SECTION 232500 – HVAC WATER TREATMENT (COMMONWEALTH CAMPUS) – CLOSED SYSTEMS

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

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

General Notes:

1. *This guide specification is intended to provide the Design Professional with a basic guideline of minimum OPP requirements.*

2. *The guide specification shall be carefully reviewed and edited with respect to application-specific project requirements. Proposed modifications shall be reviewed with OPP Staff.*

3. *Finalized version shall be included in the project contract documents.*

Editing Notes

1. *This OPP Guide specification must only be altered by notation (i.e. deleted text with strikethrough and additional text with double underline). This shall be accomplished by using Tools /Track Changes / Highlight Changes, and select "Track changes while editing" in MS Word or equivalent.*

2. *The Review Submittal Specification section shall be provided in electronic form for OPP Review.*

3. *Leave the following Note ("For Construction Document Review, Design Submittal") as part of the Review Submittal, to aid any Reviewer to understand WHY there are strikeouts and underlines. Also, leave any "DESIGNER NOTE" placed in this Guide Spec.*

4. *AFTER comments are received from PSU and incorporated, the strikeouts and underlines shall be removed, and the REVIEWER NOTEs deleted, before the spec is issued for Bidding.*

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. All sections of the project manual are directly applicable to this specification section. Should a conflict arise between specification sections or between specifications and drawings and/or code

requirements, the contractor shall notify the Architect/Engineer of the conflict in writing. If direction is not provided prior to the submission of the bid, the contractor shall price the more extensive system.

1.2 SUMMARY

A. This Section defines:
   1. The coordinated scope of work required of:
      a. The Mechanical Contractor (MC)
      b. The Water Treatment Contractor (WTC)
      c. The Owner (PSU)
      d. The Controls Contractor (BAS)
   2. The hydronic systems that will be cleaned and treated under this contract.
   3. The equipment required and procedures that must be followed in performing the work.
   4. The definition of final piping system condition and system water quality required at project completion.
   5. Submittals

B. Scope of Work
   1. Systems:
      a. System #1 (i.e. building chilled water hydronic system) [**To be edited by designer**]
      b. System #2 (i.e. building process chilled water hydronic system) [**To be edited by designer**]
      c. System #3 (i.e. building hot water hydronic system) [**To be edited by designer**]

C. Project Coordination
   1. General:
      a. The Mechanical Contractor (MC) shall subcontract the WTC to provide direction and supervision for the execution of the system cleanup.
      b. Hydronic system material and labor for the system cleanup shall be provided by the MC, and directed by the WTC. PSU will supply specific components for installation to maintain consistency in maintenance items. All items not specifically addressed as "provided by owner" will be provided and installed by the MC.
      c. All chemicals used for cleanup and system startup shall be provided by the WTC.
      d. The owner (PSU) shall be the sole judge of system quality based on testing and sampling reports provided by the WTC.
      e. PSU technicians shall not be involved in the cleaning, operation or acceptance of the systems prior to the formal project acceptance, unless directed by the owner.

The contact information shown here is for the University Park Campus only. Engineer must edit the information below for each project.

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D. Contact Information
   1. Water Treatment Contractor
      a. Nathan Hamm
      Account Manager

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GE Power and Water
Water & Process Technologies
(p) 800-786-8599, ext. 1218
(c) 315-569-7227

2. Owner
   a. Stephen Oskin
   Continuous Commissioning Engineer
   139B Office of Physical Plant
   University Park, PA 16802
   seo110@psu.edu
   814-867-4715

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1.3 PERFORMANCE REQUIREMENTS

A. Closed piping loops, including heating, cooling, heat recovery or drycooler (glycol or water) shall have the following water qualities:

B. Water Test Results:
   1. pH: maintain a value from 8 to 10.3.
   2. Conductivity: Less than 3,000 mmhos
      a. System must be capable of operating for a minimum of (4) weeks on a 10 micron filter bag.
   3. Nitrite (steel protection): maintain a level of 300 to 600 PPM (1000 PPM if system is off-line).
   4. Azole (copper protection): 3-6 PPM Total (greater than 3 PPM free and available). 6 PPM if system is offline.
   5. Iron: Less than 0.5 PPM
   6. Copper: Less than 0.2 PPM
   7. Bacteriological testing (i.e. bioscan, dipslide): Less than or equal to 1,000 Cells/ml. A bioscan of ATP at 50 RLU or lower.
   8. Mild steel corrosion coupons: Less than 0.5 mils per year (MPY) corrosion rate. (1 mil = 0.001")
   9. Copper corrosion coupons: Less than 0.1 mils per year (MPY) corrosion rate.
   10. Glycol percentage and type must be listed on test results.

The University standard for freeze protection utilizes Propylene Glycol (PG) in new facilities and in systems that have been fully flushed and cleaned, provided the mechanical system has capacity for the increased viscosity and reduced heat transfer characteristics.

Certain new systems and the majority of the existing systems are currently filled with Ethylene Glycol (EG). While EG has superior freeze protection, viscosity and heat transfer characteristics, the environmental impact and safety concerns of this product warrant phase-out where feasible. Contact PSU for direction on existing system freeze protection.

Uninhibited glycol should be specified whenever a system with large capacity (>1000 gallons) or modifications are planned for the facility. However, the chemical treatment contractor must add nitrite-based inhibitor when the system is filled as glycol is aggressive if left untreated. Nitrite-based inhibitors are field-testable, which is a requirement of regular maintenance of large HVAC systems.

Pre-mixed, inhibited glycol should be specified whenever a system with small capacity (<1000 gallons) or where no modifications are planned for the facility. Phosphate-based inhibitors are not field-testable, and requires laboratory testing to show compliance. This is appropriate in systems that are not planned to be frequently accessed, or where the local water source has poor quality. Choosing this system requires that all make-up be done with pre-mixed, purchased solutions.

Design Professional shall determine and edit the appropriate concentration below to assure adequate freeze protection, minimum pump energy penalty, and avoiding biological growth for each application.

Applications may require higher concentrations for maintaining full circulation of fluid such as snow-melting, glycol runaround heat recovery, hydronic systems subjected to 100% outside air, process cooling applications requiring circulating fluid near or below 32°F.

Other applications can also include adequate burst protection in non-circulating, isolated parts or zones of a hydronic system where intermittent or seasonal operation increase the danger of freezing (for example – exterior piping and evaporator of air cooled chillers systems).

The concentration must also be kept above approximately 25% to avoid glycol becoming food source for bacteria and thus promoting biological growth which can lead to the formation of glycolic acid. Review with University's HVAC Water Treatment Representative. That minimum can be higher than the minimum calculated for minimum freeze/burst protection.

Remove the non-applicable glycol below:

C. Glycol Systems
- a. **[Propylene Glycol]**
  - ~~a.~~1) Uninhibited (Preferred for large systems or systems that are regularly opened or modified)
    - ~~1)~~a) Minimum Concentration: **[30%]** (by volume)
    - ~~a)~~b) Tolerance: 0 to +5%
    - ~~2)~~c) Pre-inhibited glycol is not acceptable, i.e.: Phosphate Inhibited Blends or premixes. If a system is filled with inhibited glycol without written acceptance from PSU, the system will be drained, cleaned, flushed and refilled with the appropriate solution at the contractor's expense.
    - d) Inhibitor: Uninhibited
  - 2) Inhibited (Preferred for small systems (<1000 gallons) or systems that are not planned for modification)
    - a) Minimum Concentration: **[30%]** (by volume)
    - b) Tolerance: 0 to +5%
    - c) Pre-inhibited glycol, factory blended with deionized water and inhibitors.
    - d) Inhibitor: Steel and copper inhibitors by chemical manufacturer, suitable for use in HVAC systems.
  - 3)
- b. **[Ethylene Glycol]**
  - 1) Uninhibited (Preferred for large systems or systems that are regularly opened or modified)

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~~1)~~a) Minimum Concentration: **[30%]** (by volume) — Formatted: PR5
~~a)~~b) Tolerance: 0 to +5%
~~2)~~c) Pre-inhibited glycol is not acceptable, i.e.: Phosphate Inhibited Blends or premixes. If a system is filled with inhibited glycol without written acceptance from PSU, the system will be drained, cleaned, flushed and refilled with the appropriate solution at the contractor's expense. — Formatted: PR5
d) Inhibitor: Uninhibited

2) Inhibited (Preferred for small systems (<1000 gallons) or systems that are not planned for modification)
a) Minimum Concentration: **[30%]** (by volume)
b) Tolerance: 0 to +5%
c) Pre-inhibited glycol, factory blended with deionized water and inhibitors.
~~3)~~d) Inhibitor: Steel and copper inhibitors by chemical manufacturer, suitable for use in HVAC systems — Formatted: PR5

1.4 ACTION SUBMITTALS

A. MC shall submit product data for each type of product indicated. These must clearly indicate the model number along with all options that are being provided. Include dimensional data and pipe connection size.

B. Design engineer shall submit to WTC an estimated hydronic system volume for each system included in the project scope. Volume estimate shall be based on piping and component sizing and amount. This estimate must be provided prior to MC contacting WTC for quote as chemical quantities are directly related to system volume.

C. WTC shall submit post flush/clean/treatment test report.

PART 2 - PRODUCTS

2.1 MANUAL CHEMICAL-FEED EQUIPMENT

A. Bypass chemical pot feeder. Manufacturer: Neptune. Model#: DBF-2HP, no exceptions.

2.2 CHEMICAL TREATMENT TEST EQUIPMENT

A. Corrosion Test-Coupon Assembly: Constructed of corrosive-resistant material (304SS), complete with piping, valves, flow control device, and (4) coupon holders. Pipe Size: 1" NPT. Manufacturer: GE. Model#: 2032806. Furnished ~~by owner~~and~~,~~ installed by MC.

2.3 SIDE STREAM BAG FILTER AND HOUSING

A. Stainless steel vessel. Gaskets rated for ~~230~~250°F minimum. ~~1 ½~~2 " NPT side inlet and bottom outlet. Manufacturer: Filter Specialist Inc. Model# ~~CBFP11 or~~ CBFP12B0150N02N02NA1N. Furnished ~~by owner,~~and installed by MC. Filtration Media (Filter Bag) for inside the housing provided by WTC.

B. Bag filter. Rated for 250°F minimum. Welded Polyester bag and ring. Manufacturer: Filter Specialist Inc. Model#BPENG-XX-P2PEWE
~~A.~~1. **[10 micron][25 micron][50 micron]**

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Bag filters are selected based on the integrity of the system. New systems should be provided with a 10 micron bag, existing or renovated systems with good water quality should be provided with a 10 or 25 micron bag, systems with poor water quality or piping integrity should be supplied with 50 micron bags.

2.4 RECIRCULATION PUMP

Circulator pumps are required only where combination air/dirt separators are implemented. These separators are typically installed on the suction side of the main circulation pumps, which requires the use of sidestream circulators to induce flow through the bag filters. Pumps must be placed in a “push-thru” arrangement to avoid cavitation.

A. Grundfos inline circulator pump. Pump shall be sized based on criteria in standard PSU chemical treatment detail. 120V, plug style connection.

2.5 CHEMICALS

A. Excluded from MC scope. Provided by WTC, Chemicals shall be as recommended by WTC that are compatible with piping system components and connected equipment, and that can attain water quality specified in Part 1 "Performance Requirements".

Choose either a makeup water meter (water-only systems), or a glycol feed system (glycol systems). Glycol systems must have no means of direct connection to the system from the potable water source.

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2.6 MAKE-UP WATER METER

A. Direct read water meter with remote capability. Manufacturer: Neptune. Model#: T-10 Size: 5/8", Tricon 4-20mA encoder option. Furnished and installed by MC, connection to local control system by BAS contractor.

B. Controls contractor to provide and install SCADA meter interface unit (SMIU) Ether Meter Model EM-100 required for interface to BAS system.

2.7 GLYCOL FEED SYSTEMS

Designer must select either a single or dual feeder. If dual feeders are chosen, both systems must have identical glycol type and percentage. Delete the unused section.

A. Single System Connection
   1. Neptune Model G-50-1
      a. Tank: 50 Gallon Polyethylene
      b. Pump: Bronze Rotary Gear, 1.5 gpm @ 100 psi
      c. Controls:
         1) Hand – Off – Auto control.
         2) Low level and operational pilot lights
         3) Dry contact for low-level alarm connected to DDC control system
      d. Power: Plug, 115/1/60
      e. Solution: ~~Pre-mixed, uninhibited glycol (PG or EG, 30%)~~Per glycol section above.

B. Dual System Connection
   1. Neptune Model G-50-2
      a. Tank: 50 Gallon Polyethylene
      b. Pump: Bronze Rotary Gear, 1.5 gpm @ 100 psi
      c. Controls:
         1) Hand – Off – Auto control.
         2) Low level and operational pilot lights
         3) Dry contact for low-level alarm connected to DDC control system
      d. Power: Plug, 115/1/60
      e. Solution: Per glycol section above.~~Pre-mixed uninhibited glycol (PG or EG, 30%)~~

PART 3 - EXECUTION

3.1 INSTALLATION

A. MC shall install bypass chemical pot feeder(s), glycol feed systems, and side stream filter(s) on concrete bases, level and plumb. Anchor floor-mounted equipment to substrate. Maintain manufacturer's recommended clearances and arrange such that all equipment that will require service is accessible.

B. MC shall install coupon station(s) on wall near water chemical application equipment. Alternatively strut materials may also be used to construct a freestanding bracket for mounting.

C. MC shall install makeup water meters in all closed loop, non-glycol hydronic systems.

D. Install bypass piping or hoses at the supply and return piping connections at heat exchangers, chillers, cooling towers, pumps and cooling coils, etc, to prevent debris from being caught or causing damage to equipment which will be connected to the piping system

E. MC shall insulate all systems in compliance with the mechanical insulation specifications. Direct connections between pipe hangers and piping are prohibited.

F. MC is responsible for installation of all hardware items in the construction drawings and specifications.

~~F.~~G. MC shall coordinate cleaning, flushing and treatment prior to filling and pressure testing system. Once water is added to the system, these processes must begin immediately. At no point should untreated water be circulated in the system outside of these processes. Any damage to the system while operated by the contractor shall be repaired at no cost to the owner.

Remove this section if project is for an entirely new system.

~~G.~~H. MC shall perform all of the hydronic piping system modifications indicated on the design drawings. Unless noted otherwise, the MC shall furnish and install all piping, equipment, and appurtenances indicated.

~~H.~~I. The Controls Contractor (BAS) shall implement a control strategy to provide **[daily] [weekly]** circulation of the of the entire hydronic system to prevent stagnation of the system. The control strategy shall be fully automated for this purpose. The WTC shall work with the design engineer, controls contractor and the MC to develop a circulation plan that will ensure flow throughout the facility. In variable volume systems, the pumping system is not designed to operate the entire system at design flow. A coordinated isolation plan is required to circulate the system in sections.

~~I.~~J. The Controls Contractor (BAS) shall implement a control strategy to provide single action (one BAS command) circulation of the of the entire hydronic system to allow circulation of the system during treatment.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. MC shall install piping adjacent to equipment to provide manufacturer or engineer required and recommended service and maintenance clearances.

C. MC shall make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified elsewhere in these contract specifications.

D. MC shall install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Section "General-Duty Valves for HVAC Piping." [**To be edited by designer**]

E. All components shall be installed with unions, flanges, isolation valves, and bypasses where required to maintain system operation during routine maintenance and repair. Under no

circumstances should a hydronic system require shutdown to service water treatment equipment.

F. Refer to Section "Domestic Water Piping Specialties" for backflow preventers required in makeup water connections to potable-water systems. [To be edited by designer]

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. PSU shall inspect field-assembled components and equipment installation, including piping and electrical connections.
   2. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
   3. MC shall test for leaks and defects per the Hydronic Piping specification section.

Designer is to select one or both sections below to direct system cleaning. It is up to the discretion of the designer to modify the sequence based on project scope. The Owner must accept the modified scope prior to issuing documents for bid.

3.4 FLUSHING AND CLEANING (New Systems)

A. The system must be pressure tested and accepted as leak free per the “Hydronic Piping” specification by the owner prior to flushing and cleaning.

B. Control systems that operate automatic isolation valves, temperature control valves, or other automated hydronic devices must be in place and operational prior to cleaning. Manual operation of automated valves is not acceptable.

C. On completely new piping system installations, the contractor shall use temporary strainers to flush and clean the piping systems. Do not use Owner’s permanent strainers to trap debris during pipe flushing operations. Fit the temporary construction strainers with a line size blowoff valve.

D. The MC/WTC shall submit a cleaning and chemical treatment plan to the owner for approval prior to execution.

E. For new systems that will connect to existing systems utilize section 3.5 Flushing and Cleaning (Existing / Expanded / Modified systems)

F. The MC shall:
   1. Fill the system with fresh water. Meter the fill level to ascertain the system volume.
   2. Open/close automated valves as required to achieve flow in all areas.
      a. The WTC shall work with the design engineer, controls contractor and the MC to develop a circulation plan that will ensure flow throughout the facility. In variable volume systems, the pumping system is not designed to operate the entire system at design flow. A coordinated isolation plan is required to circulate the system in sections.

b. The system should be operated as close to 10 ft/sec as possible during the cleaning and flushing operations.
c. Install all piping main bypasses as required to facilitate cleaning.

3. Enable the pumps, and circulate the system for a length of time to be determined by the WTC. The circulation cycle time will vary greatly depending on flow, system size and isolation strategy.
4. Flush the system with fresh water for time period as directed by the WTC.
5. Disable the pumps.
6. The WTC will test and verify flush water quality before proceeding.
7. Drain the system.
8. Remove all startup strainers from the system, and clean. This includes strainers at pumps, terminal devices, fill points, etc.
9. Purge the dirt separator (if not connected directly to side stream filter), and replace the side stream filter bag.
10. Fill the system and chemically clean the system as directed by the WTC.
11. Perform additional strainer cleanings in the defined systems as requested by the WTC.
12. Repeat the cleaning process until the WTC deems the system acceptable.
13. Perform final flush as directed by WTC.
14. The WTC will test and verify the final flush water condition before proceeding.
15. Remove all startup strainers from the system, and replace with the specified operational strainer. This includes strainers at pumps, terminal devices, fill points, etc.
16. Refill system to operating pressure, WTC shall treat the system for normal operation.
17. The WTC will provide test reports of system water quality to the owner for verification.

G. The WTC shall:
1. Develop an approved cleaning and treatment plan in coordination with the MC and the BAS contractor.
2. Utilizing labor provided by the MC as needed, flush and chemically clean the defined hydronic systems as required to obtain completely clean and scale free internal piping surfaces.
   a. Criteria for system acceptance:
      1) Acceptable water test results within defined ranges from the main pump location.
      2) Acceptable water test results within defined ranges from remote areas in quantities and locations defined by the WTC and PSU.
3. After system cleaning is complete, provide water treatment as needed to allow the loop water quality parameters to fall within the ranges specified under section 1.2 “Performance Requirements”.
4. Maintain hydronic water system testing and treatment throughout the warranty period of (1) year after project acceptance.
5. Provide a project closeout report and ongoing maintenance plan to the owner
   a. Domestic water test results
   b. Initial startup water test results
   c. Monthly water test results during warranty operation
   d. System maintenance schedule
   e. Final water test results, at conclusion of warranty period.
6. At [**four**] week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that chemical treatment program is maintaining water quality within performance requirements specified in this Section. WTC shall

schedule the monthly testing with PSU to involve owner representatives. Submit written reports of water analysis advising Owner of changes necessary to adhere to Part 1 "Performance Requirements" Article.

3.5 FLUSHING AND CLEANING (Existing / Expanded / Modified Systems)

A. Existing systems shall be cleaned and flushed prior to the installation of new work. Existing systems typically have large amounts of debris and contaminants that can cause damage to new components, and once removed, may cause excessive leakage. Every effort shall be made to remove this debris prior to installation and operation of new equipment.

B. Control systems that operate automatic isolation valves, temperature control valves, or other automated hydronic devices must be in place and operational prior to cleaning. Manual operation of automated valves is not acceptable.

Remove either paragraph C or D based on project scope. Large scale renovations or cleanup projects should use C. Smaller projects should use paragraph D. Request direction from the Owner for clarification.

C. New equipment (or otherwise in very good condition) shall not be used for the circulation of chemical cleaning solutions intended to remove built-up scale and corrosion in existing piping systems at any point, before or after system modification. Options may include the following:

1. If the existing pump system are already in poor condition and/or would not be appropriate for meeting final operating conditions and are not economical to salvage and thus to be entirely replaced anyway, the contractor may use the existing pump for the circulation of cleaner/dirty fluid prior to replacement.

2. If the existing pump system is otherwise in good condition and planned to be reused after chemical cleaning operations, then:
   a. Include all materials and labor for inspection and cleaning of all wetted parts and replacing of worn items, at a minimum the definite replacement of the seals, after all chemical cleaning and flushing is completed and before system is refilled with final clean fluid.

Pumps that have been running in closed systems with contaminated, dirty water are at much higher risk of premature mechanical seal failures. Furthermore, existing pumps that are run during restorative chemical pipe cleaning and flushing processes will assuredly have their seals compromised or damaged to the point of imminent or immediate failure thereafter due to the high concentration of dissolved and suspended solids removed from the internal pipe surfaces. Projects that are intended to include major pipe cleanup using aggressive chemical cleaners shall include option b. Coordinate below with list of Allowances, Unit Prices or Alternate Bids in Division 1, whatever is most appropriate for the project scope. Request direction from the Owner for clarification if unsure.

   b. [**For each existing pipe system to be restored via chemical cleaning, provide cost to furnish and install a temporary pump with performance characteristics to achieve the purposes of restorative chemical pipe cleaning**

and handling the associated aggressive and abrasive circulating fluid for the duration of the process. Upon system acceptance, the cleaning circulator is to be removed and replaced with the specified operational pump. Additional cleaning is not to be required once the new pump is in place.]

D. When constructing minor piping modifications or additions verify with Owner if the Owner's pumps and strainers can be used for flushing and chemical cleaning operations. When the flushing and cleaning operations are complete, the contractor shall insure the strainer baskets and screens installed in the piping systems permanent strainers replaced with clean elements. Keep temporary strainers in service until the equipment has been tested, then replace straining element with a new strainer and deliver the old straining elements to Owner. Fit the Owners strainers with a line size blowoff valve.

E. The MC shall:
1. Install bypasses to facilitate system flush as directed by the Engineer or Owner.
    a. Bypasses are typically located where steel connects to copper, where main piping terminates, or at terminal equipment.
2. Starting with an existing system where the system is filled and operational.
3. Remove all strainers from the system, and clean or replace as necessary. This includes strainers at pumps, terminal devices, fill points, etc.
4. Open/close automated valves as required to achieve flow in all areas.
    a. The WTC shall work with the design engineer, controls contractor and the MC to develop a circulation plan that will ensure flow throughout the facility. In variable volume systems, the pumping system is not designed to operate the entire system at design flow. A coordinated isolation plan is required to circulate the system in sections.
    b. The system should be operated as close to 10 ft/sec as possible during the cleaning and flushing operations.
    c. Install all piping main bypasses as required to facilitate cleaning.
5. Enable the pumps, and circulate the system for a length of time to be determined by the WTC. The circulation cycle time will vary greatly depending on flow, system size and isolation strategy.
6. Flush the system with fresh water for a time period as directed by the WTC.
7. Purge the dirt separator (if not connected directly to side stream filter), and replace the side stream filter bag (if present).
8. Remove all strainers from the system, clean and replace. This includes strainers at pumps, terminal devices, fill points, etc.
9. Refill system to normal operating pressure and chemically clean the system as directed by the WTC.
10. Perform additional strainer cleanings in the defined systems as requested by the WTC. Compensation for this work will be based upon unit prices to clean single strainers 3/4 inch through 8 inch. MC shall fill out and submit at bid time the unit price sheet included at the end of this specification section. The initial bid should include three (3) strainer cleanings and removal of the new startup strainers.
11. Repeat the cleaning process until the WTC deems the system acceptable.
12. Modify the systems per the construction documents/job scope.
13. Fill the system with fresh water. Meter the fill level to ascertain the new system volume.
14. Open/close automated valves as required to achieve flow in all areas.

a. The WTC shall work with the design engineer, controls contractor and the MC to develop a circulation plan that will ensure flow throughout the facility. In variable volume systems, the pumping system is not designed to operate the entire system at design flow. A coordinated isolation plan is required to circulate the system in sections.
b. The system should be operated as close to 10 ft/sec as possible during the cleaning and flushing operations.
c. Install all piping main bypasses as required to facilitate cleaning.

15. Enable the pumps, and circulate the system for a length of time to be determined by the WTC. The circulation cycle time will vary greatly depending on flow, system size and isolation strategy.
16. Flush the system with fresh water for time period as directed by WTC.
17. Remove all startup and existing strainers from the system, clean, and reinstall. This includes strainers at pumps, terminal devices, fill points, etc.
18. Purge the dirt separator (if not connected directly to side stream filter), and replace the side stream filter bag.
19. Fill the system to new operating pressure as defined by Design Engineer and chemically clean the system as directed by the WTC.
20. Perform additional strainer cleanings in the defined systems as requested by the WTC.
21. Repeat the cleaning process until the WTC deems the system acceptable.
22. Remove all startup strainers from the system, and replace with the specified operational strainer. This includes strainers at pumps, terminal devices, fill points, etc.
23. Refill system to operating pressure, WTC shall treat the system for normal operation.
24. Provide test reports of system water quality to the owner for verification.

F. The WTC shall:

1. Develop an approved cleaning and treatment plan in coordination with the MC and the BAS contractor.
2. Utilizing labor provided by the MC as needed, flush and chemically clean the defined hydronic systems as required to obtain completely clean and scale free internal piping surfaces.
   a. Criteria for system acceptance:
      1) Acceptable water test results within defined ranges from the main pump location.
      2) Acceptable water test results within defined ranges from remote areas in quantities and locations defined by the WTC and PSU.
3. After system cleaning is complete, provide water treatment as needed to allow the loop water quality parameters to fall within the ranges specified under section 1.2 “Performance Requirements”.
~~4. Maintain hydronic water system testing and treatment throughout the warranty period of (1) year after project acceptance.~~
~~5.~~4. Provide a project closeout report and ongoing maintenance plan to the owner
   a. Domestic water test results
   b. Initial startup water test results
   c. Monthly water test results during warranty operation
   d. System maintenance schedule
   e. Final water test results at end of warranty period

~~0. At [**four**] week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that chemical treatment program is maintaining water quality within performance requirements specified in this Section. WTC shall schedule the monthly testing with PSU to involve owner representatives. Submit written reports of water analysis advising Owner of changes necessary to adhere to Part 1 "Performance Requirements" Article.~~

~~3.7~~3.6 WARRANTY

A. Hydronic system acceptance will not occur until after receipt of an approved water quality test report from WTC.

B. The MC shall warrant the installation of the Hydronic System in compliance with the project contract requirements.

C. The WTC shall warrant the individual components, work products and chemical treatment of the system for one (1) year from project acceptance. <**Not applicable for existing systems**>

D. The Owner reserves the right to independently test water systems to ensure compliance with the established criteria. If a discrepancy should arise between the WTC results and the Owner's results, an independent testing agency will be contracted to verify the testing results. In the event that the independent results verify that the system is not within compliance, the WTC shall clean and treat the system at no cost to the owner, with system acceptance verified by the independent testing agency.

END OF SECTION 232500