# SECTION 23 25 00

# HVAC WATER TREATMENT

**BASED ON DFD MASTER SPECIFICATION DATED 11/29/2023**

This section has been written to cover most (but not all) situations that you will encounter. Depending on the requirements of your specific project, you may have to add material, delete items, or modify what is currently written. The Division of Facilities Development expects changes and comments from you.

# P A R T 1 - G E N E R A L

## SCOPE

This section includes specifications for chemical treatment of all water, steam, and condensate systems. Included are the following topics:

PART 1 - GENERAL

Scope

Reference

Related Work

Quality Assurance

Shop Drawings

Operation and Maintenance Data

Design Criteria

Maintenance Service

PART 2 - PRODUCTS

Manufacturers

System Cleaner

System Inhibitor

Algaecides

Glycol

Closed Water System Treatment

Steam System Treatment

Open Water System Treatment (Cooling towers)

Fuel Oil System Treatment

Treatment Equipment

Test Equipment

PART 3 - EXECUTION

Preparation

Cleaning Sequence

Glycol Water Systems

Closed Water Systems

Steam Systems

Open Water Systems

Fuel Oil Systems

Test Cabinet

Construction Verification

Appendix

Pipe Cleaning and Treatment Report

## REFERENCE

Applicable provisions of Division 1 shall govern work under this Section.

## RELATED WORK

Section 23 05 15 - Piping Specialties

Section 23 08 00 – Commissioning of HVAC

## QUALITY ASSURANCE

Refer to division 1, General Conditions, Equals and Substitutions.

## SHOP DRAWINGS

Refer to division 1, General Conditions, Submittals.

Required for all equipment and chemicals specified including data concerning dimensions, capacities, materials of construction, weights, operating sequence, composite wiring diagrams and appropriate identification. Chemical data to include the description of the chemical, its composition, its function, and the associated material safety data sheet.

Chemicals may be furnished by the Owner with the cost of the initial treatment being charged back to this project. Edit the preceding paragraph as appropriate when chemicals are to be furnished by the contractor.

## OPERATION AND MAINTENANCE DATA

Provide for the services of the manufacturer's trained representative to approve the installation and instruct the user agency in the operation of each system.

Include data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations.

## DESIGN CRITERIA

Recommend a periodic test procedure and chemical treatment program for each system.

Treat the following systems:

* Chilled water
* Hot water
* Reclaim water
* Glycol water
* Condenser water
* Steam boiler water
* Steam condensate
* Fuel oil

Provide the initial chemical treatment for all systems based on a complete system fluid analysis prior to the equipment installation. The initial chemical treatment supply of chemicals for each system shall be adequate for the start-up and testing period, for the time the systems are being operated by the Contractor for temporary heating and cooling, and for one year after start-up of the system.

The chemicals used in the condenser water treatment system shall use only liquid chemicals and shall contain no phosphates or chromates.

Provide electrical devices, motors, wiring and conduit in accordance with the applicable sections of the Electrical Specifications.

## MAINTENANCE SERVICE

Furnish service and maintenance of treatment systems for one year from date of substantial completion.

Provide [monthly][\_\_\_\_\_\_\_] technical service visits to perform field inspections and make water analysis on site. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit two copies of field service report after each visit.

Provide laboratory and technical assistance services for the warranty period.

Include [two][\_\_\_\_\_\_\_] hour training course for operating personnel, instructing them on installation, care, maintenance, testing, and operation of the treatment systems. Arrange course at startup of systems.

Provide site inspection of equipment during scheduled shutdown to evaluate success of the treatment program. Make recommendations in writing based on these inspections.

# P A R T 2 - P R O D U C T S

## MANUFACTURERS

Betz Entac, Dearborn Div. - W. R. Grace & Co., Kurita, Mitco Water Labs, Mogul Corporation, Nalco Chemical Co., Western Water Management, or approved equal.

## SYSTEM CLEANER

Blend of organic alkaline penetrants, emulsifiers, surfactants and corrosion inhibitors that remove grease and petroleum products from the interior of piping systems. Cleaners that contain trisodium phosphate are specifically not acceptable.

Trisodium phosphate will react with calcium to form a calcium phosphate precipitate in most Wisconsin water. This will reduce heat transfer and increase system pressure drop.

System cleaner on glycol systems must be checked to verify that it is compatible with the glycol solution.

## SYSTEM INHIBITOR

Scale and corrosion inhibitor consisting of boron nitrite, benzol thiazol, benzotriazole, mercapto-benzo-thiazole, and tolyltrizole silicates.

## ALGAECIDES

Chlorine release agents such as sodium hypochlorite or calcium hypochlorite, or microbicides such as quaternary ammonia compounds, tributyl tin oxide, methylene bis (thiocyanate), or isothiazolones, all in a liquid format.

## GLYCOL

Inhibited ethylene glycol based material specifically designed for use in closed heat transfer systems. Dow Chemical Dowtherm SR-1, Union Carbide UCARTHERM, or approved equal.

Do not allow the use of automotive type antifreeze. Automotive antifreeze is formulated for intermittent service in automotive engines and often contains a silicate inhibitor which can gel in HVAC systems. A gel can also form with the specified products if the incorrect type of water is used in the initial fill of the heating or cooling system; refer to the Part 3 specifications below.

Water filters are recommended in glycol systems. They are specified in Section 23 05 15 - Piping Specialties.

## CLOSED WATER SYSTEM TREATMENT

Sequestering agent to reduce deposits and adjust pH: polyphosphate.

Corrosion inhibitors: boron-nitrite, sodium nitrite and borax, sodium totyltriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.

Conductivity enhancers: phosphates or phosphonates.

## STEAM SYSTEM TREATMENT

Sequestering agent to reduce hardness and prevent feed line congestion: phosphate.

Base to provide alkalinity: hydroxide.

Oxygen scavenger: sodium sulphite or hydrazine.

Carbon dioxide neutralizer: volatile amines such as morpholine or cyclohexylamine.

Filming amines: octadecylamine.

## OPEN WATER SYSTEM TREATMENT (Cooling Towers)

Sequestering agent to inhibit scaling: phosphonates, sodium polyphosphates, lignin derivatives, or synthetic polymer polyelectrolytes.

Acid to reduce alkalinity and pH: sulphuric acid.

Corrosion inhibitor: zinc-phosphate, phosphonate-phosphate, phosphonate-molybdate and phosphonate-silicate, sodium tolyltriazole, or low molecular weight polymers.

Algaecide: chlorine release agents such as sodium hypochlorite or calcium hypochlorite, or microbicides such as quaternary ammonia compounds, tributyl tin oxide, methylene bis (thiocyanate), or isothiazolones.

On the drawings, include a 3/4" shutoff valve upstream and downstream of the pump discharge shutoff valve so that a coupon test rack can be added at a future date.

## FUEL OIL SYSTEM TREATMENT

Organic amines, stabilizers, and dispersants to eliminate sludge formation, minimize oil oxidation, and deactivate metals causing oil degradation.

## TREATMENT EQUIPMENT

BYPASS FEEDER:

5 gallon minimum capacity, 125 psig working pressure, either a screw type cover or a valved funnel opening to feed chemical into the system, prime coat of paint.

It may be necessary to include a brief schedule of systems and the size of feeder required for each system. Bypass feeders are specified for each closed water system and steam system, Feeders are available for 300 psig operating pressure where needed.

SOLUTION METERING PUMP:

Positive displacement, diaphragm pump with adjustable flow rate, thermoplastic construction, continuous-duty fully enclosed electric motor and drive, and relief valve.

SOLUTION TANKS:

[30] [50] gallon capacity, polyethylene, self-supporting, [1] [5] gallon graduated markings; molded fiberglass cover with recess for mounting pump, agitator, and liquid level switch.

AGITATOR:

Totally enclosed electric motor; stainless steel clamp, motor mount, and propeller.

LIQUID LEVEL SWITCH:

Polypropylene housing with integrally mounted polyvinylchloride air trap, receptacles for connection to metering pump, and low level alarm contact.

SAMPLE COOLER:

Neptune Chemical Pump Co., Sentry Equipment Corp., or approved equal. Shell and coil heat exchanger specifically designed for sample cooling; constructed of 300 series stainless steel coil and shell; not less than one square foot of heat exchange surface; suitable for tube side conditions of pressure to 600 psig and temperature to 600°F with shell side conditions of 200 psig of cooling water at temperatures to 200°F maximum; removable shell for inspection and/or cleaning of the heat exchange surfaces; connections for cooling water inlet and outlet, steam inlet, and cooled condensate outlet.

This specification is adequate for all central plant systems except the boilers in the UW-Madison Charter Street Plant and the boilers at the Madison Capitol Heat & Power Plant. For those boilers, tube side conditions of 600 psig at 725°F must be specified.

CONDUCTIVITY CONTROLLER:

Packaged monitor controller with solid state circuiting, five percent accuracy, linear dial adjustment, built-in calibration switch, on-off switch and light, control function light, output to control circuit.

Conductivity controllers should be included for each open water system and each steam system unless the agency using the building has other provisions for checking for suspended solids.

WATER METER:

Displacement type cold water meter with sealed, tamper-proof magnetic drive, bronze housing, 125 psig minimum working pressure, impulse contact register when required by the sequence, single pole double throw dry contact switch. Meters must be capable of being used with remote readout heads and capable of being sealed to prevent tampering.

The meter and the contact register need to be sized and specified for each project and each system on that project.

SOLENOID VALVES:

Forged brass body, globe pattern, normally open or closed as required, general purpose solenoid enclosure unless another type is recommended for the specific application, and continuous duty coil with voltage compatible with the remainder of the system components. Use stainless steel body and trim in lieu of brass if brass is not compatible with valves installed in the lines handling the chemical treatment.

TIMERS:

Electronic timers, infinitely adjustable over full range of 150 seconds to five minutes, mounted together in cabinet with hand-off-automatic switches and status lights.

HAND PUMP:

Rotary hand pump for dispensing fluid from shipping drums, corrosion resistant housing, steel suction pipe, polyethylene or polyvinylchloride discharge pipe, threaded fitting for connection to a 2" bung opening on the drumhead. Hand pump to be capable of pumping against a head of \_\_\_\_\_\_\_\_ feet.

The hand pump must be specified so it can fill the entire system with the working fluid and produce a pressure of approximately 5 psig at the high point in the system. Thus, there can be a significant different in the pump requirements if the system is filled from the bottom versus being filled from the top.

## TEST EQUIPMENT

Provide an enameled test cabinet with local fluorescent light, capable of accommodating a sufficient quantity of 10 milliliter burettes and associated reagents for the tests listed below.

Provide the following test kits:

* Alkalinity titration test kit
* Chloride titration test kit
* Sulphite titration test kit
* Total hardness titration test kit
* Low phosphate test kit
* Conductivity bridge, range 0 to 10,000 microhms
* Creosol red pH slide complete with reagent
* Portable electronic conductivity meter
* High nitrite test kit

# P A R T 3 - E X E C U T I O N

## PREPARATION

Prior to cleaning, verify that systems are operational, filled, started, and vented. Use water meter to record capacity in each system.

Place terminal control valves in the full-open position

## CLEANING SEQUENCE

GENERAL:

Systems are to be cleaned before they are used for any purpose except conduct pressure test before cleaning. Add cleaner to closed systems at concentrations as recommended by the manufacturer. Remove water filter elements from the system before starting circulation. For steam systems, fill boilers only, using the water and cleaner solution.

Use neutralizer agents on recommendation of the system cleaner supplier and approval of the Architect/Engineer.

Flush open systems with clean water for one hour minimum. Drain completely and refill.

Remove, clean, and replace strainer screens.

Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

Use Division of Facilities Development form to document system cleaning, flushing, and proper startup.

HOT WATER HEATING SYSTEMS:

Add cleaner to the system water until the M alkalinity value is 250 above that of the initial fill water. Verify the M alkalinity level before and after the addition of the cleaner by means of chemical tests that are observed by the Owner's construction representative; include results of all tests in the Operating and Maintenance manuals. Apply heat while circulating, slowly raising temperature to 160°F and maintain for 12 hours minimum; vent all high points to assure 100% system circulation. Remove heat and circulate to 100°F or less; drain system as quickly as possible and refill with clean water. Circulate for 6 hours at design temperature, vent air at all high points, then drain. Refill with clean water and repeat until the system cleaner is removed and the M alkalinity level returns to normal. Remove and clean all strainers. Re-vent the system and install clean filter elements in water filters. Treat with scale and corrosion inhibitors before using the system for building heating or cooling.

CHILLED WATER SYSTEMS:

Add cleaner to the system water until the M alkalinity value is 250 above that of the initial fill water. Verify the M alkalinity level before and after the addition of the cleaner by means of chemical tests that are observed by the Owner's construction representative; include results of all tests in the Operating and Maintenance manuals. Circulate for 48 hours, then drain system as quickly as possible. Refill with clean water, circulate for 24 hours, then drain. Refill with clean water and repeat until system cleaner is removed and the M alkalinity level returns to normal. Remove and clean all strainers. Re-vent the system and install clean filter elements in water filters. Treat with scale and corrosion inhibitors before using the system for building heating or cooling.

GLYCOL WATER SYSTEMS:

Clean and flush as indicated above for hot water heating systems. Verify complete drainage by measuring amount of water used for the initial fill versus the amount actually drained to assure complete removal of the cleaning solution. Remove all traces of chloride from the system; test to verify this removal and submit test results.

STEAM SYSTEMS:

Apply heat, slowly raising boiler temperature to 160°F for 12 hours minimum. Cool, then drain as quickly as possible. Refill with clean water, drain, refill and check for sludge. Repeat until system is free of sludge. Apply heat to produce steam for piping system and maintain for 8 hours minimum. Bypass traps and waste condensate.

For clean steam system, flush as indicated above followed by passivation in accordance with ASTM A380. Flush with reverse osmosis water followed by four hours with clean steam and wasting all condensate. The clean steam generator is to be valved out of the system except when clean steam is generated.

The preceding paragraph is necessary only when "clean steam" systems are needed, normally only on laboratory or research projects. In some cases, tap water, distilled water, deionized water, or reverse osmosis/deionized water may be acceptable or required; this must be verified on each project. The clean steam generator capacity may be less than desired if the incorrect makeup fluid is used.; this must be verified with the manufacturer of the clean steam generator.

## GLYCOL WATER SYSTEMS

The fluid used for water in glycol water systems is dependent on the particular brand of glycol used. For example, the makeup water must contain less than 50 ppm of chloride, sulfate, and hard water ions when Dowtherm SR-1 is used; with Union Carbide UCARTHERM, less than 100 ppm CaCO3 hardness (less than 40 ppm Ca and Mg) and less than 100 ppm chloride and/or sulfate ions are required. If this is not available, distilled water, deionized water, or boiler condensate must be specified; a premixed solution can also be specified as both listed suppliers make this available.

Always state the amount of glycol to be used as a percentage by volume as this is the easiest measure for the contractor to use.

Do not use a pressure reducing valve and a "hard" connection to city water for makeup to these systems. Automatic makeup systems will dilute the concentration of glycol, resulting in a potential freeze condition.

Select the concentration of glycol based on the lowest anticipated temperature to which the fluid will be exposed, considering any "off" cycle in the control sequence and how the fluid is being circulated [constant flow under freezing conditions may be preferred to on/off control]. The freeze point published by many suppliers is actually the point at which crystals begin to form; the solution may actually function correctly and adequately below its published "freeze" point. Note also that the ability to transfer heat is decreased as the concentration of glycol is increased; this will result is higher flow rates, increased horsepower, and higher operating costs.

The selection of the fill point is very important as the glycol water mixture must be added to the system by means of a hand pump [preferred] or small motorized pump. It will be difficult, if not impossible, to fill a system which serves many floors from the bottom of the system.

The \_\_\_\_\_\_\_\_\_\_\_\_\_\_ system is a glycol water system.

Completely flush all traces of cleaning chemicals before adding the glycol water mixture to the system. Verify this by chemical test.

Premix the glycol water solution in a \_\_\_\_ gallon polyethylene drum to a concentration of \_\_\_\_\_\_% by volume. Use [city][distilled][deionized][boiler condensate] water to make the solution. Use a hand pump to fill system from the mixing tank. Circulate fluid for several hours, vent all high points where air may collect, add more solution to the system if needed, and test the system for proper concentration of glycol; include copy of test report in the Operating and Maintenance manuals.

Retesting the concentration after the initial fill is important because some water may have been left in the piping system from the flushing operation, thus diluting the glycol water mixture.

## CLOSED WATER SYSTEMS

Install a separate bypass type feeder at the pumps for each closed hot water heating and chilled water cooling system. Provide a separate set of supply and return lines from each pump in the system and install ball valves in each of these lines. Locate the system connection that supplies the feeder upstream of the discharge shutoff valve for the pump. Locate the system connection that returns treatment back to the system at a convenient point downstream of the pump discharge shutoff valve. Provide a drain valve at the bottom of the feeder.

Systems that are an extension from a central hot water or chilled water plant do not need the bypass feeder unless treatment is not done at the central plant.

Install a water meter upstream of the pressure reducing valve in the makeup line to each closed system. Locate the meter on the domestic water side of the pressure reducing valve and in such a manner that the meter can be easily read.

The meter is necessary for two reasons. First, it can be used to determine how much water is in the system so that the initial chemical treatment can be accurately determined. Second, it can be used to determine how much water is being lost from the system on a monthly or yearly basis.

## STEAM SYSTEMS

Provide a bypass feeder on the feedwater line to each boiler. Locate the system connection that supplies the feeder upstream of the discharge shutoff valve for the feedwater pump. Locate the system connection that returns treatment back to the system at a convenient point downstream of the feedwater pump discharge shutoff valve, by-pass orifice, and the discharge pressure controller Provide a drain valve at the bottom of the feeder.

This specification assumes that each boiler has its own feedwater pump. Most new systems are being designed with a feedwater pumping system and modulating feedwater controls at each boiler.

Provide solution pumps to feed sequestering agent and base from solution tanks into [each boiler.] [ the feedwater line close to each boiler.] Provide one pump per boiler if treatment materials can be mixed.

Provide a solution pump to feed oxygen scavenger from a solution tank into the [deaerator storage section.] [feedwater tank.]

Provide a solution pump to feed carbon dioxide neutralizer or filming amine from a solution tank into [the steam header.] [each boiler, with a separate pump for each boiler.]

Mount pumps on cover of the solution tanks. Energize solution pumps from a meter on the makeup water line when the feedwater pumps are also running. Include an agitator for each solution tank when required by the solution being stored.

Mount solution tanks on a housekeeping pad where indicated on the drawings. Provide an agitator for each tank when mixing is required for the solution. Provide a liquid level switch in each tank to deactivate the associated pump and agitator and [sound a local alarm] [give a contact closure for the building automation system] when the solution level is low.

Coordinate the location of the housekeeping pads with the Architect so that the General Contractor provides them. Coordinate the contact closure, if required, with the building automation system specifications.

Provide a conductivity controller to sample boiler water and operate the solenoid blowdown valve. Provide timer activated sampling with solenoid valve, balancing valve, and conductivity probe. Pipe to blowdown tank.

See comment for the conductivity sensor under equipment in Part 2.

Provide a motorized valve and a sample cooler for surface blowdown at each boiler. Pipe to blowdown separator with minimum pipe size of 3/4" or as indicated. Install steam strainer ahead of control valve and shutoff valve ahead of strainer. Install strainer blowdown valve with its discharge piped downstream of the flow regulating device. Provide a sample cooler connected between the strainer and the flow regulating device with shutoff valves, throttling valves, and piping as recommended by the manufacturer.

Provide a completely integrated and prewired system controller in a NEMA 1 control panel complete with starters for each motor, hand-off-auto selector switch for each pump, control circuit switch, one visual alarm to indicated when any solution tank has a low level, and indicator lights for controller power and each motor.

## OPEN WATER SYSTEMS (Cooling towers)

Provide automatic water treatment system for blowdown, inhibitor feed, and biocide feed. Inhibitor application to be meter activated, blowdown to be conductivity activated, and biocide to be meter activated with blowdown locked out to ensure biocide retention time.

System to incorporate solid state integrated circuits and digital light emitting diode (LED) displays in a NEMA 12 steel enclosure with gasketed and lockable door. Provide a wall support or floor stand for the system controller. Assembly shall be completely prewired, requiring field wiring for external power, pump motor(s), water meter(s), bleed-off solenoid, and tank low level alarm connection(s).

Control dissolved solids based on conductivity and include LED digital readout display (microhm/cm); temperature compensated sensor probe adaptable to sample stream manifold; high, low, and normal conductance indicator lights (LED's) with field adjustable trip points; hand-off-automatic switch for solenoid bleed valve in the blowdown line and in the sample line; and illuminated indication that the bleed valve is operating. Solenoid valve in the blowdown line to operate under control of the conductivity controller while the solenoid valve in the sample line to open whenever the associated circulating pump is operating. Include a water meter in the drain line from the tower to totalize all water bled or drained from the system.

Add inhibitor based on makeup volume and include solid state timer adjustable from 1/4 to 5 minutes; hand-off-automatic switch for the chemical feed pump; illuminated indication that the feed pump is operating; a makeup water meter with a contact register and indicator for totalization of all makeup water; and solution tank, pump, and agitator (if required) for each inhibitor used.

Biocide programmer to include a 24 hour timer with 14 day skip feature to permit activation any hour of the day; precision solid state bleed lockout timer (0 to 9 hours) and biocide pump timer (0 to 2-1/4 hours), clock controlled; solid state alternator to enable the use of two different formulations; hand-off-automatic switch for each biocide feed pump; solution tank, pump, and agitator (if required) for each of two different biocides.

For those systems where the water analysis indicates that an acid feed system is needed, include the following: a solid state timer adjustable from 1/4 to 5 minutes; hand-off-automatic switch for the acid feed pump; illuminated indication that the feed pump is operating; pH sensor; display of the pH of the water; low pH alarm; and solution tank, pump, and agitator (if required).

Include system interlocks so that chemicals are not injected when the system pumps are off or when the blowdown solenoid is open.

Provide isolated contacts for remote indication of each alarm.

Provide sufficient suction and discharge tubing for the application, three foot extended foot valve assembly for each chemical tank, check valve for each pump discharge line, corporation stop and injection assembly, and all valves and strainers as indicated.

## FUEL OIL SYSTEMS

Fuel oil system treatment will be manually inserted into each fuel oil tank at the fill point.

## TEST CABINET

Locate test cabinet where indicated on the drawings.

## CONSTRUCTION VERIFICATION

Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 23 08 00 in accordance with the procedures defined for construction verification in Section 01 91 01 or 01 91 02.

END OF SECTION

# PIPE CLEANING AND TREATMENT REPORT

**State of Wisconsin DFD Project Number:\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Department of Administration**

**Division of Facilities Development Date Submitted: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Project Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

 **Location: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

 **Contractor: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**System Tested: Hot Water\_\_\_ Glycol Water\_\_\_ Chilled Water\_\_\_ Fuel Oil\_\_\_\_**

 **Condensor Water\_\_\_ Steam\_\_\_ Condensate\_\_\_**

**System Volume:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Materials Used (Provide MSDS for each)**

**Cleaner:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Quantity Used:\_\_\_\_\_\_\_\_\_\_\_\_**

**Inhibitor:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Quantity Used:\_\_\_\_\_\_\_\_\_\_\_\_**

**Sequestering Agent:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Quantity Used:\_\_\_\_\_\_\_\_\_\_\_\_**

**Algaecide:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Quantity Used:\_\_\_\_\_\_\_\_\_\_\_\_**

**Neutralizer:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Quantity Used:\_\_\_\_\_\_\_\_\_\_\_\_**

**Glycol:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Quantity Used:\_\_\_\_\_\_\_\_\_\_\_\_**

**Glycol Solution Water Source:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Percent glycol by volume:\_\_\_**

**M Alkalinity**

 **Prior to Cleaning:\_\_\_\_\_\_\_\_\_\_\_\_\_\_ During Cleaning:\_\_\_\_\_\_\_\_\_\_\_ After Flushing:\_\_\_\_\_\_\_\_\_\_\_\_**

**System Temperature**

 **Prior to Cleaning:\_\_\_\_\_\_\_\_\_\_\_\_ During Cleaning:\_\_\_\_\_\_\_\_\_\_\_**

 **Date/Time Date/Time**

**Duration Start Stop**

**Initial Circulation \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_**

**Drain down \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_**

**System Refill \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_**

**Final Circulation \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_**

**Heating system Warmup \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_**

**Component Checklist (Describe procedures performed at each)**

**Strainers:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Filters:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Vents:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Drains:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Traps:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Branch Lines:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Terminal Units:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Boilers:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Chillers:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Comments:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

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