UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated April 2026
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DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 25 00

CHEMICAL TREATMENT OF WATER FOR MECHANICAL SYSTEMS

05/21

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC | **UFGS-23 25 00 (May 2021)**

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UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 23 25 00

CHEMICAL TREATMENT OF WATER FOR MECHANICAL SYSTEMS
05/21

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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).

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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.

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

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B40.100	(2022) 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	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA MG 00001	(2024) Motors and Generators

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 200-1-13	(2016) Environmental Quality -- Minimizing the Risk of Legionellosis Associated with Building Water Systems on Army Installation
PWTB 420-49-5	(1998) Industrial Water Treatment Procedures

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-430-08N	(2004) Central Heating Plants

1.2 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity

or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

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

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

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

SD-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

1.3 MAINTENANCE MATERIAL SUBMITTALS

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. Include a complete list of parts and supplies, with source of supply, with the data.

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.
****

Ensure 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 are 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 [05 50 13 MISCELLANEOUS METAL FABRICATIONS] [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.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 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. Minimize to risk of Legionellosis by following the guidance in EM 200-1-13.

2.1.2 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. Include in the two-year use all applications of equipment and materials under similar circumstances and of similar size. Ensure the two years' experience has 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 are 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 are required to 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 are required to be reasonably convenient to the equipment installation and 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 provides the chemicals required, the concentrations required, and the water treatment equipment sizes and flow rates required. The company provides all chemicals required for the [condenser] [condenser and chilled] water systems and fills the systems with chemicals to the levels specified. The chemical is required to meet the requirements of this specification as well as the recommendations from the manufacturers of the condenser and cooling tower. Acid treatment chemicals are not allowed to be used.

2.1.3 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.

****

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

2.2 EQUIPMENT

2.2.1 Nameplates

Provide a nameplate for each major component of equipment that includes the manufacturer's name, address, type or style, and catalog or serial number securely attached to the item of equipment. Provide nameplates for:

a. Pump(s)

b. Pump Motor(s)

c. Water Treatment Controller(s)

2.2.2 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.
****

Ensure all electrical equipment, motors, motor efficiencies, and wiring complies with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide electrical motor driven equipment specified complete with motors, motor starters, and controls. Provide electrical characteristics and enclosure types as shown, and unless otherwise indicated, provide all motors of 745 W 1 horsepower and above with open, drip-proof, or totally enclosed fan cooled enclosures, high efficiency type. Perform field wiring in accordance with manufacturer's instructions. Each motor is required to conform to NEMA MG 00001 and be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Provide continuous duty motors 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. Furnish motor starters with [NEMA 1] [NEMA 3R] [NEMA [_____]] enclosures. Provide 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.

2.2.3 Gauges

Provide gauges that 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.

2.3 COMPONENTS

2.3.1 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 are required to 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.

Provisions should be made to effectively dose, monitor and control a water treatment program to include (1) inhibitor and biocide injection (2) water sampling, (3) corrosion coupon sampling, and (4) effective bleed and control points.

2.3.1.1 Condenser Water Limits

Meet the following condenser water limits, 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, minimize blowdown 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.

2.3.1.2 Glycol Solution

****

NOTE: If freeze protection for condenser water is not required or addressed using a different method, 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.

****

Coordinate minimum glycol concentration with manufacturer to avoid corrosion inhibitor degradation. Test the glycol in accordance with ASTM D1384 with less than 0.013 mm 0.5 mils penetration per year for all system metals. Provide glycol that contains corrosion inhibitors. Silicate based inhibitors are not acceptable. Ensure the solution is compatible with pump seals, other elements of the system, and water treatment chemicals used within the system.

2.3.1.3 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.

2.3.1.4 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. Maintain biocides to control bacteria below 10,000 colony forming units per milliliter.

a. Phosphonate Type Treatment

(1)

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

b. Zinc-Phosphonate Type Treatment

(1)

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

c. Zinc-Molybdate Type Treatment

(1)

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

2.3.1.4.1 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 automatically feed chemicals into the condenser water based on makeup water rate. Use electrical signals from a water meter on the makeup water line to control the output of chemical feed pumps. Set the system initially 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. Include in the manuals all testing procedures used in determining water quality.

2.3.1.4.2 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 must 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. Furnish chemical feed pumps of the positive displacement diaphragm type. Furnish all pump cylinders, plungers, ball check valves, and check valve bodies made of corrosion resistant materials suitable for the chemicals being pumped. Ensure the cylinders of the provided pumps are replaceable for increased or reduced pressure or capacity ranges.

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

c. Provide drive motors rated at 110 volt, single phase with drip-proof enclosures. Provide two chemical tanks 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. Ensure tanks have filling and drain connections and gauge glasses. Furnish each tank with one pump, mounted and piped with pipe materials and fittings suitable for working pressure and compatible with the chemicals in the tank it is in contact with, with suction strainer and stainless steel screen, and with 13 mm 1/2 inch relief valve with steel body and stainless steel trim. Provide a tank bottom that is dished concave to a radius equal to the diameter of the tank. Provide motor-driven agitator. Size the tanks to have sufficient capacity to require recharging only once per [7] [14] [21] [_____] days during normal operation.

2.3.1.4.3 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. Construct the injection assemblies of stainless steel. Locate the discharge of the assemblies in the condenser water piping as recommended by the manufacturer. Include with each assembly a shutoff valve and check valve at the point of entrance into the condenser water line.

2.3.1.4.4 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.

2.3.1.4.5 Timers

Provide timers which are of the automatic reset, adjustable type, and are electrically operated. Ensure the timers are designed to work with the contacting head water meters. Include the water meter cable with the timer. Ensure timers control operation of the chemical feed pumps and are suitable for a 120 volt current. Locate the timers within the water treatment control panel.

2.3.1.4.6 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. Provide a high and low set point on the conductivity meter above which the meter opens a solenoid valve on the bleed line. Locate the bleed line attachment to the condenser water piping downstream of the recirculating pumps and upstream of the chemical injection point. Extend the bleed line to the nearest drain for continuous discharge.

2.3.1.4.7 Control Panel

****

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.

****

Provide a NEMA 12 control panel enclosure suitable for surface mounting. Construct the panel of [stainless steel] [coated steel] with a hinged door and lock. Include 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

2.3.1.4.8 Chemical Piping

Construct the piping and fittings of [schedule 80 PVC] [stainless steel] suitable for the water treatment chemicals.

2.3.1.4.9 Sequence of Operation

Add chemicals based upon sensing the make-up water flow rate and activating appropriate timers. Provide a separate timer for each chemical. Control the blow down based upon the conductivity of the condenser water. Control the injection of the chemical required for biological control manually set for proper chemical feed. The water treatment company is required to determine and set a timer set points, blow down rates, and chemical pump flow rates.

2.3.1.4.10 Test Kits

Provide one test kit of each type required to determine the water quality as outlined within the operation and maintenance manuals.

2.3.2 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.

****

Provide a [7.57] [18.92] [_____] L [2] [5] [_____] gallon shot feeder on the chilled water piping as indicated. Furnish the feeder with an air vent, gauge glass, funnel, valves, fittings, and piping.

2.3.2.1 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. Consult with a water treatment company to determine the exact treatment levels for chilled water treatment.

****

Coordinate minimum [ethylene][propylene] glycol concentration with manufacturer to avoid corrosion inhibitor degradation. Test the glycol in accordance with ASTM D1384 with less than 0.013 mm 0.5 mils penetration per year for all system metals. Ensure the glycol contains corrosion inhibitors. Silicate based inhibitors are not acceptable. Ensure the solution is compatible with pump seals, other elements of the system, and

water treatment chemicals used within the system.

2.3.2.2 Chilled Water Treatment

Treat chilled water with either a borax/nitrite type treatment or a molybdate type treatment. Both types of treatment are acceptable for use with glycol. Maintain borax/nitrite treatment at the limits of [ ] ppm nitrite, [ ] ppm copper corrosion inhibitor (TT or MBT), and pH of 8.5 to 9.5. Maintain molybdate treatment at the limits of [ ] ppm molybdate, [ ] ppm copper corrosion inhibitor (TT or MBT), and pH of 8.0 to 9.0.

2.3.2.3 Dual Temperature Systems

Dual hot/chilled water systems that are treated with borax/nitrite are also to be treated with a biocide.

2.3.2.4 Chilled Water Test Kits

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

2.3.3 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).

2.3.3.1 Chemical Feeder

Provide a [7.57] [18.92] [_____] L [2] [5] [_____] gallon shot feeder on the hot water piping as indicated. Base the size and capacity of feeder upon local requirements and water analysis. Furnish the feeder with an air vent, gauge glass, funnel, valves, fittings, and piping.

2.3.3.2 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. 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.

****

Provide a water softening system as specified in Section 22 31 03 WATER SOFTENERS, CATION-EXCHANGE (SODIUM CYCLE).

2.3.3.3 Low and Medium Temperature Hot Water Treatment

Treat hot water with either a borax/nitrite type treatment or a molybdate type treatment. Both types of treatment are acceptable to use with glycol. Maintain borax/nitrite treatment 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. Maintain molybdate treatment 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.

2.3.3.4 Dual Temperature Systems

Dual hot/chilled water systems treated with borax/nitrite are required to also be treated with a biocide.

2.3.3.5 Test Kit Requirements

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

2.3.4 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.
****

2.3.4.1 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.
****

Provide a feeder unit for each boiler. Ensure chemical feeder provided is automatic proportioning, shot type, or pump type. Provide all appurtenances necessary to ensure the system performs in compliance with the requirements outlined herein. Base the size and capacity of feeder upon local requirements and water analysis.

2.3.4.2 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 are required to be positive displacement diaphragm type. Furnish the pump cylinders, plungers, ball check valves, and check valve bodies fabricated from corrosion resistant materials suitable for the chemicals being pumped. Ensure cylinders used are replaceable for increased or reduced pressure or capacity ranges.

b. Provide for a flow rate of the pumps that is adjustable from 0 to 100 percent while in operation. Ensure volumetric accuracy of the pumps is within one percent over the range indicated. Ensure pump capacities are adjustable by positioning crank pin with micrometer setscrews. Divide stroke length scale in percentage graduations engraved on scale. Ensure the discharge pressure of pumps is not less than 1.5 times the line pressure at the point of connection. Design the pumps to feed the chemical solutions into the HTW return line to the system circulating pumps with a capacity to feed a maximum of [5.3] [_____] mL/second [5] [_____] gph. Provide the pumps with a pressure relief valve and a check valve mounted in the pump discharge. Control the pumps by an external controller/timer receiving signals from the makeup water meter.

c. Provide drive motors that are 110 volt, single phase and have drip-proof enclosures. Provide the tanks 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. Ensure tanks have both filling and drain connections and gauge glass. Furnish each tank with one pump, mounted and piped with black iron pipe and fittings suitable for working pressures and compatible with the chemicals in the tank it is in contact with, with suction strainer and stainless steel screen, and with 13 mm 1/2 inch relief valve with steel body and stainless steel trim. Provide tank with a dished concave bottom to a radius equal to the diameter of the tank. Provide units suitable for phosphate, caustic feed and sulfite feeding. Provide sulfite tank with a floating cover to completely cover the surface of the solution. Include a motor-driven agitator. Size tanks to have sufficient capacity to require recharging only once per [7] [14] [21] [_____] days during normal operation.

d. For auto proportioning systems, provide controllers designed to be used with selected system specifically for the purpose of injecting chemicals into boiler systems.

e. Mount system components on metal buses or supports instead of mounting directly to the floor.

2.3.4.3 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. Hardness must be maintained below 2 ppm.

****

Provide water softening system as specified in Section 22 31 03 WATER SOFTENERS, CATION-EXCHANGE (SODIUM CYCLE).

2.3.4.4 Treated Water Limits

Consult with the boiler manufacturer for the determination of the boiler water chemical composition limits. Provide for the following recirculating hot water chemical limits unless dictated differently by the boiler manufacturer's recommendations:

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

2.3.5 Test Kit

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

2.3.6 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 3-430-08N (Central Heating Plants) and PWTB 420-49-5 (Industrial Water Treatment Procedures). Provide chemicals that meet all required federal, state, and local environmental regulations for the treatment of boilers and discharge to the sanitary sewer. Engage the services of a company regularly engaged in the treatment of boilers to determine the correct concentrations required for water treatment. The company is required to maintain the chemical treatment and provide all chemicals required for a period of 1 year from the date of occupancy. Do not use filming amines, hydrazine and chelants. Ensure the water treatment chemicals remain stable throughout the operating temperature range of the system and are compatible with pump seals and other elements of the system.

2.3.6.1 Boiler Water Limits

Provide for boiler water limits 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.

2.3.6.2 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. Generally, all boilers operating above 100 kPa 15 psi require softened water.

****

Provide the water softening system as specified in Section 22 31 03 WATER SOFTENERS, CATION-EXCHANGE (SODIUM CYCLE).

2.3.6.3 Boiler Water Treatment System

Provide water treatment system capable of automatically feeding chemicals to prevent corrosion and scale within the boiler and condensate system. Ensure automatic chemical feed systems feed chemicals into the boiler based on makeup water rate. Use electrical signals from a water meter on the makeup water line to control the output of chemical feed pumps.

2.3.6.4 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. Use chemical feed pumps that are positive displacement diaphragm type. Ensure the pump cylinders, plungers, ball check valves, and check valve bodies are fabricated of corrosion resistant materials suitable for the chemicals being pumped. Ensure cylinders are replaceable for increased or reduced pressure or capacity ranges. Ensure the flow rate of the pumps is adjustable from 0 to 100 percent while in operation. Ensure volumetric accuracy of the pumps is within one percent over the range indicated. Pump capacities are required to be adjustable by positioning crank pin with micrometer setscrews. Divide stroke length scale in percentage graduations engraved on scale.

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

c. Provide drive motors rated for 110 volt, single phase and are equipped with drip-proof enclosures. Provide tanks 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. Ensure tanks have filling and drain connections and gauge glass. Furnish each tank with one pump, mounted and piped with pipe and fittings suitable for working pressures and compatible with the chemicals in the tank it is in contact with, with suction strainer and stainless steel screen, and with 13 mm 1/2 inch relief valve with steel body and stainless steel trim. Shape tank bottom to be dished concave to a radius equal to the diameter of the tank. Ensure the tank for sodium sulfite is equipped with a floating cover to minimize contact with air. Provide a motor-driven agitator. Size the tanks to have sufficient capacity to require recharging only once per [7] [14] [21] [_____] days during normal operation.

2.3.6.5 Steam Boiler Chemical Injection Assemblies

Provide an injection assembly at each chemical injection point located along the boiler piping as indicated. Provide injection assemblies that are constructed of stainless steel. Extend the discharge of the assemblies to the centerline of the piping. Include a shutoff valve and check valve with each assembly at the point of entrance into the water line.

2.3.6.6 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.

2.3.6.7 Steam Boiler Timers

Provide timers that are automatic reset, adjustable type, and electrically operated. Design timers to work with the contacting head water meters. Include the water meter cable with the timer. Ensure timers control operation of the chemical feed pumps. Ensure timers are suitable for a 120 volt current. Use timers to control the electrical signals from the water meters to the chemical feed pumps.

2.3.6.8 Steam Boiler Control Panel

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

Provide control panel constructed of a NEMA 12, single door, wall-mounted box conforming with NEMA 250. Ensure the panel is constructed of [coated steel] [stainless steel] with a hinged door and lock. Ensure the panel contains, 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

2.3.6.9 Boiler Blowdown

****
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]. Provide a bottom blowdown connection and valve to allow removal of solids and water from the bottom of the boiler.

2.3.6.10 Boiler Chemical Piping

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

Fabricate the piping and fittings of [steel] [stainless steel].

2.3.6.11 Boiler Test Kits

Provide 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.

2.3.7 Supplemental Components/Services

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

Ensure drain and makeup water piping complies with the requirements of Section 22 00 00 PLUMBING, GENERAL PURPOSE. Connect drains to sanitary sewer systems by means of an indirect waste connection.

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.

3.2.1 Piping

Fabricate all connections between dissimilar metals using dielectric unions.

3.3 FIELD QUALITY CONTROL

3.3.1 Tests

If the waters of the mechanical systems are not in conformance with the specified requirements or in accordance with manufacturer's recommendations, the contractor is required to direct the water treatment company to take corrective action to achieve compliance. Perform daily operational tests 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. Identify the date, time, frequency and collection location for each test within the schedules.

3.3.2 Condenser Water Quality Tests

3.3.2.1 Small Systems (weekly)

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

pH	[_____]

Total Alkalinity (as CaCO3)	[_____] ppm (mg/L)
Conductivity	[_____] micromho/cm

3.3.2.2 Tests for Large Systems (daily)

Daily, for cooling systems with a capacity larger than 175.8 kW 50 tons, ensuring the following items are 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)

3.3.3 Chilled Water Testing (monthly)

Perform the following tests on chilled water on a monthly basis.

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

3.3.4 Hot Water Boiler Water Quality Testing

3.3.4.1 Low and Medium Temperature Systems (monthly)

Complete and record monthly testing for the following parameters.

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

3.3.4.2 High Temperature Hot Water Systems (daily)

Complete and record daily testing for the following parameters.

pH	[_____]

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

3.3.5 Steam Boiler Water Testing

3.3.5.1 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. Base the determination of the type of treatment and frequency of testing on the recommendations of by the water treatment chemical vendor.

3.3.5.2 Medium Steam Systems (twice weekly)

Record the following items twice a week for steam boiler systems operating between 0.25 MW 25 hp and 1 MW 100 hp and utilize data 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)

3.3.5.3 Large Steam Systems (daily)

Record the following items daily for steam boiler systems operating above 100 kPa 15 psi and 1 MW 100 hp and utilize data 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)

3.3.6 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.

3.3.6.1 Condenser Water QA Tests

Submit test reports in bound 216 by 279 mm 8-1/2 by 11 inch booklets. Within the reports, identify the chemical composition of the condenser water. Also include in the reports 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. Document any required corrective actions undertaken within the report.

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

b.

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	

c. For cooling systems with capacities greater than 175.8 kW 50 ton), analyze the condenser water a minimum of once a month for a period of one year by the water treatment company. Ensure the analysis includes the following information recorded in accordance with ASTM D596.

d.

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	

3.3.6.2 Chilled Water Quality Assurance Testing (quarterly)

Perform the following tests quarterly 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	

3.3.6.3 Hot Water Boiler Water Quality Assurance Testing

a. Complete quarterly testing of Low and Medium Temperature Systems and record the following parameters.

b.

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

c. Have an independent consultant analyze the hot water boiler water once a month for a period of 1 year. Include the following information recorded in accordance with ASTM D596 in the monthly report.

d.

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	

3.3.6.4 Steam Boiler Water QA Tests

Submit the water quality test report identifying the chemical composition of the boiler, feedwater and condensate water. Include in the report a comparison of the condition of the boiler water with the manufacturer's or chemical vendor's recommended conditions. Document any required corrective action 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. Perform the following tests

quarterly.

b.

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	

c. Large steam boilers are those operating above 100 kPa 15 psi and 1 MW 100 hp. Retain an independent consultant to analyze the boiler water a minimum of once a month for a period of 1 year. Include the following information recorded in accordance with ASTM D596 in the monthly report.

d.

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	

3.3.7 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. Install testers or coupons in flowing system water through a sidestream or rack system. Test both mild steel and copper metal samples in the corrosion testers in accordance with ASTM D2688. Replace and analyze samples every 3 months. Rates of corrosion less than 3 mpy for steel and 0.2 mpy for copper are acceptable. Install corrosion testers on the piping systems of the following systems.

Condenser loop
Chilled water system
Hot water loop
Condensate

3.4 CLOSEOUT ACTIVITIES

3.4.1 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. Conduct the training to include a total of [_____] 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. Include within the condensed operation instructions all preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system. Frame the posted instructions under glass or laminated plastic and post where indicated by the Contracting Officer. Ensure the field instructions cover all of the items contained in the Operation and Maintenance Manuals as well as demonstrations of routine maintenance operations.

3.5 INSPECTIONS

3.5.1 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; instruct the water treatment company to provide all chemicals and labor for cleaning or repairing the equipment as required by the manufacturer's recommendations.

3.5.2 Boiler/Piping Test

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

Thirty days 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, instruct the water treatment company to 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 are required to be made by the water treatment company at no additional cost.

-- End of Section --