valve.
- G. Install automatic chemical-feed equipment for steam boiler and steam condensate systems and include the following:
 - 1. Install makeup-water softener.
 - 2. Install water meter in makeup-water supply.
 - 3. Install inhibitor injection pumps and solution tanks with injection timer sensing contacts in water meter.
 - a. Pumps shall operate for timed interval when contacts close at water meter in makeup-water supply connection.
 - 4. Install test equipment and furnish test-kit to Owner.
 - 5. Install RO unit for makeup water.
 - 6. Install TSS controller with sensor and bleed valves.
 - a. Bleed valves shall cycle to maintain maximum TSS concentration.
 - 7. Install inhibitor injection timer with injection pumps and solution tanks.
 - a. Pumps shall operate for timed interval on contact closure at water meter in makeup-water supply connection. Injection pump shall discharge into main steam supply header.
- H. Install automatic chemical-feed equipment for [**condenser**] [**fluid-cooler spray**] water and include the following:
 - 1. Install makeup-water softener.
 - 2. Install water meter in makeup-water supply.

3. Install inhibitor injection pumps and solution tanks with injection timer sensing contacts in water meter.
 - a. Pumps shall operate for timed interval on contact closure at water meter in makeup-water supply connection. Injection pump shall discharge into boiler feedwater tank or feedwater supply connection at boiler.
4. Install test equipment and provide test-kit to Owner. Install test-coupon assembly in bypass circuit around circulating pumps unless otherwise indicated on Drawings.
5. Install TSS controller with sensor and bleed valves.
 - a. Bleed valves shall cycle to maintain maximum TSS concentration.
6. Install pH sensor and controller with injection pumps and solution tanks.
 - a. Injector pumps shall operate to maintain required pH.
7. Install biocide feeder alternating timer with two sets of injection pumps and solution tanks.
 - a. Injection pumps shall operate to feed biocide on an alternating basis.
8. Install ozone generator with diffusers in condenser-water piping.
 - a. Ozone generator shall operate continuously with condenser-water flow.
9. Install UV-irradiation lamps in condenser-water piping.
 - a. UV lights shall operate continuously with condenser-water flow.

3.3 OZONE-GENERATOR INSTALLATION

- A. Install ozone generator and equipment on concrete bases level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor mineral and brine tanks and floor-mounting accessories to substrate.
- B. Install seismic restraints for equipment and floor-mounting accessories and anchor to building structure. See Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.
- C. Pipe ozone from ozone generator to condenser water with stainless-steel pipe and fittings with welded joints.
- D. Install **[two]** **[three]**-piece, stainless-steel ball valve in ozone supply to condenser water.
- E. Pipe cooling water to ozone generator and to air-gap drain fitting with stainless-steel pipe and fittings with welded joints where enclosed in ozone-generator room.
- F. Install **[two]** **[three]**-piece, stainless-steel ball valve in cooling water supply to ozone generator.

- G. Mounting supports for ozone generator shall be ASTM A 666, Type 316 stainless steel.
- H. Mount breathing apparatus outside ozone-generator room.
- I. Mount and install ozone detector, warning lights, and audible alarm inside ozone-generator room. Mount another set of warning lights and audible alarm just outside the main entrance to ozone-generator room.

3.4 UV-IRRADIATION UNIT INSTALLATION

- A. Install UV-irradiation units on concrete bases level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor mineral and brine tanks and floor-mounting accessories to substrate.
- B. Install seismic restraints for UV-irradiation units and floor-mounting accessories and anchor to building structure. See Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

3.5 WATER SOFTENER INSTALLATION

- A. Install water softener equipment on concrete bases level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor mineral and brine tanks and floor-mounting accessories to substrate.
- B. Install seismic restraints for tanks and floor-mounting accessories and anchor to building structure. See Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.
- C. Install brine lines and fittings furnished by equipment manufacturer but not factory installed.
- D. Prepare mineral-tank distribution system and underbed for minerals and place specified mineral into mineral tanks.
- E. Install water-testing sets on wall adjacent to water softeners.

3.6 RO UNIT INSTALLATION

- A. Install RO unit and storage tank on concrete bases level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor RO unit and storage tank with pumps to substrate.
- B. Install seismic restraints for tanks and floor-mounting accessories and anchor to building structure. See Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.
- C. Install interconnecting piping and controls furnished by equipment manufacturer but not factory installed.
- D. Install water-testing sets on wall adjacent to RO unit.

3.7 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to equipment, allow space for service and maintenance.
- C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Section 232113 "Hydronic Piping."
- D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Section 230523.11 "Globe Valves for HVAC Piping," Section 230523.12 "Ball Valves for HVAC Piping," Section 230523.13 "Butterfly Valves for HVAC Piping," and Section 230523.15 "Gate Valves for HVAC Piping."
- E. See Section 221119 "Domestic Water Piping Specialties" for backflow preventers required in makeup-water connections to potable-water systems.
- F. Confirm applicable electrical requirements in electrical Sections for connecting electrical equipment.
- G. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- H. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.8 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:
 - 1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
 - 2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
 - 3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC system's startup procedures.
 - 4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
 - 5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.

7. Cap and subject piping to static water pressure of **50 psig (345 kPa)** above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
 8. Repair leaks and defects with new materials and retest piping until no leaks exist.
- C. Equipment will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Sample boiler water at one-week intervals after boiler startup for a period of five weeks, and prepare test report advising Owner of changes necessary to adhere to "Performance Requirements" Article for each required characteristic. Sample boiler water at **[four] [six] [eight] <Insert number>**-week intervals following the testing noted above to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section.
- F. At **[four] [six] [eight] <Insert number>**-week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis advising Owner of changes necessary to adhere to "Performance Requirements" Article.
- G. Comply with ASTM D 3370 and with the following standards:
1. Silica: ASTM D 859.
 2. Steam System: ASTM D 1066.
 3. Acidity and Alkalinity: ASTM D 1067.
 4. Iron: ASTM D 1068.
 5. Water Hardness: ASTM D 1126.

3.9 MAINTENANCE SERVICE

- A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion, scale formation, and biological growth for **[cooling, chilled-water piping] [heating, hot-water piping] [heating, steam and condensate piping] [steam and condensate system for humidifier and cooking appliance applications] [condenser-water piping]** and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion and shall include the following:
1. Initial water analysis and HVAC water-treatment recommendations.
 2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
 3. Periodic field service and consultation.
 4. Customer report charts and log sheets.
 5. Laboratory technical analysis.
 6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

3.10 DEMONSTRATION

- A. **[Engage a factory-authorized service representative to train] [Train]** Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.

END OF SECTION 232500