UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021
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DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 25 00

CHEMICAL TREATMENT OF WATER FOR MECHANICAL SYSTEMS

11/08

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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021

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SECTION 23 25 00

CHEMICAL TREATMENT OF WATER FOR MECHANICAL SYSTEMS
11/08

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NOTE: This guide specification covers the requirements for chemical treatment of water for mechanical systems.

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

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

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

****

PART 1 GENERAL

1.1 REFERENCES

****

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

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

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

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

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B40.100	(2013) Pressure Gauges and Gauge Attachments

ASTM INTERNATIONAL (ASTM)

ASTM D596	(2001; R 2018) Standard Guide for Reporting Results of Analysis of Water
ASTM D1384	(2005; R 2019) Corrosion Test for Engine Coolants in Glassware
ASTM D2688	(2015; E 2016) Standard Test Method for Corrosivity of Water in the Absence of Heat Transfer (Weight Loss Methods)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2018) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA MG 1	(2018) Motors and Generators

U.S. ARMY CORPS OF ENGINEERS (USACE)

PWTB 420-49-5	(1998) Industrial Water Treatment Procedures

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-230-03	(2012; with Change 2, 2020) Water Treatment

1.2 SUMMARY

This section covers the provisions and installation procedures necessary for a complete and totally functional water system(s) chemical treatment. Provide and install the system with all necessary System Components, Accessories, Piping Components, and Supplemental Components/Services.

1.3 SUBMITTALS

****
NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification

technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

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

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

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

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

SD-03 Product Data

Water Treatment System; G[, [_____]]
Water Analysis; G[, [_____]]
Spare Parts
Field Instructions
Tests; G[, [_____]]
Training Course; G[, [_____]]

SD-06 Test Reports

Condenser Water QA Tests
Steam Boiler Water QA Tests

SD-10 Operation and Maintenance Data

Water Treatment System

1.4 QUALITY CONTROL

1.4.1 Safety

****

NOTE: Catwalk, ladder and guardrail may be required. If so, select the applicable item and delete the others and indicate on drawings the selected item. If not applicable, delete the entire sentence within the brackets.

****

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Install safety devices so that proper operation of equipment is not impaired. Provide [catwalk,] [ladder,] [and guardrail] where indicated and in accordance with Section [08 31 00 ACCESS DOORS AND PANELS] [05 51 33 METAL LADDERS].

1.4.2 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. Carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

1.5 DELIVERY, STORAGE, AND HANDLING

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

1.6 MAINTENANCE

Submit spare parts data for each different item of material and equipment specified, after approval of the detail drawings, not later than [_____] months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with source of supply

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

a. Provide materials and equipment which are standard products of a manufacturer regularly engaged in the manufacturing of such products, that are of a similar material, design and workmanship and that have been in satisfactory commercial or industrial use for two years prior to bid opening.

b. The two-year use shall include applications of equipment and materials under similar circumstances and of similar size. The two years experience shall have been satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a two-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown.

c. All products shall be supported by a service organization. Submit a certified list of qualified permanent service organizations for support of the equipment, including their addresses and qualifications. These service organizations shall be reasonably convenient to the equipment installation and shall be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

d. The selected service organization shall provide the chemicals required, the concentrations required, and the water treatment equipment sizes and flow rates required. The company shall provide all chemicals required for the [condenser] [condenser and chilled] water systems and fill the systems with chemicals to the levels specified. The chemical shall meet the requirements of this specification as well as the recommendations from the manufacturers of the condenser and cooling tower. Acid treatment chemicals shall not be used.

2.2 NAMEPLATES

Each major component of equipment shall have the manufacturer's name, address, type or style, and catalog or serial number on a plate securely attached to the item of equipment. Nameplates shall be provided for:

a. Pump(s)

b. Pump Motor(s)

2.3 ELECTRICAL WORK

****

NOTE: Where motor starters for mechanical equipment are provided in motor-control centers, the references to motor starters will be deleted. Mechanical designer must ensure that the electrical designer is provided with electrical requirements for chemical feed pumps.

****

Electrical equipment, motors, motor efficiencies, and wiring shall be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide electrical motor driven equipment specified complete with motors, motor starters, and controls. Electrical characteristics and enclosure type shall be as shown, and unless otherwise indicated, all motors of 745 W 1 horsepower and above with open, dripproof, or totally enclosed fan cooled enclosures, shall be high efficiency type. Field wiring shall be in accordance with manufacturer's instructions. Each motor shall conform to NEMA MG 1 and be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. All motors shall be continuous duty with the enclosure specified. Provide motor starters complete with thermal overload protection and other appurtenances necessary for the motor control indicated. Furnish motors with a magnetic across-the-line or reduced voltage type starter as required by the manufacturer. Motor starter shall be provided with [NEMA 1] [NEMA 3R] [NEMA [_____]] enclosures. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, shall be provided.

2.4 GAUGES

Gauges shall conform to ASME B40.100, Class 1, 2, or 3, Style X, Type I or III as required, 115 mm 4-1/2 inches in diameter with phenolic or metal case.

2.5 WATER ANALYSIS

****

NOTE: A water analysis may be available from the user. If an analysis is not available, an analysis will be performed during the design, and appropriate data will be entered.

Cooling towers with a capacity greater than 176 kW 50 tons will be provided with automatic chemical feed and blow down systems. Smaller towers will be provided with continuously activated systems. Indicate the location of the entire water treatment system. Delete all the information under this paragraph if a cooling tower is not used in the system.

****

Conditions of make-up water to be supplied to the boilers, cooling towers and chilled water systems reported in accordance with ASTM D596 are as follows:

Date of Sample	[_____]
Temperature	[_____] degrees C
Silica (SiO 2)	[_____] ppm (mg/L)
Insoluble	[_____] ppm (mg/L)
Iron, total (Fe)	[_____] ppm (mg/L)
Aluminum (Al)	[_____] ppm (mg/L)
Calcium (Ca)	[_____] ppm (mg/L)
Magnesium (Mg)	[_____] ppm (mg/L)
Carbonate (HCO 3)	[_____] ppm (mg/L)
Sulfate (SO 4)	[_____] ppm (mg/L)
Chloride (Cl)	[_____] ppm (mg/L)
Nitrate (NO 3)	[_____] ppm (mg/L)
Turbidity	[_____] ntu

pH	[_____]
Residual Chlorine	[_____] ppm (mg/L)
Total Alkalinity	[_____] ppm (mg/L)
Non-Carbonate Hardness	[_____] ppm (mg/L)
Total Hardness	[_____] ppm (mg/L)
Dissolved Solids	[_____] ppm (mg/L)
Conductivity	[_____] micromho/cm

2.6 CONDENSER WATER TREATMENT SYSTEMS

The use of chemical-treatment products containing hexavalent chromium (Cr) is prohibited. Treat the water to be used in the condenser water systems to maintain the conditions recommended by this specification as well as the recommendations from the manufacturers of the condenser and evaporator coils. Chemicals shall meet all required federal, state, and local environmental regulations for the treatment of condenser-side heat exchangers, cooling towers and direct discharge to the sanitary sewer.

2.6.1 Condenser Water Limits

The condenser water limits shall be as follows, unless dictated differently by the cooling tower or chiller manufacturer's recommendations:

Treatment type	Phosphonate/Polymer
Puckorius Index	4 minimum
Langelier Index	4 maximum
Total Dissolved Solids	5000 ppm maximum
Calcium Hardness	1200 ppm maximum
Silica	150 ppm maximum
pH	7.5 - 8.5

For treated condenser/cooling tower water, blowdown must be minimized until the first of one of the top 5 limits is reached. Specific requirements for treatment chemicals and levels are listed below in paragraphs dealing with small and large systems.

2.6.2 Glycol Solution

****

NOTE: If freeze protection for condenser water is not required, this paragraph should be deleted.

When a glycol system is used, the size of the HVAC systems should be corrected due to changes in specific heat and viscosity. ASHRAE's "HVAC systems and Equipment Handbook" should be consulted for the appropriate calculation procedures. Ethylene glycol should be used for HVAC systems. However, if the heat transfer media has the possibility of mixing with a potable water system, propylene glycol should be used. The required concentration should be entered based upon the anticipated ambient or operating temperature.
****

Provide for the system a [_____] percent concentration by volume of industrial grade [ethylene] [propylene] glycol, and corrosion inhibitors. Test the glycol in accordance with ASTM D1384 with less than 0.013 mm 0.5 mils penetration per year for all system metals. The glycol shall contain corrosion inhibitors. Silicate based inhibitors are not acceptable. The solution shall be compatible with pump seals, other elements of the system, and water treatment chemicals used within the system.

2.6.3 Chemical Treatment for Small Systems

For cooling systems with a capacity of 175.8 kW 50 tons or less, provide the following chemical treatment. For corrosion control provide 6.8 to 9.1 kg 15 to 20 pounds polyphosphate in nylon mesh bag in cooling tower sump. If biocide is needed, use either 1-bromo-3-chloro-5.5-dimethylhydantoin or gluteraldehyde as recommended by manufacturer.

2.6.4 Chemical Treatment for Large Systems

For cooling systems with capacities greater than 175.8 kW 50 tons provide one of the three following chemical treatments with the limits indicated. The zinc and molybdate in the last two treatments help to meet the maximum corrosion requirements in waters that tend to be more corrosive. Biocides must be maintained to control bacteria below 10,000 colony forming units per milliliter.

a. Phosphonate Type Treatment

Phosphate	3-5 ppm
Polymer	3-4 ppm
TT	1-2 ppm
Biocides	as required

b. Zinc-Phosphonate Type Treatment

Phosphate	3-5 ppm

Polymer	3-4 ppm
Zinc	1-2 ppm
TT	1-2 ppm
Biocides	as required

c. Zinc-Molybdate Type Treatment

Phosphate	3-5 ppm
Polymer	3-4 ppm
Molybdate	10-15 ppm
Zinc	2-3 ppm
TT	1-2 ppm
Biocides	as required

2.6.4.1 General Requirements

Provide a water treatment system capable of automatically feeding chemicals and bleeding the system to prevent corrosion, scale, and biological formations. Submit [6] [_____] complete copies, at least 5 weeks prior to the purchase of the water treatment system, of the proposed water treatment plan including a layout; control scheme; a list of existing make-up water chemistry, including the items listed in paragraph Water Analysis; a list of treatment chemicals to be added; the proportion of chemicals to be added; the final treated water control levels; and a description of health, safety and environmental concerns for handling the chemicals plus any special ventilation requirements. Automatic chemical feed systems shall automatically feed chemicals into the condenser water based on makeup water rate. Electrical signals from a water meter on the makeup water line shall be used to control the output of chemical feed pumps. The system shall be initially set manually based on the water analysis of the make-up water. Submit [6] [_____] complete copies of operating and maintenance manuals for the step-by-step water treatment procedures. The manuals shall include testing procedures used in determining water quality.

2.6.4.2 Chemical Feed Pumps and Tanks

****

NOTE: The required maximum pump flow rate will be shown on the drawings. The flow rate will depend upon the makeup water flow rate, the chemical composition of the makeup water and the concentration of the chemical supplied. A water treatment company should be consulted for determining the proper maximum pump flow rate.

A water treatment company will be consulted to determine the number of tanks required and shall be shown on plans. The number will depend on the size of the boiler, makeup water flow rate, and makeup water composition. A potable water line will be provided near the tanks for the mixing of chemicals.
****

a. Furnish chemical feed pumps and tanks as a package with the pumps mounted on and piping connected to the tank. The chemical feed pumps shall be positive displacement diaphragm type. The pump's cylinders, plungers, ball check valves, and check valve bodies shall be of corrosion resistant materials suitable for the chemicals being pumped. Cylinders shall be replaceable for increased or reduced pressure or capacity ranges.

b. The flow rate of the pumps shall be adjustable from 0 to 100 percent while in operation. Volumetric accuracy of the pumps shall be within one percent over the range indicated. Pump capacities shall be adjustable by positioning crank pin with micrometer setscrews. Stroke length scale shall be divided in percentage graduations engraved on scale. The discharge pressure of pumps shall not be less than 1.5 times the line pressure at the point of connection. The pumps shall be provided with a pressure relief valve and a check valve mounted in the pump discharge. The pumps shall be controlled by an external controller/timer receiving signals from the makeup water meter.

c. Drive motors shall be 110 volt, single phase and shall have drip-proof enclosures. Provide two chemical tanks. The tanks shall be constructed of [materials compatible with the chemicals to be stored in the tank] [high density polyethylene] [stainless steel] [fiber reinforced plastic] with a hinged cover and mounted on legs. Tanks shall have filling and drain connections and gauge glass. Each tank shall be furnished with one pump, mounted and piped with black iron pipe and fittings, with suction strainer and stainless steel screen, and with 13 mm 1/2 inch relief valve with steel body and stainless steel trim. Tank bottom shall be dished concave to a radius equal to the diameter of the tank. Motor-driven agitator shall be provided. The tanks shall have sufficient capacity to require recharging only once per [7] [14] [21] [_____] days during normal operation.

2.6.4.3 Chemical Injection Assembly

Provide an injection assembly at each chemical feed point. Locate the injection assembly downstream of recirculating pumps and upstream of the condenser. The injection assemblies shall be constructed of stainless steel. The discharge of the assemblies shall extend to the centerline of the condenser water piping. Each assembly shall include a shutoff valve and check valve at the point of entrance into the condenser water line.

2.6.4.4 Water Meter

Provide water meters with an electric contacting register and remote accumulative counter. Install the meter within the make-up water line, as indicated.

2.6.4.5 Timers

Timers shall be of the automatic reset, adjustable type, and electrically

operated. The timers shall be designed to work with the contacting head water meters. The timer should include the water meter cable. The timers will control operation of the chemical feed pumps. The timers shall be suitable for a 120 volt current. The timers shall be located within the water treatment control panel.

2.6.4.6 Bleed (Blowdown) Line

Control the flow through the bleed line by a conductivity meter and probe installed to measure the conductivity of the condenser water. The conductivity meter shall have a high and low set point above which the conductivity meter shall open a solenoid valve on the bleed line. The bleed line attachment to the condenser water piping shall be located downstream of the recirculating pumps and upstream of the chemical injection point. The bleed line shall be extended to the nearest drain for continuous discharge.

2.6.4.7 Control Panel

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NOTE: The MAN-OFF-AUTO switch should be deleted for continuously fed systems. In areas where a panel could come in contact with the water treatment chemical, choose the stainless steel construction.

****

The control panel shall be a NEMA 12 enclosure suitable for surface mounting. The panel shall be constructed of [stainless steel] [coated steel] with a hinged door and lock. The panel shall contain a laminated plastic nameplate identifying each of the following functions:

(1) Main power switch and indicating light
(2) MAN-OFF-AUTO selector switch
(3) Indicating lamp for bleed-off valve
(4) Indicating lamp for each chemical feed pump
(5) Set point reading for each timer

2.6.4.8 Chemical Piping

The piping and fittings shall be constructed of [schedule 80 PVC] [stainless steel] suitable for the water treatment chemicals.

2.6.4.9 Sequence of Operation

The chemicals shall be added based upon sensing the make-up water flow rate and activating appropriate timers. A separate timer shall be provided for each chemical. The blow down shall be controlled based upon the conductivity of the condenser water. The injection of the chemical required for biological control shall be controlled by a timer that can be manually set for proper chemical feed. All timer set points, blow down rates, and chemical pump flow rates shall be determined and set by the water treatment company.

2.6.4.10 Test Kits

One test kit of each type required to determine the water quality as outlined within the operation and maintenance manuals shall be provided.

2.7 CHILLED WATER SYSTEM

****

NOTE: The services of a company regularly engaged in water treatment for mechanical systems to treat a chilled water system should only be required if the makeup water available is of very poor quality.

For dual temperature systems (chilled and heated water), coordinate the compatibility of the separate water treatment systems.

****

A [7.57] [18.92] [_____] L [2] [5] [_____] gallon shot feeder shall be provided on the chilled water piping as indicated. The feeder shall be furnished with an air vent, gauge glass, funnel, valves, fittings, and piping.

2.7.1 Requirements for Glycol Solution

****

NOTE: If freeze protection for chilled water is not required, this paragraph should be deleted. When a glycol system is used, the size of the HVAC systems should be corrected due to changes in specific heat and viscosity. ASHRAE's "HVAC systems and Equipment Handbook" should be consulted for the appropriate calculation procedures. Ethylene glycol should be used for HVAC systems. However, if the heat transfer media has the possibility of mixing with a potable water system, propylene glycol should be used. The required concentration should be entered based upon the anticipated ambient or operating temperature.

****

Provide a [_____] percent concentration by volume of industrial grade [ethylene] [propylene] glycol, and corrosion inhibitors, for the system. Test the glycol in accordance with ASTM D1384 with less than 0.013 mm 0.5 mils penetration per year for all system metals. The glycol shall contain corrosion inhibitors. Silicate based inhibitors shall not be used. The solution shall be compatible with pump seals, other elements of the system, and water treatment chemicals used within the system.

2.7.2 Chilled Water Treatment

Treat chilled water with either a borax/nitrite type treatment or a molybdate type treatment. Both types of treatment can be used with glycol. Borax/nitrite treatment shall be maintained at the limits of 600 to 1000 ppm nitrite, 40 - 50 ppm copper corrosion inhibitor (TT or MBT), and pH of 8.5 to 9.5. Molybdate treatment shall be maintained at the limits of 100 to 125 ppm molybdate, 40 - 50 ppm copper corrosion inhibitor (TT or MBT), and pH of 8.0 to 9.0.

2.7.3 Dual Temperature Systems

Dual hot/chilled water systems treated with borax/nitrite shall also be treated with a biocide.

2.7.4 Chilled Water Test Kits

One test kit of each type required to determine the water quality as outlined within the operation and maintenance manuals shall be provided (e.g. pH and nitrite or molybdate).

2.8 LOW AND MEDIUM TEMPERATURE HOT WATER BOILERS AND HEAT EXCHANGERS

Low and medium temperature hot water boilers are defined as those operating below 177 degrees C 350 degrees F, (122 degrees C 250 degrees F for Low Temperature).

2.8.1 Chemical Feeder

A [7.57] [18.92] [_____] L [2] [5] [_____] gallon shot feeder shall be provided on the hot water piping as indicated. Size and capacity of feeder shall be based on local requirements and water analysis. The feeder shall be furnished with an air vent, gauge glass, funnel, valves, fittings, and piping.

2.8.2 Water Softening System

****

NOTE: The makeup water analysis and the boiler manufacturer's recommended feed water conditions will be used to determine the need for a water softener. UFC 3-230-03 contains general guidance for the selection. Softening of makeup water for hot water boilers is required if the makeup water hardness is above 200 ppm or the makeup rate is above 1 percent.

****

The water softening system shall be as specified in Section 22 31 00 WATER SOFTENERS, CATION-EXCHANGE (SODIUM CYCLE).

2.8.3 Low and Medium Temperature Hot Water Treatment

Hot water shall be treated with either a borax/nitrite type treatment or a molybdate type treatment. Both types of treatment can be used with glycol. Borax/nitrite treatment shall be maintained at the limits of 600 to 1000 ppm nitrite, 40 - 50 ppm copper corrosion inhibitor (TT or MBT) and pH of 8.5 to 9.5. Molybdate treatment shall be maintained at the limits of 100 to 125 ppm molybdate, 40 - 50 ppm copper corrosion inhibitor (TT or MBT) and pH of 8.0 to 9.0.

2.8.4 Dual Temperature Systems

Dual hot/chilled water systems treated with borax/nitrite shall also be treated with a biocide.

2.8.5 Test Kit Requirements

One test kit of each type required to determine the water quality as outlined within the operation and maintenance manuals shall be provided (e.g. pH and nitrite or molybdate).

2.9 HIGH TEMPERATURE HOT WATER BOILERS

****

High Temperature Hot Water Boilers are defined as those operating above 177 degrees C 350 deg F. The chemical treatment requires more attention (daily), the makeup water requires softening and the chemicals and limits differ from the low and medium temperature hot water boilers.

****

2.9.1 Chemical Feeder Unit

****

NOTE: The required maximum pump flow rate will be shown on the drawings. The flow rate will depend upon the makeup water flow rate, the chemical composition of the makeup water and the concentration of the chemical supplied. A water treatment company should be consulted for determining the proper maximum pump flow rate.

A company regularly engaged in water treatment for mechanical systems will be consulted to determine the number of tanks required to be shown on the drawings. The number will depend on the size of the boiler, makeup water flow rate, and makeup water composition. A potable water line will be provided near the tanks for the mixing of chemicals.

****

A feeder unit shall be provided for each boiler. Chemical feeder shall be automatic proportioning, shot type, or pump type. All appurtenances necessary for satisfactory operation shall be provided. Size and capacity of feeder shall be based upon local requirements and water analysis.

2.9.2 Pumps and Tanks

a. Furnish chemical feed pumps and tanks as a package with the pumps mounted on and piping connected to the tank. The chemical feed pumps shall be positive displacement diaphragm type. The pump cylinders, plungers, ball check valves, and check valve bodies shall be of corrosion resistant materials suitable for the chemicals being pumped. Cylinders shall be replaceable for increased or reduced pressure or capacity ranges.

b. The flow rate of the pumps shall be adjustable from 0 to 100 percent while in operation. Volumetric accuracy of the pumps shall be within one percent over the range indicated. Pump capacities shall be adjustable by positioning crank pin with micrometer setscrews. Stroke length scale shall be divided in percentage graduations engraved on scale. The discharge pressure of pumps shall not be less than 1.5 times the line pressure at the point of connection. The pump shall be designed to feed the chemical solutions into the HTW return line to the system circulating pumps and shall have capacity to feed a maximum of [5.3] [_____] mL/second [5] [_____] gph. The pumps shall be provided with a pressure relief valve and a check valve mounted in the pump discharge. The pumps shall be controlled by an external controller/timer receiving signals from the makeup water meter.

c. Drive motors shall be 110 volt, single phase and shall have drip-proof enclosures. The tanks shall be constructed of [materials compatible with the chemicals to be stored in the tank] [high density polyethylene] [stainless steel] [fiber reinforced plastic] with a hinged cover and mounted on legs. Tanks shall have filling and drain connections and gauge glass. Each tank shall be furnished with one pump, mounted and piped with black iron pipe and fittings, with suction strainer and stainless steel screen, and with 13 mm 1/2 inch relief valve with steel body and stainless steel trim. Tank bottom shall be dished concave to a radius equal to the diameter of the tank. Units shall be for phosphate, caustic feed and sulfite feeding. Sulfite tank shall have a floating cover to completely cover the surface of the solution. Motor-driven agitator shall be provided. The tanks shall have sufficient capacity to require recharging only once per [7] [14] [21] [_____] days during normal operation.

2.9.3 Water Softening System

****

NOTE: The makeup water analysis and the boiler manufacturer's recommended feed water conditions will be used to determine the need for a water softener. UFC 3-230-03 contains general guidance for the selection. Hardness must be maintained below 2 ppm.

****

The water softening system shall be as specified in Section 22 31 00 WATER SOFTENERS, CATION-EXCHANGE (SODIUM CYCLE).

2.9.4 Treated Water Limits

The boiler manufacturer shall be consulted for the determination of the boiler water chemical composition limits. The recirculating hot water chemical limits shall be as follows unless dictated differently by the boiler manufacturer's recommendations:

pH	9.3-9.9
Sulfite	30-60 ppm
Hardness	Less than 2.0 ppm

2.10 Test Kit

One test kit of each type required to determine the water quality as outlined within the operation and maintenance manuals shall be provided (e.g. pH, hardness and sulfite).

2.11 STEAM BOILER WATER TREATMENT

****

NOTE: The chemical piping will be indicated on the drawing. Piping for feeding sulfite will be connected to the storage section of the deaerator or

feedwater heater or to the feedwater line. Piping for other treatment chemicals will be connected to the boiler drum. The chemical shot feeder will not be required for larger steam boilers.

If steam is used for cooking or humidification, a separate heat exchanger will be required due to environmental constraints with the use of amines (AR 420-49, 6-5b).

****

Provide a water treatment system capable of feeding chemicals and blowdown of the system to prevent corrosion and scale within the boiler and piping distribution system. Treat the water to maintain the conditions recommended by the boiler manufacturer or UFC 3-230-03 (Central Boiler Plants) and PWTB 420-49-5 (Industrial Water Treatment Procedures). Chemicals shall meet required federal, state, and local environmental regulations for the treatment of boilers and discharge to the sanitary sewer. The services of a company regularly engaged in the treatment of boilers shall be used to determine the correct concentrations required for water treatment. The company shall maintain the chemical treatment and provide all chemicals required for a period of 1 year from the date of occupancy. Filming amines, hydrazine and chelants shall not be used. The water treatment chemicals shall remain stable throughout the operating temperature range of the system and shall be compatible with pump seals and other elements of the system.

2.11.1 Boiler Water Limits

The boiler water limits shall be as follows unless dictated differently by the boiler manufacturer's recommendations:

Causticity (OH)	20-200 ppm
Total Alkalinity (CaCO3)	200-800 ppm
Phosphate (PO4)	30-60 ppm
Polymer (dispersant) or Tannin	5-10 ppm or medium color, respectively
Dissolved Solids (water tube boilers)	3000-3500 ppm
Dissolved Solids (fire tube boilers)	3500-5000 ppm
Suspended Solids	15 ppm Maximum
Sodium Sulfite	20-40 ppm
Silica	Less than 200 ppm
Dissolved Oxygen	Less than 7 ppb
Iron	Less than 10 ppm

pH (Condensate)	7.5 - 8
Conductivity (Condensate)	Less than 35 micromhos
Hardness (Condensate and makeup)	Less than 2 ppm

The above limits apply to boilers operating above 100 kPa 15 psi up 2070 kPa 300 psi. Above 2070 kPa 300 psi these limits decrease. Use ABMA or chemical vendor recommended limits above 2070 kPa 300 psi.

2.11.2 Water Softening System

****

NOTE: The makeup water analysis and the boiler manufacturer's recommended feed water conditions will be used to determine the need for a water softener. UFC 3-230-03 contains general guidance for the selection. Generally, all boilers operating above 100 kPa 15 psi require softened water.

****

The water softening system shall be as specified in Section 22 31 00 WATER SOFTENERS, CATION-EXCHANGE (SODIUM CYCLE).

2.11.3 Boiler Water Treatment System

The water treatment system shall be capable of automatically feeding chemicals to prevent corrosion and scale within the boiler and condensate system. Automatic chemical feed systems shall feed chemicals into the boiler based on makeup water rate. Electrical signals from a water meter on the makeup water line shall be used to control the output of chemical feed pumps.

2.11.4 Steam Boiler Chemical Feed Pumps and Tanks

****

NOTE: The required maximum pump flow rate will be shown on the drawings. The flow rate will depend upon the makeup water flow rate, the chemical composition of the makeup water and the concentration of the chemical supplied. A water treatment company should be consulted for determining the proper maximum pump flow rate.

A company regularly engaged in water treatment for mechanical systems will be consulted to determine the number of tanks required to be shown on the drawings. The number will depend on the size of the boiler, makeup water flow rate, and makeup water composition. A potable water line will be provided near the tanks for the mixing of chemicals.

****

a. Furnish chemical feed pumps and tanks as a package with the pumps mounted on and piping connected to the tank. The chemical feed pumps shall be positive displacement diaphragm type. The pump cylinders, plungers, ball check valves, and check valve bodies shall be of

corrosion resistant materials suitable for the chemicals being pumped. Cylinders shall be replaceable for increased or reduced pressure or capacity ranges. The flow rate of the pumps shall be adjustable from 0 to 100 percent while in operation. Volumetric accuracy of the pumps shall be within one percent over the range indicated. Pump capacities shall be adjustable by positioning crank pin with micrometer setscrews. Stroke length scale shall be divided in percentage graduations engraved on scale.

b. The discharge pressure of pumps shall not be less than 1.5 times the line pressure at the point of connection. The pumps shall be provided with a pressure relief valve and a check valve mounted in the pump discharge. The pumps shall be controlled by an external controller/timer receiving signals from the makeup water meter.

c. Drive motors shall be 110 volt, single phase and shall have drip-proof enclosures. The tanks shall be constructed of [materials compatible with the chemicals to be stored in the tank] [high density polyethylene] [stainless steel] [fiber reinforced plastic] with a hinged cover and mounted on legs. Tanks shall have filling and drain connections and gauge glass. Each tank shall be furnished with one pump, mounted and piped with black iron pipe and fittings, with suction strainer and stainless steel screen, and with 13 mm 1/2 inch relief valve with steel body and stainless steel trim. Tank bottom shall be dished concave to a radius equal to the diameter of the tank. The tank for sodium sulfite will have a floating cover to minimize contact with air. Motor-driven agitator shall be provided. The tanks shall have sufficient capacity to require recharging only once per [7] [14] [21] [_____] days during normal operation.

2.11.5 Steam Boiler Chemical Injection Assemblies

Provide an injection assembly at each chemical injection point located along the boiler piping as indicated. The injection assemblies shall be constructed of stainless steel. The discharge of the assemblies shall extend to the centerline of the piping. Each assembly shall include a shutoff valve and check valve at the point of entrance into the water line.

2.11.6 Steam Boiler Water Meter

Provide the water meter with an electric contacting register and remote accumulative counter. Install the meter within the makeup water line, as indicated.

2.11.7 Steam Boiler Timers

Timers shall be of the automatic reset, adjustable type, and electrically operated. The timers shall be designed to work with the contacting head water meters. The timer should include the water meter cable. The timers will control operation of the chemical feed pumps. The timers shall be suitable for a 120 volt current. The timers shall be used to control the electrical signals from the water meters to the chemical feed pumps.

2.11.8 Steam Boiler Control Panel

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NOTE: The MAN-OFF-AUTO switch should be deleted for continuously fed systems.

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The control panel shall be a NEMA 12, single door, wall-mounted box conforming with NEMA 250. The panel shall be constructed of [coated steel] [stainless steel] with a hinged door and lock. The panel shall contain, as a minimum, the following functions identified with a laminated plastic nameplate:

a. Main power switch and indicating light
b. MAN-OFF-AUTO selector switch
c. Indicating lamp for each chemical feed pump
d. Indicating lamp for the water softener

2.11.9 Boiler Blowdown

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NOTE: Typically, automatic blowdown will be economical for boilers with capacities greater than 2.9 MW 10,000,000 Btuh.
****

Provide the boiler with [continuous blowdown] [automatic blowdown based upon conductivity or boiler load]. Bottom blowdown connection and valve shall also be present to allow removal of solids and water from the bottom of the boiler.

2.11.10 Boiler Chemical Piping

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NOTE: If steel piping is selected, an interior coating may be required depending upon the chemicals used.
****

The piping and fittings shall be constructed of [steel] [stainless steel].

2.11.11 Boiler Test Kits

One test kit of each type required to determine the water quality as outlined in paragraph Boiler Water Limits above and within the operation and maintenance manuals.

2.12 SUPPLEMENTAL COMPONENTS/SERVICES

****
NOTE: All drain and makeup water piping should be indicated on the drawings.
****

Drain and makeup water piping shall comply with the requirements of Section 22 00 00 PLUMBING, GENERAL PURPOSE. Drains which connect to sanitary sewer systems shall be connected by means of an indirect waste.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

Provide all chemicals, equipment and labor necessary to bring all system waters in conformance with the specified requirements. Perform all work in accordance with the manufacturer's published diagrams, recommendations, and equipment warranty requirements.

3.3 PIPING

Connections between dissimilar metals shall be made with a dielectric union.

3.4 TRAINING COURSE

Submit a schedule, at least 2 weeks prior to the date of the proposed training course, that identifies the date, time, and location for the training. Conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total [_____] hours of normal working time and start after the system is functionally completed but prior to final acceptance tests. Submit field instructions, at least 2 weeks prior to construction completion, including equipment layout, wiring and control diagrams, piping, valves and control sequences, and typed condensed operation instructions. The condensed operation instructions shall include preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system. The posted instructions shall be framed under glass or laminated plastic and posted where indicated by the Contracting Officer. The field instructions shall cover all of the items contained in the Operation and Maintenance Manuals as well as demonstrations of routine maintenance operations.

3.5 TESTS

If the waters of the mechanical systems are not in conformance with the specified requirements or in accordance with manufacturer's recommendations, the water treatment company shall take corrective action to enable compliance. Daily operational tests shall be performed in the directed frequencies to maintain required control to prevent corrosion, scaling and damage to equipment during operation Submit test schedules, at least 2 weeks prior to the start of related testing, for the condenser/chilled/boiler/condensate/feedwater water quality tests. The schedules shall identify the date, time, frequency and collection location for each test.

3.5.1 Condenser Water Quality Tests

3.5.1.1 Small Systems (weekly)

Once a week, for cooling systems with a capacity of 175.8 kW 50 tons or less, the following items shall be recorded.

pH	[_____]
Total Alkalinity (as CaCO3)	[_____] ppm (mg/L)

Conductivity	[_____] micromho/cm

3.5.1.2 Tests for Large Systems (daily)

Daily, for cooling systems with a capacity larger than 175.8 kW 50 tons, the following items shall be recorded.

pH	[_____]
Total Alkalinity (as CaCO3)	[_____] ppm (mg/L)
Conductivity	[_____] micromho/cm
Phosphate	[_____] ppm (mg/L)
Zinc, if used (Zn)	[_____] ppm (mg/L)
Molybdate, if used (Mo)	[_____] ppm (mg/L)

3.5.2 Chilled Water Testing (monthly)

Once a month, the following tests will be performed on chilled water.

pH	[_____]
Nitrite or Molybdate	[_____] ppm (mg/L)
Conductivity	[_____] micromho/cm

3.5.3 Hot Water Boiler Water Quality Testing

3.5.3.1 Low and Medium Temperature Systems (monthly)

Monthly testing shall be completed and recorded for the following parameters.

pH	[_____]
Nitrite or Molybdate	[_____] ppm (mg/L)

3.5.3.2 High Temperature Hot Water Systems (daily)

Daily testing shall be completed and recorded for the following parameters.

pH	[_____]

Sulfite	[_____] ppm (mg/L)
Hardness	[_____] ppm (mg/L)

3.5.4 Steam Boiler Water Testing

3.5.4.1 Small Steam Systems

The type of treatment required for small steam systems (below 0.25 MW 25 hp) varies greatly depending on local water and system conditions. The type of treatment and frequency of testing shall be determined by the water treatment chemical vendor.

3.5.4.2 Medium Steam Systems (twice weekly)

Twice a week for steam boiler systems operating between 0.25 MW 25 hp and 1 MW 100 hp the following items will be recorded and utilized for operation purposes.

pH	[_____]
P Alkalinity (as CaCO3)	[_____] ppm (mg/L)
Total Dissolved Solids	[_____] ppm (mg/L)
Phosphate (PO4)	[_____] ppm (mg/L)
Sulfite (NaSO3)	[_____] ppm (mg/L)

3.5.4.3 Large Steam Systems (daily)

Daily, for steam boiler systems operating above 100 kPa 15 psi and 1 MW 100 hp, the following items will be recorded and utilized for operational purposes.

Sulfite (NaSO3)	[_____] ppm (mg/L)
P Alkalinity (as CaCO3)	[_____] ppm (mg/L)
Conductivity	[_____] micromho/cm
Neutralized Conductivity	[_____] micromho/cm
Total Dissolved Solids	[_____] ppm (mg/L)
Phosphate (PO4)	[_____] ppm (mg/L)
Condensate pH	[_____]
Condensate Conductivity	[_____] micromho/cm

Condensate Hardness (as CaCO3)	[_____] ppm (mg/L)
Makeup Water Hardness (as CaCO3)	[_____] ppm (mg/L)

3.5.5 Quality Assurance Testing

****
NOTE: It is important to require Quality Assurance (QA) testing performed by an independent industrial water treatment laboratory/consultant to sustain good water chemistry control. Systems without good chemistry control will experience higher equipment replacement costs, energy and operating costs, higher water usage, more plant shutdowns, higher and decreased safety.
****

Conduct QA testing periodically by an independent water treatment lab/consultant to verify to managers that the mechanical and water treatment systems are being maintained properly. Provide the QA evaluation reports to the government COR.

3.5.5.1 Condenser Water QA Tests

Submit test reports in bound 216 by 279 mm 8-1/2 by 11 inch booklets. The reports shall identify the chemical composition of the condenser water. The reports shall also include a comparison of the manufacturer's or chemical vendor's recommended operating conditions for the cooling tower and condenser in relation to the actual condition of the condenser water. Any required corrective action shall be documented within the report.

a. For cooling systems with a capacity of 175.8 kW 50 ton or less, the following tests shall be performed

Presence of scale/corrosion	[_____]
Polyphosphate	[_____] ppm (mg/L)
Biocide	[_____] ppm (mg/L)
pH	[_____]
Total Alkalinity (as CaCO3)	[_____] ppm (mg/L)
Calcium Hardness (as CaCO3)	[_____] ppm (mg/L)
Conductivity	[_____] micromho/cm
Written evaluation summary	

b. For cooling systems with capacities greater than 175.8 kW 50 ton), the condenser water shall be analyzed a minimum of once a month for a period of one year by the water treatment company. The analysis shall include the following information recorded in accordance with ASTM D596.

Date of Sample	[_____]
Temperatures (before & after condenser)	[_____] & [_____] degrees C
pH	[_____]
Silica (SiO2)	[_____] ppm (mg/L)
Iron (total, as Fe(2)O(3))	[_____] ppm (mg/L)
Copper (Cu)	[_____] ppm (mg/L)
Calcium Hardness(CaCO3)	[_____] ppm (mg/L)
Total Hardness (as CaCO3)	[_____] ppm (mg/L)
Chloride (Cl)	[_____] ppm (mg/L)
Total Alkalinity (as CaCO3)	[_____] ppm (mg/L)
Conductivity	[_____] micromho/cm
Total Dissolved Solids	[_____] ppm (mg/L)
Phosphonate (as PO4)	[_____] ppm (mg/L)
Zinc (if used) (Zn)	[_____] ppm (mg/L)
Molybdate (if used) (Mo)	[_____] ppm (mg/L)
Tolyltriazole (TT)	[_____] ppm (mg/L)
Biocide	[_____] ppm (mg/L)
Bacteria colony count	[_____] colonies/mL
Makeup water pH	[_____] ppm (mg/L)
Makeup water Iron	[_____] ppm (mg/L)
Makeup water Silica	[_____] ppm (mg/L)
Makeup water Calcium Hardness	[_____] ppm (mg/L)
Makeup water Total Hardness	[_____] ppm (mg/L)
Makeup water Total Alkalinity	[_____] ppm (mg/L)
Makeup water Chloride (Cl)	[_____] ppm (mg/L)
Makeup water Conductivity	[_____] micromho/cm

Written evaluation summary	

3.5.5.2 Chilled Water Quality Assurance Testing (quarterly)

Quarterly, the following tests shall be performed on chilled water.

pH	[_____]
Nitrite or Molybdate	[_____] ppm (mg/L)
Conductivity	[_____] micromho/cm
Iron (total, as Fe(2)O(3))	[_____] ppm (mg/L)
Written evaluation summary	

3.5.5.3 Hot Water Boiler Water Quality Assurance Testing

a. Quarterly testing of Low and Medium Temperature Systems shall be completed and recorded for the following parameters.

pH	[_____]
Nitrite or Molybdate	[_____] ppm (mg/L)
Iron (total, as Fe(2)O(3))	[_____] ppm (mg/L)
Written evaluation summary	

b. The hot water boiler water shall be analyzed once a month for a period of 1 year by an independent consultant. The analysis shall include the following information recorded in accordance with ASTM D596.

pH	[_____]
Sulfite (Na2SO3)	[_____] ppm (mg/L)
Hardness(as CaCO3)	[_____] ppm (mg/L)
Iron (total, as Fe(2)O(3))	[_____] ppm (mg/L)
Written evaluation summary	

3.5.5.4 Steam Boiler Water QA Tests

Submit the water quality test report identifying the chemical composition of the boiler, feedwater and condensate water. The report shall include a comparison of the condition of the boiler water with the manufacturer's or chemical vendor's recommended conditions. Any required corrective action shall be documented within the report.

a. Small and Medium Steam Boiler Systems (quarterly)are systems operating between 0.25 MW 25 hp and 1 MW 100 hp. The following tests shall be performed quarterly.

pH	[_____]
Sulfite, if used, (NaSO3)	[_____] ppm (mg/L)
P Alkalinity (as CaCO3)	[_____] ppm (mg/L)
Total Dissolved Solids	[_____] ppm (mg/L)
Phosphate, if used, (PO4)	[_____] ppm (mg/L)
Polymer, if used	[_____] ppm (mg/L)
Iron (total, as Fe(2)O(3))	[_____] ppm (mg/L)
Condensate pH	[_____]
Condensate Conductivity	[_____] micromho/cm
Condensate Hardness (as CaCO3)	[_____] ppm (mg/L)
Condensate Iron (total, as Fe(2)O(3))	[_____] ppm (mg/L)
Makeup Water Hardness (as CaCO3)	[_____] ppm (mg/L)
Written evaluation summary	

b. Large steam boilers are those operating above 100 kPa 15 psi and 1 MW 100 hp. The boiler water shall be analyzed a minimum of once a month for a period of 1 year by an independent consultant. The analysis shall include the following information recorded in accordance with ASTM D596.

Date of Sample	[_____]
pH	[_____]
Sulfite (NaSO3)	[_____] ppm (mg/L)
P Alkalinity (as CaCO3)	[_____] ppm (mg/L)
Conductivity	[_____] micromho/cm
Neutralized Conductivity	[_____] micromho/cm
Total Dissolved Solids	[_____] ppm (mg/L)

Phosphate (PO4)	[_____] ppm (mg/L)
Polymer, if used	[_____] ppm (mg/L)
Silica (SiO2)	[_____] ppm (mg/L)
Iron (total, as Fe(2)O(3))	[_____] ppm (mg/L)
Condensate pH	[_____]
Condensate Conductivity	[_____] micromho/cm
Condensate Hardness (as CaCO3)	[_____] ppm (mg/L)
Condensate Iron (total, as Fe(2)O(3))	[_____] ppm (mg/L)
Makeup Water Hardness (as CaCO3)	[_____] ppm (mg/L)
Written evaluation summary	

3.5.6 Corrosion Testers

****

NOTE: Choose from the systems below to be monitored with corrosion testers.

****

Install corrosion coupon and rack systems to verify corrosion control in the systems. Testers or coupons are installed in flowing system water through a sidestream or rack system. Both mild steel and copper metal samples are to be tested in the corrosion testers in accordance with ASTM D2688. Samples are to be replaced and analyzed every 3 months. Rates of corrosion less than 3 mpy for steel and 0.2 mpy for copper are acceptable. Corrosion testers shall be installed on the piping systems of the following systems.

Condenser loop
Chilled water system
Hot water loop
Condensate

3.6 INSPECTIONS

3.6.1 Inspection General Requirements

Thirty days after project completion, inspect the cooling tower and condenser for problems due to corrosion, scale, and biological growth. If the cooling tower and condenser are found not to conform to the manufacturer's recommended conditions, and the water treatment company recommendations have been followed; the water treatment company shall provide all chemicals and labor for cleaning or repairing the equipment as required by the manufacturer's recommendations.

3.6.2 Boiler/Piping Test

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NOTE: If a steam boiler is not used, delete the reference to condensate piping.
****

Thirty day after project completion, inspect the boiler and condensate piping for problems due to corrosion and scale. If the boiler is found not to conform to the manufacturer's recommendations, and the water treatment company recommendations have been followed, the water treatment company shall provide all chemicals and labor for cleaning or repairing the equipment as required by the manufacturer's recommendations. If corrosion is found within the condensate piping, proper repairs shall be made by the water treatment company.

-- End of Section --