SECTION 232500 - HVAC WATER TREATMENT

Revise this Section by deleting and inserting text to meet Project-specific requirements.

This Section uses the term "Architect." Change this term to match that used to identify the design professional as defined in the General and Supplementary Conditions.

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

1. GENERAL
	* + 1. RELATED DOCUMENTS

Retain or delete this article in all Sections of Project Manual.

* + - * 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
			1. SUMMARY
				1. Section includes the following HVAC water-treatment systems:

Manual and automatic chemical-feed equipment and controls.

Ozone-generator biocide equipment and controls.

Stainless steel pipes and fittings.

UV-irradiation unit, biocide equipment, and controls.

Chemical-treatment test equipment.

Chemicals.

HVAC makeup-water softeners.

RO equipment for HVAC makeup water.

TDS controllers.

TSS controllers.

Water-filtration equipment.

* + - 1. DEFINITIONS

Retain terms that remain after this Section has been edited for a project.

* + - * 1. EEPROM: Electrically erasable, programmable read-only memory.
				2. PPM: Parts per million.
				3. RO: Reverse osmosis.
				4. TDS: Total dissolved solids consist of salts and other materials that combine with water as a solution.
				5. TSS: Total suspended solids include both organic and inorganic solids that are suspended in the water. These solids may include silt, plankton, and industrial wastes.
			1. SUBMITTALS
				1. Submittals for this section are subject to the re-evaluation fee identified in Article 4 of the General Conditions.
				2. Manufacturer’s installation instructions shall be provided along with product data.
				3. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).
				4. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for the following products:

Bypass feeders.

Water meters.

Inhibitor injection timers.

pH controllers.

TDS controllers.

TSS controllers.

Biocide feeder timers.

Chemical solution tanks.

Injection pumps.

Ozone generators.

UV-irradiation units.

Chemical test equipment.

Chemical material safety data sheets.

Inhibited ethylene glycol.

Inhibited propylene glycol.

Water softeners.

RO units.

Multimedia filters.

Self-cleaning strainers.

Replaceable bag- or cartridge-type filters.

Centrifugal separators.

* + - * 1. Shop Drawings: Pretreatment equipment and chemical- [**and ozone-generator-biocide-**] [**and UV-irradiation-biocide-**] treatment equipment, showing tanks, maintenance space required, and piping connections to HVAC systems.

Include plans, elevations, sections, and attachment details.

Include diagrams for power and control wiring.

* + - * 1. Water-Analysis Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider.

Retain "Field quality-control reports" paragraph below if Contractor is responsible for field quality-control testing and inspecting.

* + - * 1. Field quality-control reports.

Retain "Water-Treatment Program" paragraph below if retaining "Maintenance Service" Article.

* + - * 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.

Retain "Passivation Confirmation Report" paragraph below for open systems that contain a galvanized cooling tower or an evaporative or a fluid cooler.

* + - * 1. Passivation Confirmation Report: Verify passivation of galvanized-steel surfaces, and confirm this observation in a letter to Architect.
			1. CLOSEOUT SUBMITTALS
				1. 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.
			2. QUALITY ASSURANCE

See Section 014000 "Quality Requirements" for a definition of the term "experienced."

* + - * 1. 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.
1. PRODUCTS

Manufacturers and products listed in SpecAgent and MasterWorks Paragraph Builder are neither recommended nor endorsed by the AIA or Deltek. Before inserting names, verify that manufacturers and products listed there comply with requirements retained or revised in descriptions and are both available and suitable for the intended applications.

* + - 1. HVAC WATER-TREATMENT MANUFACTURERS

Retain this article to require a single-source responsibility for all water-treatment equipment and materials.

* + - * 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Anderson Chemical Company.

Aqua-Chem, Inc.

Barclay Water Management, Inc.

Boland Trane Services.

Cascade Water Services, Inc.

Earthwise Environmental Inc.

H-O-H Water Technology, Inc.

Metro Group, Inc. (The).

Nalco; an Ecolab company.

Sonitec-Vortisand Inc.

Suez Water Technologies (Formerly GE Water).

Watcon, Inc.

Approved equivalent.

* + - 1. PERFORMANCE REQUIREMENTS

The companies listed above supply water-treatment chemicals. They will also furnish and install all required hardware and provide a complete on-site HVAC water-treatment program.

* + - * 1. Provide all hardware, chemicals, and other material necessary to maintain HVAC water quality in all systems as indicated in this Specification. 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.
				2. 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.

Desirable water-quality values differ widely, depending upon raw water conditions, piping system materials, and service conditions. Recommendations from water-treatment companies vary. Specified target values must be determined by careful consideration of all operating conditions and with the assistance of a qualified water chemistry expert.

* + - * 1. Closed hydronic systems, including [hot-water heating below **250 deg F**] [chilled water] [dual-temperature water] [glycol heating] [and] [glycol cooling] shall have the following water qualities:

pH: Maintain a value within <**7-10 pH units**>.

Alkalinity: Maintain a value within <**100-500**> ppm as CaCO(3).

Steel Corrosion Inhibiters: Provide sufficient inhibitors to limit mild steel corrosion to <**0.50**> mils per year. Maintain soluble iron concentrations at or below <**0.10**> ppm.

Yellow Metal Corrosion Inhibitor: Provide sufficient copper and brass corrosion inhibitors to limit copper corrosion to <**0.10**> mils per year. Maintain soluble copper concentrations at or below <**0.20**> ppm.

Scale Control: Provide softened water for initial fill and makeup. [**Where softened water is not used, provide sufficient scale inhibitors to prevent formation of scale and maintain all scale-forming material in solution.**]

Dispersants: Provide sufficient dispersants to prevent sedimentation of fine particulate matter.

Microbiological Limits:

Total Aerobic Plate Count: Maintain a maximum value of <**1,000**> organisms/mL.

Total Anaerobic Plate Count: Maintain a maximum value of <**100**> organisms/mL.

Nitrate Reducers: Maintain a maximum value of <**100**> organisms/mL.

Sulfate Reducers: Maintain a maximum value of <**zero**> organisms/mL.

Iron Bacteria: Maintain a maximum value of <**zero**> organisms/mL.

<**Insert other applicable requirements**>.

* + - * 1. Open hydronic systems, including [**condenser**] [**and**] [**fluid-cooler spray**] water, shall have the following water qualities:

pH: Maintain a value within <**6.5 to 8.5 pH units**>.

Alkalinity: Maintain a maximum value of <**100**> ppm as CaCO(3).

Silica in Cooling Towers: Maintain a value no higher than <**100**> ppm.

Silica in Evaporative Condensers: Maintain a value no higher than <**100**> ppm.

Hardness in Cooling Towers: Maintain a value no higher than <**1,200**> ppm as CaCO(3).

Hardness in Evaporative Condensers: Maintain a value no higher than <**750**> ppm as CaCO(3).

Steel Corrosion Inhibiters: Provide sufficient inhibitors to limit mild steel corrosion to <**0.50**> mils per year. Maintain soluble iron concentrations at or below <**0.10**> mg/L.

Yellow Metal Corrosion Inhibitor: Provide sufficient copper and brass corrosion inhibitors to limit copper corrosion to <**0.10**> mils per year. Maintain soluble copper concentrations at or below <**0.20**> ppm.

Scale Control: [**Provide softened water for initial fill and makeup.**] [**Provide sufficient scale inhibitors to prevent formation of scale and maintain all scale-forming material in solution.**]

Dispersants: Provide sufficient dispersants to prevent sedimentation of fine particulate matter.

Microbiological Limits:

Total Aerobic Plate Count: Maintain a maximum value of <**10,000**> organisms/mL.

Total Anaerobic Plate Count: Maintain a maximum value of <**1,000**> organisms/mL.

Nitrate Reducers: Maintain a maximum value of <**100**> organisms/mL.

Sulfate Reducers: Maintain a maximum value of <**zero**> organisms/mL.

Iron Bacteria: Maintain a maximum value of <**zero**> organisms/mL.

<**Insert other applicable requirements**>.

Retain "Passivation for Galvanized Steel" paragraph below for cooling towers, evaporative coolers, or other equipment with galvanized-steel components, to avoid white rust. All galvanized-steel component surfaces exposed to cooling water must be properly passivated in accordance with manufacturer's instructions during initial startup. Water quality, especially pH and alkalinity, must be maintained within manufacturer's required parameters during the passivation period and during later operation to avoid serious damage to galvanized surfaces.

* + - * 1. Passivation for Galvanized Steel:

Passivation of all galvanized-steel cooling towers and other system components must be conducted strictly in accordance with manufacturer's instructions in order to validate warranties. During the required passivation period, all water-quality parameters must be maintained in accordance with manufacturer's specifications, and all other requirements must be observed.

* + - * 1. Steam Boiler and Steam Condensate:

Retain "Steam Condensate" subparagraph below if chemical treatment is required for condensate piping system. Chemicals that carry over from boiler to treat the condensate-water piping may make steam unfit for humidification or foodservice.

Steam Condensate:

pH: Maintain a value within <**8.5 to 9.5 pH units**>.

Alkalinity: Maintain a value no higher than <**5 to 50**> ppm as CaCO(3).

Steel Corrosion Inhibiters: Provide sufficient inhibitors to limit mild steel corrosion to <**0.50**> mils per year. Maintain soluble iron concentrations at or below <**0.10**> ppm.

Yellow Metal Corrosion Inhibitor: Provide sufficient copper and brass corrosion inhibitors to limit copper corrosion to <**0.10**> mils per year. Maintain soluble copper concentrations at or below <**0.20**> mg/L.

Ammonia: Maintain a value of <**20**> ppm.

<**Insert other requirements if necessary**>.

Steam boiler operating at 100 psig and less shall have the following water qualities:

Silica: Maintain a value no higher than <**0.20**> ppm as SiO(2).

TSS: Maintain a value no higher than <**15**> ppm.

TDS: Maintain a value no higher than <**3500**> ppm.

Total Alkalinity: Maintain a value no higher than <**700**> ppm as CaCO(3).

pH: Maintain a value within <**9.5-11.5**> pH.

<**Insert other applicable requirements**>.

* + - 1. MANUAL CHEMICAL-FEED EQUIPMENT

Retain this article for closed piping systems, such as chilled-water, hot-water, and dual-temperature piping.

* + - * 1. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet. Provide quarter- turn or threaded fill cap with gasket seal and diaphragm arranged to lock the top onto the feeder when exposed to system pressure in the vessel. Provide a NPS 3/4 IN quarter-turn valve on inlet and outlet.

Capacity: [**2 gal.**] [**5 gal.**] <**Insert value**>.

Minimum Working Pressure: [**125 psig**] [**175 psig**] <**Insert value**>.

* + - 1. AUTOMATIC CHEMICAL-FEED EQUIPMENT

Retain one or more of "Water Meter, Oscillating Piston," "Water Meter, Turbine Type, Threaded," and "Water Meter, Turbine Type, Flanged" paragraphs below. If retaining more than one paragraph, indicate on Drawings where meters are to be installed. Open systems and large closed systems, of more than 400 gpm (25 L/s), should be equipped with a meter. Coordinate type of meter signal with controllers and DDC system.

* + - * 1. Water Meter, Oscillating Piston:

AWWA C700, oscillating-piston, magnetic-drive, totalization meter.

Body: Bronze.

Minimum Working-Pressure Rating: 150 psig.

Maximum Pressure Loss at Design Flow: 3 psig.

Registration: Gallons or cubic feet.

End Connections: Threaded.

[**Controls: Flow-control switch with normally open contacts, rated for maximum 10 A, 250-V ac, that will momentarily close at adjustable increments of total flow.**]

[**Provide an electronic or digital interface for flow rate indication at central workstation compatible with DDC system, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC." Low-voltage signal must be capable of transmitting 1000 feet.**]

[**All electrical components, devices, and accessories must be listed and labeled as defined in NFPA 70, by a qualified testing agency, and must be marked for intended location and application.**]

* + - * 1. Water Meter, Turbine Type, Threaded:

AWWA C701, turbine-type, totalization meter.

Body: Bronze.

Minimum Working-Pressure Rating: 100 psig.

Maximum Pressure Loss at Design Flow: 3 psig.

Registration: Gallons or cubic feet.

End Connections: Threaded.

[**Controls: Flow-control switch with normally open contacts, rated for maximum 10 A, 250-V ac, that will momentarily close at adjustable increments of total flow.**]

[**Provide an electronic or digital interface for flow rate indication at central workstation compatible with DDC system, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC." Low-voltage signal must be capable of transmitting 1000 feet.**]

[**All electrical components, devices, and accessories must be listed and labeled as defined in NFPA 70, by a qualified testing agency, and must be marked for intended location and application.**]

* + - * 1. Water Meter, Turbine Type, Flanged:

AWWA C701, turbine-type, totalization meter.

Body: [**Bronze**] [**Epoxy-coated cast iron**].

Minimum Working-Pressure Rating: 150 psig.

Maximum Pressure Loss at Design Flow: 3 psig.

Registration: Gallons or cubic feet.

End Connections: Flanged.

[**Controls: Flow-control switch with normally open contacts, rated for maximum 10 A, 250-V ac, that will momentarily close at adjustable increments of total flow.**]

[**Provide and electronic or digital interface for flow rate indication at central workstation compatible with DDC system, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC." Low-voltage signal must be capable of transmitting 1000 feet.**]

[**All electrical components, devices, and accessories must be listed and labeled as defined in NFPA 70, by a qualified testing agency, and must be marked for intended location and application.**]

Retain "Inhibitor Injection Timers" paragraph below for open systems.

* + - * 1. Inhibitor Injection Timers:

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."**]

Programmable timers with infinite adjustment over full range, mounted in cabinet with hand-off-auto switches and status lights.

Test switch.

Hand-off-auto switch for chemical pump.

Illuminated legend to indicate feed when pump is activated.

Programmable lockout timer with indicator light. Lockout timer to deactivate the pump and activate alarm circuits.

Digital display makeup totalizer to measure amount of makeup and bleed-off water from two water meter inputs.

Retain "pH Controller" paragraph below for open systems that require acid injection for pH control.

* + - * 1. pH Controller:

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."**]

Digital display and touch pad for input.

Sensor probe adaptable to sample stream manifold.

High, low, and normal pH indication.

High or low-pH-alarm-light trip points, field adjustable; with silence switch.

Hand-off-auto switch for acid pump.

Internal adjustable hysteresis or deadband.

Retain "TDS Controller" paragraph below for open systems, including steam boilers, cooling towers, and fluid coolers.

* + - * 1. TDS Controller:

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."**]

Digital display and touch pad for input.

Sensor probe adaptable to sample stream manifold.

High, low, and normal conductance indication.

High- or low-conductance-alarm-light trip points, field adjustable; with silence switch.

Hand-off-auto switch for solenoid bleed-off valve.

Bleed-off valve activated indication.

Internal adjustable hysteresis or deadband.

Bleed Valves:

Cooling Systems: Forged-brass body, globe pattern, general-purpose solenoid with continuous-duty coil, or motorized valve.

Steam Boilers: Motorized ball valve, steel body, and TFE seats and seals.

Retain "TSS Controller" paragraph below for open systems, including steam boilers, cooling towers, and fluid coolers when TSS controller is required.

* + - * 1. TSS Controller:

Microprocessor-based controller, 1 percent accuracy in a range from 0.001 mg/L to 50 g/L. Incorporate solid-state integrated circuits and digital display in NEMA 250, Type 4X enclosure.[**Interface for start/stop and status indication at central workstation, as described in Section 230923 "Direct Digital Control (DDC) System for HVAC."**]

[**Forms of digital communication:**] [**MODBUS RS-232**] [**MODBUS RS-485**] [**Profibus DP**].

Digital display and touch pad for input.

Sensor probe adaptable to sample stream manifold.

High- or low-value-alarm-light trip points, field adjustable; with silence switch.

Hand-off-auto switch for solenoid bleed-off valve.

Bleed-off valve activated indication.

Internal adjustable hysteresis or deadband.

Retain "Biocide Feeder Timer" paragraph below for open hydronic systems, including cooling towers and fluid coolers.

* + - * 1. Biocide Feeder Timer:

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."**]

24-hour timer with 14-day skip feature to permit activation any hour of day.

Precision, solid-state, bleed-off lockout timer and clock-controlled biocide pump timer. Prebleed and bleed lockout timers.

Solid-state alternator to enable use of two formulations.

24-hour display of time of day.

14-day display of day of week.

Battery backup, so clock is not disturbed by power outages.

Hand-off-auto switches for biocide pumps.

Biocide A and Biocide B pump running indication.

* + - * 1. Chemical Solution Tanks:

Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with minimum 110 percent containment vessel.

Molded cover with recess for mounting pump.

Capacity: [**30 gal.**] [**50 gal.**] [**120 gal.**] <**Insert value**>.

* + - * 1. Chemical Solution Injection Pumps:

Self-priming, positive displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.

Adjustable flow rate.

Metal and thermoplastic construction.

Built-in relief valve.

Motor characteristics, such as NEMA designation, temperature rating, service factor, enclosure type, and efficiency, are specified in Section 230513 "Common Motor Requirements for HVAC Equipment." If different characteristics are required, add subparagraphs below to suit Project.

Fully enclosed, continuous-duty, single-phase motor. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

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.

* + - * 1. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints, except ASTM A269/A269M, Type 304 stainless steel for steam boiler injection assemblies.
				2. Injection Assembly:

Quill: Minimum NPS 1/2 with insertion length sufficient to discharge into at least 25 percent of pipe diameter.

Ball Valve: [**Three**] [**Two**]-piece stainless steel, as described in "Stainless Steel Pipes and Fittings" Article; selected to fit quill.

Packing Gland: Mechanical seal on quill of sufficient length to allow quill removal during system operation.

Assembly Pressure/Temperature Rating: Minimum 600 psig at 200 deg F.

* + - 1. OZONE-GENERATOR BIOCIDE EQUIPMENT
				1. 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.
				2. Water-cooled generators shall be provided with cooling water at maximum [**70 deg F**] <**Insert value**> and [**35 psig**] <**Insert value**>.
				3. Generator vessels exposed to system pressure shall be constructed in accordance with 2017 ASME Boiler and Pressure Vessel Code and be equipped with pressure-relief valve.
				4. External air compressor or induced airflow through a cleanable prefilter supplies concentrated oxygen through a molecular sieve, with minus 62 deg F dew point to avoid the formation of nitric acid.
				5. 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."**]
				6. Ozone Contactors:

Bubble diffusers.

Induction injection nozzle.

Injectors with static mixers.

* + - * 1. Ozone Detector and Alarm Devices:

Detector:

Sensor: Metal dioxide semiconductor.

Concentration Range: [**0 to 10**] <**Insert range**> ppm.

Accuracy: Plus or minus 0.01 ppm.

Sensitivity: 0.01 ppm.

Response Time: Maximum 10 seconds.

Operating Temperature: 50 to 100 deg F.

Relative Humidity: 15 to 90 percent, noncondensing over the operating temperature range.

Horns:

Electric-vibrating-polarized type.

24-V dc, with provision for housing the operating mechanism behind a grille.

Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn.

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.

Visible Alarm Devices:

Xenon strobe lights listed in UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate.

Rated Light Output: [**75**] [**110**] <**Insert number**> candela.

Strobe Leads: Factory connected to screw terminals.

Retain paragraph below when Ozone system is included in project.

* + - * 1. Self-Contained Breathing Apparatus: Open-circuit, pressure-demand compressed air includes completely assembled, portable, self-contained devices designed for hazardous breathing environment application.

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 CO(2) buildup, and perspiration drain to avoid skin irritation and to prevent eyepiece, spectacle, and lens fogging.

Backplate: Orthopedically designed of [**chemical and impact-resistant, glass-fiber composite**] [**aluminum**].

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 are padded with flame-resistant material, reinforced with stainless steel cable, and attached with T-nuts, washers, and screws.

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.

Wall-Mounting Cabinet: Leakproof, corrosion-resistant, clear, plastic case.

Tested and Certified: By the National Institute for Occupational Safety and Health and by the Mine Safety and Health Administration, in accordance with 42 CFR 84, Subpart H.

* + - 1. STAINLESS STEEL PIPES AND FITTINGS
				1. Stainless Steel Tubing: Comply with ASTM A269, Type 316.
				2. Stainless Steel Fittings: Comply with ASTM A815, Type 316, Grade WP-S.

Retain "Two-Piece, Full-Port, Stainless Steel Ball Valves," or "Three-Piece, Full-Port, Stainless Steel Ball Valves" paragraph below.

* + - * 1. Two-Piece, Full-Port, Stainless Steel Ball Valves: ASTM A351, Type 316 stainless steel body; ASTM A276, Type 316 stainless steel stem and vented ball, carbon-filled TFE seats, threaded body design with adjustable stem packing, threaded ends, and 250-psig steam working pressure and 600-psig cold working pressure ratings.
				2. Three-Piece, Full-Port, Stainless Steel Ball Valves: ASTM A351, Type 316 stainless steel body; ASTM A276, Type 316 stainless steel stem and vented ball, threaded body design with adjustable stem packing, threaded ends, and 150-psig steam working pressure and 600-psig cold working pressure rating.
			1. UV BIOCIDE EQUIPMENT
				1. Target Irradiation: Minimum [**5,000 microWxs/sq. cm**] <**Insert value**>.
				2. Light Source Vessels:

ASTM A666, Type 304 stainless steel.

Construct for minimum [**150 psig**] <**Insert value**> at [**150 deg F**] <**Insert value**> in accordance with ASME Boiler and Pressure Vessel Code, and equipped with pressure-relief valve.

Light Source Sleeve: Quartz, with EPDM O-ring seals.

Light Source: Replaceable UV lamp producing minimum target irradiation of 254-nm wavelength light.

* + - * 1. Controls: Interlock with pumps to operate when water is circulating.
			1. CHEMICAL-TREATMENT TEST EQUIPMENT
				1. Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounted 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.

Retain "Sample Cooler" paragraph below for steam boilers.

* + - * 1. Sample Cooler:

Tube: Sample.

Size: NPS 1/4 tubing.

Material: ASTM A666, Type 316 stainless steel.

Pressure Rating: Minimum 2000 psig.

Temperature Rating: Minimum 850 deg F.

Shell: Cooling water.

Material: ASTM A666, Type 304 stainless steel.

Pressure Rating: Minimum 250 psig.

Temperature Rating: Minimum 450 deg F.

Capacities and Characteristics:

Tube: Sample.

Flow Rate: [**0.25 gpm**] <**Insert value**>.

Entering Temperature: [**400 deg F**] <**Insert value**>.

Leaving Temperature: [**88 deg F**] <**Insert value**>.

Pressure Loss: [**6.5 psig**] <**Insert value**>.

Shell: Cooling water.

Flow Rate: [**3 gpm**] <**Insert value**>.

Entering Temperature: [**70 deg F**] <**Insert value**>.

Pressure Loss: [**1.0 psig**] <**Insert value**>.

* + - * 1. 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.

[**Two**] <**Insert number**>-station rack for closed-loop systems.

[**Four**] <**Insert number**>-station rack for open-loop systems.

* + - 1. CHEMICALS

Revise this article to suit local conditions and recommendations of chemical-treatment manufacturer.

* + - * 1. 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.
				2. Chemicals for direct steam injection humidification and for steam used in direct contact with food to be FDA approved and safe for these uses.
				3. Cleaning chemicals:

Alkaline Boil-out Cleaning Solution for Boiler System: alkaline boil-out cleaning solution at an acceptable concentration which is capable of removing oil, grease and rust from metal surfaces of boiler. Cleaning solution shall include:

Low foaming non-ionic surfactant for penetrating oil and grease deposits.

Phosphate and soda ash to provide alkalinity.

Deposit Removal Cleaning Solution: blended neutral pH cleaning solution which is capable of removing scale and iron deposits, destroying bacteria, and passivating the metal surfaces of system.

* + - * 1. Chemical treatment chemicals:

Chemical Treatment: corrosion and scale inhibitors which contains the following components, in the form of separate chemicals:

Sulphite as an oxygen scavenger.

Phosphate as a scale inhibitor.

Caustic as an alkalinity builder.

Neutralizing amine as a corrosion control agent

Retain "Water Softener Chemicals" paragraph below for water softeners.

* + - * 1. Water Softener Chemicals:

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 <**Insert grains/cu. ft.**> of calcium carbonate of resin when regenerated with <**Insert lb**> of salt.

Salt for Brine Tanks: High-purity sodium chloride, free of dirt and foreign material. Rock and granulated forms are unacceptable.

* + - 1. INHIBITED ETHYLENE GLYCOL AND PROPYLENE GLYCOL
				1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Dow Chemical Company (The).

Dynalene.

Fremont Industries.

Houghton Chemical Corp.

 Approved equivalent.

Before retaining "Inhibited Ethylene Glycol" paragraph below, due to toxicity concerns, verify if ethylene glycol is permitted for use in specific application by locally enforced codes and authorities having jurisdiction.

* + - * 1. Inhibited Ethylene Glycol:

Ethylene glycol with inhibitor additive, to provide freeze protection for heat-transfer fluid and corrosion protection for carbon-steel, brass, copper, stainless steel, and cast-iron piping and fittings.

Inhibitor creates a passive layer on all surfaces that contact ethylene glycol to prevent corrosion by stabilizing fluid pH, to compensate for acids formed from glycol degradation.

pH value shall be maintained between <**Insert range**>, with reserve alkalinity greater than <**Insert number**> mL.

Operating Temperature Range: [**minus 60 deg F to 250 deg F**] <**Insert range**>

Concentrated inhibited ethylene glycol is to be 95.5 percent ethylene glycol by weight and 4.5 percent performance additives.

Concentrated inhibited ethylene glycol is mixed with water in proper proportion specified by the manufacturer to provide freeze protection to [**minus 20 deg F**]. Premixed heat-transfer fluid may be used, or glycol/water mixture may be prepared at time of installation. Use only deionized water for mixing.

Provide only ethylene glycol that is specifically blended for HVAC application. Automotive-type antifreeze is unacceptable.

* + - * 1. Inhibited Propylene Glycol:

Propylene glycol with inhibitor additive, to provide freeze protection for heat-transfer fluid and corrosion protection for carbon-steel, brass, copper, stainless steel, and cast-iron piping and fittings.

Inhibitor creates a passive layer on all surfaces that contact propylene glycol to prevent corrosion and stabilizes fluid pH, to compensate for acids formed from glycol degradation.

pH value shall be maintained between <**8.0 and 10.0**>, with reserve alkalinity greater than <**12**> mL.

Operating Temperature Range: [**minus 50 deg F to 250 deg F**] <**Insert range**>

Concentrated inhibited propylene glycol is to be 95.5 percent propylene glycol by weight and 4.5 percent performance additives.

Concentrated inhibited propylene glycol is mixed with water in proper proportion specified by the manufacturer to provide freeze protection to [**minus 20 deg F**] <**Insert number**>. Premixed heat-transfer fluid may be used, or glycol/water mixture may be prepared at the time of installation. Use only deionized water for mixing.

Provide only propylene glycol that is specifically blended for HVAC application. Automotive-type antifreeze is unacceptable.

* + - 1. HVAC MAKEUP-WATER SOFTENER
				1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

3M.

CSI Water Treatment Systems.

Culligan International Company.

Diamond Water Conditioning; a Griesbach company.

Diamond Water Systems, Inc.

Ecodyne Limited.

Hungerford & Terry, Inc.

Kinetico Incorporated.

Marlo Incorporated.

Parker Boiler.

Pentair, Inc.

RainSoft.

Water King.

Approved equivalent.

* + - * 1. Description: Twin mineral tanks and one brine tank, factory mounted on skid.
				2. 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.

Retain first paragraph below for projects in seismic areas; if retaining, also retain "Seismic Qualification Certificates" paragraph in "Informational Submittals" Article.

* + - * 1. 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.
				2. Mineral Tanks:

Retain first subparagraph below to require steel or stainless steel tanks to be ASME labeled; delete for non-code construction.

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

Retain first subparagraph below to require fiber-reinforced plastic tanks to be ASME labeled; delete for non-code construction.

Fabricate and label fiber-reinforced plastic filter tanks to comply with ASME Boiler and Pressure Vessel Code: Section X, if indicated.

First option in "Pressure Rating" subparagraph below is usual minimum pressure rating; use higher rating if required.

Pressure Rating: [**100 psig**] [**125 psig**] [**150 psig**] <**Insert value**> minimum.

Wetted Components: Suitable for water temperatures from [**40 to at least 100 deg F**] <**Insert range**>.

Freeboard: 50 percent minimum, for backwash expansion above the normal resin bed level.

Support Legs or Skirt: Constructed of structural steel, welded or bonded to tank before testing and labeling.

Retain "Finish" subparagraph below for steel tanks.

Finish: Hot-dip galvanized on exterior and interior of tank after fabrication.

Upper Distribution System: Single-point type, fabricated from galvanized-steel pipe and fittings.

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.

* + - * 1. Controls: Automatic; factory mounted on mineral tanks and factory wired.

Adjustable duration of regeneration steps.

Push-button start and complete manual operation override.

Pointer on pilot-control valve shall indicate cycle of operation.

Means of manual operation of pilot-control valve if power fails.

Main Operating Valves: Industrial, automatic, multiport, diaphragm type with the following features:

Slow opening and closing, nonslam operation.

Diaphragm guiding on full perimeter from fully open to fully closed.

Isolated dissimilar metals within valve.

Self-adjusting, internal, automatic brine injector that draws brine and rinses at constant rate independent of pressure.

Float-operated brine valve to automatically measure the correct amount of brine to the softener, and refill with fresh water.

Sampling cocks for soft water.

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 and that automatically resets after regeneration to preset total in gallons for next service run. Include alternator to regenerate one mineral tank with the other in service.

* + - * 1. Brine Tank: Combination measuring and wet-salt storing system.

Tank and Cover Material: Fiberglass a minimum of 3/16 inch thick; or molded polyethylene a minimum of 3/8 inch thick.

Brine Valve: Float operated and plastic fitted for automatic control of brine withdrawn and freshwater refill.

Size: Large enough for at least four regenerations at full salting.

* + - * 1. Factory-Installed Accessories:

Piping, valves, tubing, and drains.

Sampling cocks.

Main-operating-valve position indicators.

Water meters.

* + - * 1. Water Test Kit: Include in wall-mounted enclosure for water softener.

If more than one water softener is required on Project, delete "Capacities and Characteristics" paragraph below and schedule water softeners on Drawings.

* + - * 1. Capacities and Characteristics:

Continuous Service Flow Rate: <**Insert gpm**> at 15-psig pressure loss.

Peak Service Flow Rate: <**Insert gpm**> at 25-psig pressure loss.

Water Consumption: <**Insert gal./day**>.

Water Demand: <**Insert number**> hours/day.

Electrical Characteristics:

Volts: <**Insert value**>.

Phase: <**Insert value**>.

Hertz: <**Insert value**>.

Full-Load Amperes: <**Insert value**>.

Minimum Circuit Ampacity: <**Insert value**>.

Maximum Overcurrent Protection: <**Insert amperage**>.

Interrupting Capacity: <**Insert amperage**>.

Consider retaining "RO Equipment for HVAC Makeup Water" Article below for use on high-pressure steam makeup or for other steam systems with greater than 8 percent makeup.

* + - 1. RO EQUIPMENT FOR HVAC MAKEUP WATER
				1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

3M.

CSI Water Treatment Systems.

Culligan International Company.

Diamond Water Conditioning; a Griesbach company.

Ecodyne Limited.

Marlo Incorporated.

Pentair, Inc.

Water & Power Technologies Incorporated.

Water King.

Approved equivalent.

* + - * 1. Description: Factory fabricated and tested with RO membrane elements in housings, high-pressure pumps and motors, controls, valves, and prefilter; mounted on skid.
				2. 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.

Retain first paragraph below for projects in seismic areas; if retaining, also retain "Seismic Qualification Certificates" paragraph in "Informational Submittals" Article.

* + - * 1. 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.
				2. Skid Assembly: Welded-steel frame coated with epoxy protective finish.

Modify details in "RO Membrane and Housing" paragraph below where necessary to specify the products selected as basis of design.

* + - * 1. RO Membrane and Housing:

Element: Thin-film composite with U-cup brine seal, with minimum 98 percent salt rejection based on 2000-ppm water supplied at 225 psig and 77 deg F.

Housing: ASTM A666, Type 304 stainless steel, with PVC end caps held in place with stainless steel straps.

Modify details in "High-Pressure Pumps and Motors" paragraph below where necessary to specify the products selected as basis of design.

* + - * 1. High-Pressure Pumps and Motors:

Pump:

Vertical, multistage, centrifugal pump, operating at 3500 rpm, with ASTM A666, Type 304 stainless steel casing, shaft, impellers, and inlet and discharge casting.

Bearings shall be tungsten carbide and ceramic.

Cast-iron frame and flanged suction and discharge connections.

Motor characteristics, such as NEMA designation, temperature rating, service factor, enclosure type, and efficiency, are specified in Section 230513 "Common Motor Requirements for HVAC Equipment." If different characteristics are required, add subparagraphs below to suit Project.

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."

* + - * 1. Controls:

Microprocessor-based controller with digital display.

Interlock for remote start/stop control.

Membrane flush sequence when pumps shut down.

Run time indicator.

Low-pressure safety cutoff.

Panel-mounted gages as follows:

Product and concentrate.

Inlet, cartridge filter outlet, RO feed, RO concentrate, and RO product pressures.

Product conductivity monitor.

* + - * 1. Valves:

Stainless steel pump, concentrate, and recycle throttling valves rated for minimum 300 psig.

Automatic inlet shutoff valve, diaphragm type; solenoid actuated, normally closed, and constructed of glass-reinforced noryl thermoplastic.

PVC valves with EPDM seats and seals for isolation at inlet, and check and sample valves at product and concentrate. Install sample valves at cartridge filter outlet, concentrate, and product outlet.

* + - * 1. Prefilter:

Housing: Polypropylene with built-in relief or vent valve.

Element: Spun-wound polypropylene.

* + - * 1. Inlet Water-Tempering Valve: Thermostatic water-tempering valve to maintain [**77 deg F**] <**Insert value**> inlet water temperature to RO unit.
				2. Activated Carbon Filter:

Media Tank: Fiberglass-reinforced polyester rated for minimum 150 psig with internal backwash distributor and filtered water collector.

Media: 12-by-40-mesh, bituminous coal-based activated carbon.

Backwash Valve: Piston-operated control valve with drain-line, flow-control orifice.

Backwash Control: Seven-day time clock.

* + - * 1. Atmospheric Storage Tank:

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.

Control: Level switches start and stop RO unit. Low-level limit shall stop repressurization pumps and signal an alarm.

* + - * 1. Repressurization Pumps:

Pumps: Two close-coupled, single-stage centrifugal pumps with mechanical seals. Wetted components are made of ASTM A666, Type 316 stainless steel.

Controls: NEMA 250, Type 4X pump control panel constructed of fiberglass to control pumps, one operating and one standby, with automatic alternator and fail-over control.

Motor characteristics, such as NEMA designation, temperature rating, service factor, enclosure type, and efficiency, are specified in Section 230513 "Common Motor Requirements for HVAC Equipment." If different characteristics are required, add subparagraphs below to suit Project.

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."

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.

* + - * 1. Water Test Kit: Include in wall-mounting cabinet for RO unit.

If more than one RO unit is required on Project, delete "Capacities and Characteristics" paragraph below and schedule RO units on Drawings.

* + - * 1. Capacities and Characteristics:

RO Product Flow Rate: <**Insert gpm**>.

Total Water-Flow Rate: <**Insert gpm**>.

Daily Water Consumption: <**Insert gal./day**>.

Water Demand: <**Insert number**> hours/day.

Storage Tank Size: <**Insert gal.**>.

RO Inlet Operating Temperature: [**77 deg F**] <**Insert value**>.

High-Pressure Pump:

Discharge Pressure: <**Insert psig**>.

Flow Rate: <**Insert gpm**>.

Horsepower: <**Insert value**>.

Motor Speed: [**3500**] <**Insert number**> rpm.

Repressure Pumps:

Discharge Pressure: <**Insert psig**>.

Flow Rate: <**Insert gpm**>.

Horsepower: <**Insert value**>.

Motor Speed: [**3500**] <**Insert number**> rpm.

Prefilter Design (at Total Water-Flow Rate):

Filter Efficiency: [**98**] <**Insert number**> percent.

Particle Size: [**5**] <**Insert number**> microns and larger.

Clean Pressure Loss: [**2 psig**] <**Insert value**>.

Replacement Pressure Loss: [**6 psig**] <**Insert value**>.

Electrical Characteristics (Single-Point Connection):

Volts: <**Insert value**>.

Phase: <**Insert value**>.

Hertz: <**Insert value**>.

Full-Load Amperes: <**Insert value**>.

Minimum Circuit Ampacity: <**Insert value**>.

Maximum Overcurrent Protection: <**Insert amperage**>.

Interrupting Capacity: <**Insert amperage**>.

* + - 1. FILTRATION EQUIPMENT
				1. Multimedia Filters:

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Diamond Water Systems, Inc.

Everfilt.

LAKOS; a Lindsay Company.

Miami Filter, LLC.

PEP Filters, Inc.

Puroflux Corporation.

Sonitec-Vortisand Inc.

United Industries, Inc; Tower-flo Water Systems.

Approved equivalent.

Description: Factory-fabricated and -tested, simplex, multimedia filter system, consisting of filter tank, media, strainer, circulating pump, piping, and controls for removing particles from water.

Filter Tank: Corrosion resistant with distribution system and media.

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.

Retain first subparagraph below to require steel or stainless steel tanks to be ASME labeled; delete for non-code construction.

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

Retain first subparagraph below to require FRP tanks to be ASME labeled; delete for non-code construction.

Fabricate and label FRP filter tanks to comply with ASME Boiler and Pressure Vessel Code: Section X, if indicated.

Pipe Connections NPS 2 and Smaller: Threaded in accordance with ASME B1.20.1.

Steel Tank Pipe Connections NPS 2-1/2 and Larger: Steel, Class 150 flanges in accordance with ASME B16.5 or grooved in accordance with AWWA C606.

FRP Tank Pipe Connections NPS 2-1/2 and Larger: Type A, integral; [**Designation E, 125-psig**] [**or**] [**Designation F, 150-psig**] pressure category flanges of grade same as tank material, in accordance with ASTM D5421.

Motorized Valves: Flanged or grooved-end, ductile-iron butterfly type with [**EPDM**] <**Insert material**> valve seat and stem seal; with ASTM B148 aluminum bronze disc.

Strainer: Basket type mounted on pump suction.

Retain one of two "Piping" subparagraphs below.

Piping: ASTM A53; 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.

Piping: ASTM B88, Type L copper water tube, copper-alloy solder-joint fittings, and brazed, flanged, or grooved joints.

Safety Valves: Automatic pressure relief.

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.

Casing: Radially split, cast iron.

Pressure Rating: [**125 psig**] [**150 psig**] minimum.

Impeller: ASTM B584 cast bronze; statically and dynamically balanced, closed, and keyed to shaft.

Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.

Seal: Mechanical.

Motor characteristics, such as NEMA designation, temperature rating, service factor, enclosure type, and efficiency, are specified in Section 230513 "Common Motor Requirements for HVAC Equipment." If different characteristics are required, add subparagraphs below to suit Project.

Motor: Open, dripproof motor supported on the pump-bearing frame. General requirements for motors are specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

Controls: Automatic control of circulating pump and tank backwash; factory wired for single electrical connection.

Panel: NEMA 250, [**Type 4**] <**Insert type**> enclosure with time clock and pressure gages.

Pump: Automatic and manual switching; manual switch position bypasses safeties and controls.

Backwash: Automatic; with time clock and differential pressure switch.

Backwash Valve: Tank mounted with valves interlocked to single actuator.

Retain option in "Support" subparagraph below for projects in seismic areas; if retaining, also retain "Seismic Qualification Certificates" paragraph in "Informational Submittals" Article.

Support: Skid mounting.[**Fabricate supports, 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.**]

If more than one circulating multimedia filter is required on Project, delete "Capacities and Characteristics" subparagraph below and schedule multimedia filters on Drawings.

Capacities and Characteristics:

Filter Design:

Water Flow: <**Insert gpm**>.

Clean Pressure Loss: [**5 psig**] <**Insert value**>.

Maximum Media-Flow Rate: [**15 gpm/sq. ft.**] <**Insert value**>.

Filtration Efficiency: [**98**] <**Insert number**> percent.

Particle-Specific Gravity: [**1.8**] <**Insert number**>.

Particle Size: [**5**] [**10**] [**20**] [**45**] <**Insert number**> microns.

Filter Tank: With internal distribution piping.

Pressure Rating: <**Insert psig**>.

Diameter: <**Insert inches**>.

Inlet and Outlet Size: <**Insert NPS**>.

Blowdown Piping Outlet Size: <**Insert NPS**>.

Filter Media: <**Insert material**>.

Start Backwash Pressure Loss: [**13 psig**] <**Insert value**>.

Backwash Period: [**10**] <**Insert number**> minutes.

Circulating Pump:

Capacity: <**Insert gpm**>.

Total Dynamic Head: <**Insert feet**>.

Motor Speed: <**Insert number**> rpm.

Inlet Size: <**Insert NPS**>.

Outlet Size: <**Insert NPS**>.

Pump Motor Size and Electrical Characteristics:

Horsepower: <**Insert value**>.

Volts: [**120**] [**208**] [**240**] [**277**] [**480**] <**Insert number**> V.

Phase: [**Single**] [**Three**].

Hertz: [**60**] <**Insert number**> Hz.

Unit Electrical Characteristics:

Full-Load Amperes: <**Insert value**>.

Minimum Circuit Ampacity: <**Insert value**>.

Maximum Overcurrent Protection: <**Insert amperage**>.

Interrupting Capacity: <**Insert amperage**>.

* + - * 1. Self-Cleaning Strainers:

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Everfilt.

Hayward Flow Control.

Islip Flow Controls Inc.

Orival, Inc.

Sure Flow Equipment Inc.

Approved equivalent.

Description: Factory-fabricated and -tested, ASTM A126, 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.

Fabricate and label ASTM A126, Class B, cast-iron or steel strainer tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

Pipe Connections:

NPS 2 and Smaller: Threaded in accordance with ASME B1.20.1.

NPS 2-1/2 and Larger: Steel, Class 150 flanges in accordance with ASME B16.5 or grooved in accordance with AWWA C606.

Motorized Valves: Flanged or grooved-end, ductile-iron angle type with [**EPDM**] <**Insert material**> valve seat and stem seal; with ASTM B148 aluminum bronze disc.

Strainer: ASTM A666, Type 316 stainless steel.

Piping: ASTM A53; 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.

Safety Valves: Automatic pressure relief.

Hydraulic drive on some units makes motorized drive unnecessary.

Backwash Arm Drive:

Drive Casing: Cast iron.

Worm Gears: Immersed in oil.

Motor characteristics, such as NEMA designation, temperature rating, service factor, enclosure type, and efficiency, are specified in Section 230513 "Common Motor Requirements for HVAC Equipment." If different characteristics are required, add subparagraphs below to suit Project.

Motor: Open, dripproof motor supported on the strainer-bearing frame. General requirements for motors are specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

Controls: Automatic control of backwash; factory wired for single electrical connection.

Panel: NEMA 250, [**Type 4**] <**Insert type**> enclosure with time clock and pressure gages.

Backwash Arm Drive: Automatic and manual switching; manual switch position bypasses safeties and controls.

Backwash: Automatic; with time clock and differential pressure switch.

Backwash Valve: Electric actuator.

Retain option in "Support" subparagraph below for projects in seismic areas; if retaining, also retain "Seismic Qualification Certificates" paragraph in "Informational Submittals" Article.

Support: Skid mounting.[**Fabricate supports, 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.**]

If more than one strainer is required on Project, delete "Capacities and Characteristics" subparagraph below and schedule strainers on Drawings.

Capacities and Characteristics:

Strainer Design:

Water Flow: <**Insert gpm**>.

Clean Pressure Loss: [**5 psig**] <**Insert value**>.

Strainer Mesh: [**40**] [**60**] [**80**] <**Insert number**>.

Strainer Tank: With internal distribution piping.

Material: [**Cast iron**] [**Steel**] <**Insert material**>.

Pressure Rating: [**150 psig**] <**Insert value**>.

Inlet and Outlet Size: <**Insert NPS**>.

Backwash Piping Outlet Size: <**Insert NPS**>.

Start Backwash: [**10 psig**] <**Insert value**>.

Backwash Period: [**5**] <**Insert number**> minutes.

Hydraulic drive on some units makes motorized drive unnecessary.

Drive Motor Size and Electrical Characteristics:

Horsepower: <**Insert value**>.

Volts: [**120**] [**208**] [**240**] [**277**] [**480**] <**Insert number**> V.

Phase: [**Single**] [**Three**].

Hertz: [**60**] <**Insert number**> Hz.

Unit Electrical Characteristics:

Full-Load Amperes: <**Insert value**>.

Minimum Circuit Ampacity: <**Insert value**>.

Maximum Overcurrent Protection: <**Insert amperage**>.

Interrupting Capacity: <**Insert amperage**>.

* + - * 1. [**Bag**] [**Cartridge**]-Type Filters:

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Eden Equipment Company.

Filter Specialists, Inc.

Filtration Systems; Mechanical Mfg. Corporation.

Hayward Flow Control.

Parker Hannifin Corp.; Process Filtration Div.

Pentair, Inc.

PEP Filters, Inc.

Rosedale Products, Inc.

Shelco Filters.

Approved equivalent.

Description: [**Floor-mounted housing**] [**Housing**] with filter [**bags**] [**cartridges**] for removing particles from water.

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.

Pipe Connections NPS 2 and Smaller: Threaded in accordance with ASME B1.20.1.

Steel Housing Pipe Connections NPS 2-1/2 and Larger: Steel, Class 150 flanges in accordance with ASME B16.5 or grooved in accordance with AWWA C606.

Plastic Housing Pipe Connections NPS 2-1/2 and Larger: 150-psig plastic flanges.

[**Bag**] [**Cartridge**]: Replaceable; of shape to fit housing.

If more than one bag- or cartridge-type filter is required on Project, delete "Capacities and Characteristics" subparagraph below and schedule bag- or cartridge-type filters on Drawings.

Capacities and Characteristics:

Filter Design:

Water-Flow Rate: <**Insert gpm**>.

Filtration Efficiency: [**98**] <**Insert number**> percent.

Particle Size: [**10**] [**20**] <**Insert number**> microns and larger.

Clean Pressure Loss: [**2 psig**] <**Insert value**>.

Pressure Loss at Replacement: [**6 psig**] <**Insert value**>.

Housing:

Material: [**Carbon steel**] [**Plastic**].

Pressure Rating: <**Insert psig**>.

Seal Material: [**Nitrile rubber**] <**Insert material**>.

Diameter: <**Insert inches**>.

Height or Length: <**Insert inches**>.

Inlet and Outlet Size: <**Insert NPS**>.

Drain Size: [**Not applicable**] <**Insert NPS**>.

Bag Support Basket Material: [**Stainless steel**] <**Insert material**>.

[**Bag**] [**Cartridge**]:

Number Required: <**Insert number**>.

Nominal Diameter: <**Insert inches**>.

Nominal Length: <**Insert inches**>.

Media Material: [**Cotton**] [**Polyester**] [**Polypropylene**] <**Insert material**>.

* + - * 1. Centrifugal Separators:

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Culligan International Company.

Griswold Water Systems.

LAKOS; a Lindsay Company.

PEP Filters, Inc.

Puroflux Corporation.

Rosedale Products, Inc.

Approved equivalent.

Description: Simplex separator housing, with baffles and chambers for removing particles from water by centrifugal action and gravity.

Housing: With manufacturer's proprietary system of baffles and chambers.

Construction: Fabricate and label steel separator housing to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

Inlet: Designed with tangential entry to produce centrifugal flow of feedwater.

Vortex Chamber: Designed for downward vortex flow and gravity separation of particles.

Collection Chamber: Designed to hold separated particles.

Outlet: Near top of unit.

Purge: At bottom of collection chamber.

Pipe Connections NPS 2 and Smaller: Threaded in accordance with ASME B1.20.1.

Pipe Connections NPS 2-1/2 and Larger: Steel, Class 150 flanges in accordance with ASME B16.5 or grooved in accordance with AWWA C606. Provide stainless steel flanges if tank is stainless steel.

Motorized Purge Valve: Gate or plug pattern valve.

Motorized Valves: Butterfly-type, flanged or grooved-end, ductile-iron body, with [**EPDM**] <**Insert material**> valve seat and stem seal; with ASTM B148 aluminum bronze disc.

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.

Strainer: Stainless steel basket type mounted on pump suction.

Retain "Piping, Steel" or "Piping, Copper" subparagraph below.

Piping, Steel: ASTM A53; 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.

Piping, Copper: ASTM B88, Type L copper water tube, copper-alloy solder-joint fittings, and brazed, flanged, or grooved joints.

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.

Casing: Radially split, cast iron.

Pressure Rating: [**125 psig**] [**150 psig**] minimum.

Impeller: ASTM B584 cast bronze; statically and dynamically balanced, closed, and keyed to shaft.

Shaft and Shaft Sleeve: Steel shaft with copper-alloy shaft sleeve.

Seal: Mechanical.

Motor characteristics, such as NEMA designation, temperature rating, service factor, enclosure type, and efficiency, are specified in Section 230513 "Common Motor Requirements for HVAC Equipment." If different characteristics are required, add subparagraphs below to suit Project.

Motor: Open, dripproof motor supported on the pump-bearing frame. General requirements for motors are specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

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.

Controls: Automatic control of circulating pump and separator purge; factory wired for single electrical connection.

Panel: NEMA 250, [**Type 4**] <**Insert type**> enclosure.

Pump: Automatic and manual switching; manual switch position bypasses safeties and controls.

Separator Purge: Automatic and manual.

TSS Controller Interlock: Open separator purge valve with bleed-off control.

Retain option in "Support" subparagraph below for projects in seismic areas; if retaining, also retain "Seismic Qualification Certificates" paragraph in "Informational Submittals" Article.

Support: Skid mounting.[**Fabricate supports, 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.**]

If more than one separator is required on Project, delete "Capacities and Characteristics" subparagraph below and schedule separators on Drawings.

Capacities and Characteristics:

Separator Design:

Water-Flow Rate: <**Insert gpm**>.

Pressure Loss: [**5 psig**] <**Insert value**>.

Separator Efficiency: [**98**] <**Insert number**> percent.

Particle-Specific Gravity: [**1.8**] <**Insert number**>.

Particle Size: [**5**] [**10**] [**20**] [**45**] <**Insert number**> microns.

Housing:

Material: [**Steel**] [**Stainless steel**] [**Plastic**] [**Fiberglass**] <**Insert material**>.

Pressure Rating: <**Insert psig**>.

Diameter: <**Insert inches**>.

Height: <**Insert inches**>.

Inlet and Outlet Size: <**Insert NPS**>.

Purge Size: <**Insert NPS**>.

Retain "Circulating Pump" subparagraph below only if separator is circulating type.

Circulating Pump:

Capacity: <**Insert gpm**>.

Total Dynamic Head: <**Insert feet**>.

Motor Speed: <**Insert number**> rpm.

Inlet Size: <**Insert NPS**>.

Outlet Size: <**Insert NPS**>.

Pump Motor Size and Electrical Characteristics:

Horsepower: <**Insert value**>.

Volts: [**120**] [**208**] [**240**] [**277**] [**480**] <**Insert number**> V.

Phase: [**Single**] [**Three**].

Hertz: [**60**] <**Insert number**> Hz.

Full-Load Amperes: <**Insert value**>.

Minimum Circuit Ampacity: <**Insert value**>.

Maximum Overcurrent Protection: <**Insert amperage**>.

Interrupting Capacity: <**Insert amperage**>.

1. EXECUTION
	* + 1. WATER ANALYSIS

Delete this article if water analysis has been or will be performed by Owner.

* + - * 1. Perform an analysis of supply water to determine quality of water available at Project site.
			1. INSTALLATION

Coordinate this article with Drawings.

* + - * 1. Install chemical-application equipment level and plumb. Maintain manufacturer's recommended clearances. Arrange units, so controls and devices that require servicing are accessible. Anchor chemical bypass feeder and floor-mounting accessories to substrate. Install all chemical application equipment within a spill-containment area without floor drains.
				2. Install water-testing equipment on wall near water-chemical-application equipment.
				3. Install interconnecting control wiring for chemical-treatment controls and sensors.
				4. Mount sensors and injectors in piping circuits.
				5. Bypass Feeders: Install in closed hydronic systems, including[**hot-water heating,**][**chilled water,**][**dual-temperature water,**][**glycol heating,**][**and**][**glycol cooling**], and equip with the following:

Install bypass feeder in a bypass circuit around circulating pumps unless otherwise indicated on Drawings.

Retain first subparagraph below for closed systems larger than 400 gpm (24 L/s).

Install water meter in makeup-water supply.

Install test-coupon assembly in bypass circuit around circulating pumps unless otherwise indicated on Drawings.

Install a gate or full-port ball isolation valves on inlet, outlet, and drain below feeder inlet.

Install a swing check on inlet after the isolation valve.

* + - * 1. Install automatic fluid make-up equipment for glycol water system and include the following:

Chemical solution tanks.

Chemical solution injection pumps.

Water meter in makeup supply to system.

Pressure switch to operate injection pump as necessary to maintain glycol system pressure.

* + - * 1. Install automatic chemical-feed equipment for steam boiler and steam condensate systems and include the following:

Install makeup-water softener.

Install water meter in makeup-water supply.

Install inhibitor injection pumps and solution tanks with injection-timer-sensing contacts in water meter.

Pumps shall operate for timed interval when contacts close at water meter in makeup-water supply connection.

Install test equipment and furnish test-kit to Director’s Representative.

Do not retain first subparagraph below if RO unit is not specified in Part 2.

Install RO unit for makeup water.

Install TDS controller with sensor and bleed valves.

Bleed valves to cycle, to maintain maximum TDS concentration.

Install TSS controller with sensor and bleed valves.

Bleed valves to cycle, to maintain maximum TSS concentration.

Retain subparagraph below for steam-condensate treatment with amines.

Install inhibitor injection timer with injection pumps and solution tanks.

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.

* + - * 1. Install automatic chemical-feed equipment for open [**condenser**] [**fluid-cooler spray**] water and include the following:

Install water meter in makeup-water supply.

Install inhibitor injection pumps and solution tanks with injection-timer-sensing contacts in water meter.

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.

Install test equipment, and provide test-kit to Director’s Representative. Install test-coupon assembly in bypass circuit around circulating pumps unless otherwise indicated on Drawings.

Install TDS controller with sensor and bleed valves.

Bleed valves to cycle, to maintain maximum TDS concentration.

Install TSS controller with sensor and bleed valves.

Bleed valves to cycle, to maintain maximum TSS concentration.

Install pH sensor and controller with injection pumps and solution tanks.

Injector pumps shall operate to maintain required pH.

Retain one of three subparagraphs below.

Install biocide feeder alternating timer with two sets of injection pumps and solution tanks.

Injection pumps shall operate to feed biocide on an alternating basis.

Install ozone generator with diffusers in condenser-water piping.

Ozone generator shall operate continuously with condenser-water flow.

Install UV-irradiation lamps in condenser-water piping.

UV lights shall operate continuously with condenser-water flow.

* + - 1. OZONE-GENERATOR INSTALLATION
				1. 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.

Retain first paragraph below for Project in a seismic area. Add special requirements for seismic restraints here, or indicate on Drawings.

* + - * 1. 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.
				2. Pipe ozone from ozone generator to condenser water with stainless steel pipe and fittings with welded joints.
				3. Install [**two**] [**three**]-piece, stainless steel ball valve in ozone supply to condenser water.
				4. 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.
				5. Install [**two**] [**three**]-piece, stainless steel ball valve in cooling water supply to ozone generator.
				6. Mounting supports for ozone generator shall be ASTM A666, Type 316 stainless steel.
				7. Mount breathing apparatus outside ozone-generator room.
				8. 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.
			1. UV-IRRADIATION UNIT INSTALLATION
				1. 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.

Retain paragraph below for Project in a seismic area. Add special requirements for seismic restraints here, or indicate on Drawings.

* + - * 1. 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.
			1. WATER SOFTENER INSTALLATION
				1. 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.

Retain first paragraph below for Project in a seismic area. Add special requirements for seismic restraints here, or indicate on Drawings.

* + - * 1. 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.
				2. Install brine lines and fittings furnished by equipment manufacturer but not factory installed.
				3. Prepare mineral-tank distribution system and underbed for minerals, and place specified mineral into mineral tanks.
				4. Install water-testing sets on wall adjacent to water softeners.
			1. RO UNIT INSTALLATION
				1. 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.

Retain first paragraph below for Project in a seismic area. Add special requirements for seismic restraints here, or indicate on Drawings.

* + - * 1. 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.
				2. Install interconnecting piping and controls furnished by equipment manufacturer but not factory installed.
				3. Install water-testing sets on wall adjacent to RO unit.
			1. PIPING CONNECTIONS

Coordinate piping installations and specialty arrangements with Drawings and with requirements specified in piping systems. If Drawings are explicit enough, these requirements may be reduced or omitted.

* + - * 1. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
				2. Where installing piping adjacent to equipment, allow space for service and maintenance.
				3. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Section 232113 "Hydronic Piping."
				4. 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."
				5. See Section 221119 "Domestic Water Piping Specialties" for backflow preventers required in makeup-water connections to potable-water systems.
			1. ELECTRICAL CONNECTIONS
				1. Confirm applicable electrical requirements in electrical Sections for connecting electrical equipment.
				2. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
				3. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
			2. FIELD QUALITY CONTROL

Retain one of first four paragraphs below. Retain first "Testing Agency" paragraph below if Owner will hire an independent testing agency.

* + - * 1. Testing Agency: Director’s Representative will engage a qualified testing agency to perform tests and inspections.

Retain "Testing Agency" paragraph below to require Contractor to hire an independent testing agency.

* + - * 1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

Retain "Manufacturer's Field Service" paragraph below to require a factory-authorized service representative to perform tests and inspections.

* + - * 1. Manufacturer's Field Service: Engage a company field advisor to test and inspect components, assemblies, and equipment installations, including connections.

Retain "Perform tests and inspections" paragraph below to require Contractor to perform tests and inspection, and retain option to require Contractor to arrange for the assistance of a factory-authorized service agent.

* + - * 1. Perform tests and inspections[ with the assistance of a company field advisor].

Retain test requirements below with any combination of paragraphs above.

* + - * 1. Tests and Inspections:

Inspect field-assembled components and equipment installation, including piping and electrical connections.

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.

Place HVAC water-treatment system into operation, and calibrate controls during the preliminary phase of HVAC system's startup procedures.

Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.

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.

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.

Cap and subject piping to static water pressure of 50 psig 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.

Repair leaks and defects with new materials, and retest piping until no leaks exist.

* + - * 1. Equipment will be considered defective if it does not pass tests and inspections.
				2. Prepare test and inspection reports.

Add to or delete tests to suit Project. For definitions of terms used in sampling and testing, see ASTM D1129.

* + - * 1. Sample boiler water at one-week intervals after boiler startup for a period of five weeks, and prepare test report, advising Director’s Representative 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.
				2. 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 Director’s Representative of changes necessary to adhere to "Performance Requirements" Article.
				3. Comply with ASTM D3370 and with the following standards:

Silica: ASTM D859.

Steam System: ASTM D1066.

Acidity and Alkalinity: ASTM D1067.

Iron: ASTM D1068.

Water Hardness: ASTM D1126.

* + - 1. MAINTENANCE SERVICE

Verify with Owner that maintenance service is required for Project.

* + - * 1. 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:

Initial water analysis and HVAC water-treatment recommendations.

Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.

Periodic field service and consultation.

Customer report charts and log sheets.

Laboratory technical analysis.

Analyses and reports of all chemical items concerning safety and compliance with government regulations.

* + - 1. DEMONSTRATION
				1. [**Engage a Company Service Advisor to train**] [**Train**] Director’s Representative's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.

Retain paragraph below when Ozone system is included in project.

* + - * 1. Training: Provide a "how-to-use" self-contained breathing apparatus video that details exact operating procedures of equipment. When training is complete, turn over video to Director’s Representative for future use.

END OF SECTION 232500