

SECTION 23 25 01
WATER TREATMENT FOR CLOSED-LOOP HYDRONIC SYSTEMS

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 ADDITIONAL RELATED DOCUMENTS

- A. The following Division 23 Sections:
 - 1. "Meters and Gauges for HVAC Piping" for closed loop make-up water meters.
 - 2. "Hydronic Piping" for additional system flushing, passivating, and cleaning requirements.

1.3 SUMMARY

- A. Section includes the following water treatment materials for closed-loop hydronic systems:
 - 1. Manual chemical-feed equipment
 - 2. Bypass filters
 - 3. Treatment and cleaning chemicals
- B. Sub-Contracting Arrangement: The water treatment service provider shall be an independent company that is not financially affiliated with the .2 Contractor.
- C. The water treatment service provider shall oversee the entire flushing and cleaning process performed by the .2 Contractor, and perform conductivity testing, in addition to performing final chemical treatment of the system. The service provider shall provide all chemicals used throughout the process, including those used for cleaning, passivating, and final chemical treatment. Refer to Division 23 Section, "Hydronic Piping".
- D. Provide follow up maintenance service for 1 year.
- E. Refer to the Article below titled "Performance Requirements and Scope of Services" for additional required scope.

1.4 ACTION SUBMITTALS

- A. Water Treatment Service Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider. The purpose of this submittal is to establish, in a proactive manner, that the service provider proposed by the .2 Contractor to perform the work of this Section and related Sections is qualified. The .2 Contractor's failure to obtain approval for this submittal prevents the .2 Contractor from utilizing the proposed service provider. Within 60 days of contract award / notice to proceed, the .2 Contractor shall submit the following minimum information:

1. Information demonstrating compliance with requirements identified in the "Quality Assurance" article below in this Section.
 2. Company name, number of years in business, and any other name the company may have done business under in the last 10 years.
 3. Resumes of the staff proposed to manage and perform the work of this project.
 4. Identification of technicians directly employed by the proposed vendor, who live within 100 miles of the job site.
 5. Identification of no less than five (5) qualifying project experiences, with a description of the work performed, and a contact information for the Client Agency of those projects, for the individual responsible technician in charge for the performance of work for this Project.
- B. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for all products.
- C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.
1. Include plans, elevations, sections, and attachment details.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Water Analysis: Illustrate water quality available at Project site.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For chemical water treatment shall be included in the operation and maintenance manual. Include detailed manufacturer's instructions and parts list for each item of equipment, control, and accessory. Include troubleshooting maintenance guide.
- B. Closeout report and maintenance plan. Refer to "Field Quality Control" article herein.

1.7 QUALITY ASSURANCE

- A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.
1. The water treatment company shall be an independent company not financially affiliated with the .2 Contractor and shall have:
 - a. Been in continuous business no less than five (5) years. This requirement extends to the branch office proposed to provide services for this Project.
 - b. In its direct employment no less than one (1) technician qualified to service, test, and maintain the systems of this Project who lives within 100 miles of the job site.
 - c. A laboratory equipped to analyze samples in accordance with the standard methods of the American Water Works Association and the American Society of Testing and Materials.

2. The individual responsible technician in charge for the performance of work for this Project shall:
 - a. Have not less than five (5) years' continuous experience in treating water in systems of similar size and capacity and he shall be in active responsible charge of all treatment work.
 - b. Be on-site whenever any services are being provided by the water treatment service vendor company.
 3. The individual who designs the water treatment program for this Project shall have no less than ten (10) years of continuous applicable experience in treating systems similar to those on this Project, and at least one (1) of the following certifications:
 - a. A four (4) - year or graduate level degree in chemistry, chemical engineering, or corrosion engineering.
 - b. Certified Water Technologist (CWT) under the Association of Water Technologies (AWT).
 - c. Chemical Treatment Specialist under the National Association of Corrosion Engineers (NACE).
 - d. A current professional engineering (PE) license in state where the project is located.
- B. Chemical Standards: Meet state and local pollution-control regulations. Chemical containers shall be marked with the chemical name and appropriate hazard warnings as required by OSHA 29, CFR 1910.1200.

1.8 WATER TREATMENT SERVICE PROVIDER

- A. Subject to requirements, the independent water treatment service provider shall be one of the following:
1. Proaysis
 2. GE Power and Water
 3. Nalco; a Div. of Ecolab
 4. Equal as Approved by the Professional.

1.9 EXTRA MATERIALS

- A. Furnish the following extra materials, matching products installed, packaged with protective covering for storage and with identification labels clearly describing contents.
1. Treatment Chemicals: At the end of the Maintenance Service period, furnish a quantity equal to 50 percent of amount utilized in the 1st year of operation.
 2. Spare One-Shot Combination Filter-Feeder Bag Filter Media: Provide two (2) complete sets of replacement media, along with the set of media that is installed after the system has been initially flushed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. One-Shot Bypass Chemical Feeders:
 - a. Axiom Industries
 - b. GE Water and Process Technologies
 - c. Griswold Water Systems
 - d. JL Wingert
 - e. John Wood Company
 - f. Neptune / PSG Dover
 - g. Skidmore; a Div. of The Swan Group
 - h. Wessels Co.
 - i. Or equal as approved by the Professional.
 - 2. Bypass Bag Filters:
 - a. Wessels Co.
 - b. Quantrol
 - c. Rosedale Products Inc.
 - d. Shelco
 - e. Or equal as approved by the Professional.

2.2 PERFORMANCE REQUIREMENTS AND SCOPE OF SERVICES

- A. The HVAC Water-Treatment Service Provider shall provide the services detailed herein.
- B. Water quality for hydronic systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of hydronic equipment without creating a hazard to operating personnel or the environment.
- C. Base HVAC water treatment on quality of water available at Project site, hydronic system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.
 - 1. Obtain water samples at job site to determine required treatment. Provide report outlining water analysis with the chemical treatment program submission.
- D. The scope of services provided by the HVAC Water-Treatment Service Provider shall include, but is not limited to, the following:
 - 1. Provide all cleaning and treatment chemicals and testing equipment, as described in this Section.
 - 2. Supervise the hydronic system flushing, cleaning, passivating process performed by the .2 Contractor.
 - 3. Provide all chemicals required for cleaning, passivating, and flushing the systems provided by this project, for initially filling or refilling these systems, and for maintaining these systems at proper concentration levels required for effective, efficient operation of the mechanical equipment for a period of one (1) year after the acceptance of the project by the Department and Client Agency, as described herein.
 - 4. Determine the volume of each system using the make-up flow meter or similar methods to determine the correct dosing levels of cleaners and treatment chemicals.

5. Provide all water chemical treatment equipment as required to implement the chemical treatment programs specified. All chemical treatment equipment shall become the property of the Client Agency.
 6. Instruct .2 Contractor on installation of chemical feeding equipment.
 7. Provide startup assistance for and supervision of .2 Contractor to flush the systems, clean with detergents and passivators, and initially fill systems with required chemical treatment prior to operation.
 - a. Direct flushing, cleaning and/or disinfection, pretreatment, metal passivation, startup and debugging operations.
 - b. Direct and perform chemical control tests during both construction and the warranty period.
 8. Provide the Architect with complete written instructions in shop manual format for chemical feeding and test procedures.
 9. Demonstrate to the Client Agency the proper application of the written instructions.
 10. Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion and scale formation for closed loop hydronic piping and equipment. Services and chemicals shall be provided for a period of one (1) year from date of Substantial Completion. Refer to the "Maintenance Service" Article in this Section.
- E. The .2 Contractor shall install all feeding equipment; such equipment shall become the property of the Client Agency. The .2 Contractor shall be responsible for all wiring, piping, valves, fittings, switches and miscellaneous equipment required for water treatment.
- F. Establish and maintain the following water quality for closed loop hydronic systems for the entirety of the warranty period:
1. pH: Maintain a value within 8.0 to 10.0.
 2. Conductivity: Maintain a maximum value of 3,000 micromho/cm (microSiemens/cm)
 3. Total Alkalinity as CaCO₃: Maintain a value within 20 to 250 ppm.
 - a. Use an offsite water source if the make-up total hardness exceeds 200 ppm. Do not artificially soften the water.
 4. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
 5. Total Suspended Solids (TSS): Maintain a maximum value of 10 ppm.
 6. Total Dissolved Solids (TDS): Maintain a maximum value of 3,000 ppm.
 7. Dissolved Oxygen: Maintain a maximum of 5 ppm, but no less than 1 ppm (to ensure molybdate efficacy)
 8. Turbidity: Maintain a value less than 15 NTU.
 9. Boron: Maintain a value within 100 to 200 ppm.
 10. Soluble Iron: Less than 2 ppm.
 11. Soluble Copper: Maintain a maximum value of 1 ppm.
 12. Chloride: Maintain a maximum value of 175 ppm.
 13. Sulfate: Maintain a maximum value of 250 ppm.
 14. Ammonia: Maintain a maximum value of 2 ppm.
 - a. Provide an activated carbon filter on the make-up water supply as required to remove chloramine (source of ammonia).
 15. Phosphates: less than 1 ppm. (as ortho-phosphate, PO₄)
 16. Foam: None visible in samples.
 17. Microbiological Limits:

- a. Total Aerobic Plate Count: Maintain a maximum value of 1,000 organisms/mL.
- b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/mL.
- c. Nitrate Reducers: Maintain a maximum value of 100 organisms/mL.
- d. Sulfate Reducers: Maintain a maximum value of zero organisms/mL.
- e. Iron Bacteria: Maintain a maximum value of zero organisms/mL.

2.3 MANUAL CHEMICAL-FEED EQUIPMENT

- A. One-Shot Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch funneled fill opening and air release valve in the top, drain valve on bottom, and NPS 3/4 bottom inlet and top side outlet for connection to the hydronic system. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.
 - 1. Capacity: 5 gallons.
 - 2. Minimum Working Pressure: 125 psig.

2.4 BYPASS BAG FILTERS

- A. Vessel material of construction shall be type 304 stainless steel with a 304 stainless steel basket, and with BUNA N gaskets suitable for up to 230 deg. F., hinged cap, and swing out bolts and eye nuts. 150 psig working pressure with threaded pipe connections. Provide pressure gauges on both connections, and a 3-legged filter stand. ASME constructed and labeled for 150-psig minimum working pressure and 240 deg. F. maximum operating temperature.
- B. Bag media shall be 5-micron size. Filter bags shall be polyester fiber, felt material. Bags shall be suitable for up to 325 deg. F. Bags shall be of a standard size, size #1 through #4.
 - 1. Provide two (2) sets of replacement media specified above, in addition to the set of 50-micron media that is initially installed after the system has been initially flushed.
- C. Size and Manufacturer: The vessel shall be Rosedale Products Inc. Series 4, size '4-12" with no less than 1.2 sq. ft. of filter area, minimum 1-1/4" connection size, and suitable for up to 15 gpm, or approved equal by Quantrol, Shelco, or Wessels.

2.5 CHEMICALS

- A. Water treatment chemicals shall be compatible with piping system components and connected equipment. Chemicals and chemical concentrations shall be as recommended by water treatment service provider and implemented as required in order to attain water quality specified in the "Performance Requirements and Scope of Services" Article herein, however the basic chemical program described below shall be followed unless the water treatment service provider obtains approval from the Professional for deviations.
- B. Closed System Water Chemical Treatment Program: Sequestering agent to reduce deposits and adjust pH, non-oxidizing biocides to control biological growth, corrosion inhibitors, and oxygen scavengers (to reduce dissolved oxygen from make-up water when necessary, such as during initial treatment, after system modifications, etc.).
 - 1. Corrosion Inhibitors: All inhibitors and inhibitor blends shall be designed and selected specifically for mixed-metallurgy systems containing aluminum, copper, brass, stainless

steel, cast iron, and carbon steel. The system pH shall be adjusted to a range required for the inhibitor used.

- a. Heating Hot Water Systems: Nitrite, molybdate, and azole.
- b. Use of nitrite only in lieu of use of molybdate as specified herein is not acceptable. Other types of inhibitors not specified herein, such as chromate, PEHA, HEHA, silicates, sulphite, hydrazine, etc. shall not be used.

- a) Exception: Where the local sewer authority strictly prohibits the discharge of molybdate in the specified concentrations. In such cases, silicates and/or nitrite may be used in substitution, however the concentration of nitrite and its potential for contributing to biological growth shall be carefully monitored in systems other than heating hot water loops. Silicates may not be used in systems with temperatures that exceed 160 deg. F.

- c. Required Concentrations:

- 1) Molybdate as MoO₄: maintain a level of 300 to 450 ppm.
 - 2) Azole in the form of tolytriazole (TTA): No less than 10 ppm total, with greater than 5 PPM free and available.
 - 3) Nitrite (steel corrosion protection) as NO₂: maintain a level of 800 to 1,200 ppm, except in systems that do not ever operate above 130 deg. F. where nitrite shall not be used.

- 2. Dispersants: Inhibitor blends shall include polymer dispersing agents to minimize the potential for the formation of CaCO₃ scale deposits.
- 3. Biocides: Non-oxidizing, non-cationic type, with bio-dispersant agents.
- 4. Oxygen Scavengers: Buffered, catalyzed sodium sulphite.
- 5. pH Buffers: Borates.

- C. System Cleaner: Commercially available liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products. Cleaner shall also provide for metal passivation, and shall form a corrosion resistant film on metallic surfaces to prevent 'flash corrosion'. Cleaners shall be compatible with the piping system materials. Special care shall be taken with systems that contain galvanized steel and aluminum.

- 1. A separate cleaning agent and passivating agent may be provided in lieu of an all-in-one cleaner/passivator product, but chemical compatibility shall be verified.
- 2. Acceptable cleaners / passivators are the following:
 - a. GE 'Ferroquest 7101' (Note: Do not use on systems containing galvanized metals.)
 - b. Nalco Water '3D TRASAR'
 - c. Chem-Aqua '61502' with Chem-Aqua '32115'
 - d. Sentinel 'X300'.
 - e. Equal as Approved by the Professional

PART 3 - EXECUTION

3.1 WATER ANALYSIS

- A. Perform an analysis of supply water to determine quality of water available at Project site. Issue the results of the tests to the Client Agency and Professional.

3.2 EQUIPMENT INSTALLATION AND CONNECTIONS

- A. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.
- B. Piping installation requirements are specified in other Division 23 Sections. The Drawings indicate the general arrangement of piping, fittings, and specialties.
- C. Where installing piping adjacent to equipment, allow space for service and maintenance.
- D. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings.
- E. Install shutoff valves on HVAC water-treatment equipment inlet and outlet.
- F. Confirm applicable electrical requirements in electrical Sections for connecting electrical equipment.
- G. Bypass Filter Assembly Installation:
 - 1. Provide an autoflow regulating valve for required bag filter flow.
 - 2. Provide manual air vent in tap at high point of bolt-on top.
 - 3. Provide individual pressure gauges to indicate entering and leaving pressures.
 - 4. Coordinate insulation of units operating below ambient dew point to prevent condensation. Provide removable insulating cover on removable top portion.
- H. Ground equipment and connect wiring according to applicable electrical requirements in electrical Division 26 Sections for connecting electrical equipment.

3.3 PIPING SYSTEM FLUSHING AND CLEANING

- A. Refer to Division 23 Section 232113, "Hydronic Piping", for additional requirements.
- B. Flush the system clear of debris. Flush the system till the water runs visibly clear and has an electrical conductivity no more than 100 microSiemens greater than that of the fresh water supply. Verify that equipment is bypassed during the flushing operation.
- C. Place terminal control valves in OPEN position during cleaning and verify that equipment is no longer bypassed.
- D. Use water meter to record the volume of each system to determine the correct dosing levels of cleaners.
- E. Add cleaning chemicals. Cleaning chemical shall provide both chemical passivation and dissolution of oils and grease as herein specified. Provide anti-foaming agent as required.
- F. Hot-Water Heating- System: Apply heat while circulating, slowly raising system to design temperature; maintain for a minimum of 24 hours. Remove heat and allow to cool; drain and refill with clean water. Circulate for 12 hours at design temperature, then drain. Refill with clean water and repeat until system cleaner is removed, as evidenced by tests showing the drain water to have the same pH, conductivity, TDS, iron, phosphate, and chloride levels as the make-up water source.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
 - 1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
 - 2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
 - 3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of hydronic systems' startup procedures.
 - 4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
 - 5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 6. Leave uncovered and unconcealed new, altered, extended, and replaced hydronic piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
 - 7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
 - 8. Repair leaks and defects with new materials and retest piping until no leaks exist.
- B. Equipment will be considered defective if it does not pass tests and inspections.
 - 1. Prepare initial test and inspection reports.

3.5 MAINTENANCE SERVICE

- A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion, scale formation, and biological growth for closed-loop water piping and equipment. Services and chemicals shall be provided for a period of one (1) year from date of Final Inspection and shall include the following:
1. Initial water analysis and hydronic water-treatment recommendations.
 2. Startup assistance for .2 Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
 3. Periodic field service and consultation.
 4. Customer report charts and log sheets.
 5. Laboratory technical analysis.
 6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.
 7. Provide on-site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program and make recommendations in writing based upon these inspections.
- B. After the initial analysis and treatment during system start-up, at six (6)-week intervals following Substantial Completion, perform separate water analyses on each closed loop to observe if the systems are maintaining water quality within performance requirements specified in this Section. Make all required changes and submit written reports of water analysis advising the Client Agency of changes made to adhere to the provisions of the "Performance Requirements and Scope of Services" Article herein.
1. A total of nine (9) analyses, etc. are required for the period of maintenance service.
 2. Comply with ASTM D 3370 and with the following water testing standards:
 - a. Silica: ASTM D 859.
 - b. Acidity and Alkalinity: ASTM D 1067.
 - c. Iron: ASTM D 1068.
 - d. Water Hardness: ASTM D 1126.
- C. Provide a project closeout report and ongoing maintenance plan to the Client Agency at the end of the 1-year maintenance warranty period. The report shall include:
1. Domestic water test results
 2. Initial startup water test results
 3. Water test results during warranty period
 4. System maintenance schedule
 5. Final water test results, at conclusion of warranty period.
 6. Observed system leakage rate for each system for each regular (6 week) analysis interval as well as for the full 1 year warranty - absolute value and as a percentage of the system volume. Make recommendations for corrective actions when system leakage rate exceeds 4% of system volume per year, or 0.4% per month.

3.6 TRAINING AND DEMONSTRATION

- A. Provide services to instruct Client Agency's personnel in operation, maintenance, and testing procedures of water treatment system.
1. Arrange course at startup of systems.

2. Review procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
 3. Review data in the operation and maintenance manuals.
- B. Schedule training with Client Agency, through the Architect, with at least 7 days' advance notice.

END OF SECTION