SECTION 23 25 01 - CHEMICAL WATER TREATMENT - START-UP

PART 1 - GENERAL

1.1 SUMMARY

A. This standard includes flushing, cleaning, and treating the following systems:
   1. Flushing, Cleaning, and Treating of water filled systems that interface with the CUP
   2. Flushing, Cleaning, and Treating of water filled systems that do not interface with the CUP
   3. Steam and condensate systems
   4. Pre-cleaning and passivation of condenser water and cooling tower systems

1.2 SYSTEM DESIGN REQUIREMENTS

A. Flushing, Cleaning, and Treating of Systems into the university Distribution System(s).
   1. The university Facilities Operations Department personnel are highly motivated to employ the best possible treatment practices to insure the boilers, chillers and associated piping meet or exceed their expected lifespan. The university Central Utility Plant (CUP) personnel co-ordinates the cleaning process for all Chilled Water, Heating Water, Steam, Condensate, Condenser Water, and Cooling Towers.
   2. Expansion to the distribution system of the university requires the interface of new piping with the existing piping. With this in mind, the university CUP requires that consistent cleaning and passivation practices are performed throughout the campus on all projects. The goal is for all new facilities are as follows:
      a. Insure that all systems are properly flushed, cleaned, and passivated to minimize foulants returned to the CUP when opened to the existing distribution system.
      b. Insure that the treatment practices employed are compatible with current treatment programs.
      c. Insure that pretreatment practices meet the minimum requirement of the university CUP.
   3. Due to the size of the campus chilled water system, creative approaches are being applied to the treated water to manage the inevitable conditions where various contaminants may enter the loop as a result of system expansion. The general goals will be consistent with industry standards for proper treatment of the systems on site. Below is a summary of these standards:
      a. Chilled water mild steel corrosion rates of <0.5 MPY.
      b. Chilled water copper corrosion rates of no greater than 0.1 MPY.
      c. Aerobic biological counts in the chilled water not to exceed 50,000 CFU/ml, sulfate reducing bacteria counts <10 CFUs.
      d. No scale in the chilled water system.
      e. Condensate mild steel corrosion rates of <5.0 MPY.
      f. Condensate copper corrosion rates of <0.1 MPY.
      g. Steam will contain <10 ppb of dissolved oxygen at all times.
   4. An equivalent chemical may be used after it has been approved for compatibility by the university CUP. The contractor's chemical vendor will provide data sheets to the university CUP with the request for approval for an equivalent chemical. Equivalent chemicals cannot be used until they have been approved by the university CUP.
   5. It is the contractor's responsibility to ensure that the system(s) is clean, and has been properly treated. It is the university Water Treatment contractor's responsibility to verify that the system(s) has been properly treated and is ready to be opened into the university Distribution System(s).
   6. Co-ordinate with the university CUP personnel and the current university CUP Water Treatment contractor to determine which tests and inspections will be monitored.
   7. Contact the university Outage Coordinator to schedule the opening of any/all system(s) into the same university system(s). The university Outage Coordinator must have all required paperwork on file before they will schedule a system startup.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

A. Chilled Water and Heating Water Systems

1. Chilled water piping must be pre-cleaned and passivated prior to operation. To accomplish this, a method must be provided to circulate these lines at design flow during cleaning. Design minimum flows are stated as a function of pipe diameter in the table below:

Pipe diameter in inches	Cross sectional area in feet	Minimum flow GPM for 2 ft/sec velocity
6	0.2	180
8	0.35	314
12	0.79	708
16	1.4	1256
24	3.14	2818
36	7.06	6284

2. Taps will be installed, in the vault, on the building side of the supply and return isolation valves. The building pump or temporary circulation pump will circulate the water during the pretreatment process.
3. The addition of Isothiazolin biocide is required. It needs to be added after the system cleaning has been accepted. The nitrite must be added 24 hours after the nitrite has been added.
4. During the flushing, cleaning, and treating process, insure that the minimum flow of 2 feet/second is met. Flow less than 2 feet/second is not acceptable. Flows greater than 2 feet/second, up to the maximum design flow of the system, are acceptable and will assist in the flushing, cleaning, and treating process. Maximum flow is preferred but not required.
5. If possible, on heating water systems, heat the bulk water to 120 degrees F during the circulation period.
6. The university CUP must approve all products that will be used prior to the start of the process. Only factory blended products will be considered. Products blended onsite are not allowed.
7. Biological samples can only be taken Monday through Thursday (Holidays excepted). The sample is sent overnight to the lab. Until the test results return acceptable, a system will not be allowed to be opened into the existing university Distribution system.
8. Two options exist for pre-cleaning. One approach is an alkaline based approach and the other is a nitrite based approach. Consult the university CUP prior to choosing an approach. The alkaline based pre-cleaner applies a minimum of 500 ppm of total inorganic phosphate within the treated water. The pre-cleaner should also contain detergents and dispersants designed to perform an effective cleaning at pH values of 11.5 or higher. The pretreatment plan should also include a minimum of 10 ppm of organic copper corrosion inhibitor such as “TT” in the bulk water. An alternative nitrite based approach uses nitrite, detergents, dispersants and 10 ppm of organic copper corrosion inhibitor such as “TT”. This product is applied to achieve nitrite residuals of in excess of 600 ppm as NO2. These treatment levels can be achieved by adding 2.5 gallons of Nalco-2859, or an equivalent product, to the system per 1000 gallons of system capacity.
   a. Flushing, Cleaning, and treating Chilled Water and Heating Water systems using an Alkaline Based Cleaner. Remember that the timeline below is dependent upon all things occurring as they are written. The time line below is bare bones for an average sized system. Smaller projects may be able to save some time during the filling and draining periods.
      1) Day 1: Fill the entire system that is available with city water and continuously circulate the water with one of the system pumps throughout the building, through all chilled water lines, including lines to vaults. If there is more than one pump in the system, alternate the pumps at least once during this process to ensure each pump is run.
      2) Day 2 (24 hours after step #1): The university CUP and/or the university Water Treatment contractor, the contactors water treatment vendor, and the contractor to test the water for conductivity and view the water for clarity. If there are no issues,

the university CUP will give a verbal "OK" to the contractor onsite to proceed with the drain down. This "OK" will be followed up with an e-mail to all interested parties.

3) Day 3: Refill the entire system that is available with city water and add the approved alkaline based cleaner. Your water treatment consultant will need to calculate the correct amount of cleaner needed. Circulate the water with one of the system pumps throughout the building, through all chilled water lines, including lines to vaults. If there is more than one pump in the system, alternate the pumps at least once during this process to ensure each pump is run. Run each pump at least two separate times.
4) Day 4: Continue to circulate the entire system with the cleaner in it throughout the building, including lines to vaults (If required). If there is more than one pump in the system, alternate the pumps at least once during this process to ensure each pump is run. We would like to see each pump to run two separate times.
5) Day 5 (A minimum of 48 hours after step #3 has been completed): The university CUP and/or the university Water Treatment contractor, the contactors water treatment vendor, and the contractor to test water for pH and conductivity. If the pH test is above 11.5 and the conductivity is elevated well above city water conductivity, a verbal "OK" will be given that the pH of the water is acceptable and the drain down and flushing out of the cleaner can start. This "OK" will be followed up with an e-mail to all interested parties.
6) Day 6: If the following does not occur as written, all dates below this will be affected. When the conductivity is within 10% of the conductivity of the City of Aurora water, contact the university CUP. The university CUP will meet with the contactors water treatment vendor and the contractor at the site and test the water for conductivity and pH. If the conductivity test is within 10% of the conductivity of the City of Aurora water, a verbal "OK" will be given that it is acceptable to add the Isothiazolin biocide. Circulate the system for 24 hours and then proceed to step #7. This "OK" will be followed up with an e-mail to all interested parties.
7) Day 7 (24 hours after step #6 has been completed): Add enough of the approved inhibitor (Nitrite) to raise the level of nitrite in the system to a minimum of 600 ppm. Your water treatment consultant will need to calculate the correct amount of chemical needed.
8) Day 9 (A minimum of 48 hours after step #7 has been completed): Contact the university CUP. The university CUP and/or the university Water Treatment contractor will meet with the contactors water treatment vendor and the contractor at the site and test the water for conductivity and nitrite, and a biological sample will be taken and sent overnight to the lab. If the nitrite is at 600 ppm or higher and the conductivity is elevated, a verbal OK of the nitrite level will be given. If the nitrite level is low, a verbal denial will be given and more nitrite will need to be added. Conductivity will be tested to verify that the conductivity is elevated above city water conductivity. A sample for biological testing will be taken and sent overnight to the university Water Treatment contractors testing lab. We encourage you to have you water treatment consultant to have biological testing performed on the water. Ensure that the lab that performs the testing will test for aerobic, anaerobics and denitrifying bacteria.
9) Keep the system flowing until it is opened up to the university Chilled Water Distribution system.
10) When the test results become available, we will share them with all interested parties. If the sample passes the biological tests, proceed to the next step. If the sample fails one or more of the tests, we will need to met as a group and discuss re-cleaning and re-treating of the system.
11) Once the system has successfully passed all tests, schedule with university Outage Coordinator to open the system up to the university Chilled Water Distribution system.

b. Flushing, Cleaning, and treating Chilled Water and Heating Water systems using a Nitrite Based Cleaner. Remember that the timeline below is dependent upon all things occurring as they are written. The time line below is bare bones for an average sized system. Smaller projects may be able to save some time during the filling and draining periods.
   1) Day 1: Fill the entire system that is available with city water and continuously circulate the water with one of the system pumps throughout the building, through all chilled water lines, including lines to vaults. If there is more than one pump in the system, alternate the pumps at least once during this process to ensure each pump is run.
   2) Day 2 (24 hours after step #1): The university CUP and/or the university Water Treatment contractor, the contactors water treatment vendor, and the contractor to test the water for conductivity and view the water for clarity. If there are no issues, the university CUP will give a verbal "OK" to the contractor onsite to proceed with the drain down. This "OK" will be followed up with an e-mail to all interested parties.
   3) Day 3: Refill the entire system that is available with city water and add the approved nitrite based cleaner. Circulate the water with one of the system pumps throughout the building, through all chilled water lines, including lines to vaults. If there is more than one pump in the system, alternate the pumps at least once during this process to ensure each pump is run. Run each pump two separate times.
   4) Day 4: Continue to circulate the entire system with the cleaner in it throughout the building, including lines to vaults (If required). If there is more than one pump in the system, alternate the pumps at least once during this process to ensure each pump is run. We would like to see each pump to run two separate times.
   5) Day 5 (A minimum of 48 hours after step #3 has been completed): The university CUP and/or the university Water Treatment contractor, the contactors water treatment vendor, and the contractor to test water for nitrite and conductivity. If the nitrite test is above 600 ppm and the conductivity is elevated above city water conductivity, a verbal "OK" will be given that the nitrite level in the water is acceptable and the bleed/fill of the nitrite based cleaner can start. With the pump still running, open a ¾" drain to a sanitary sewer and start to purge water from the system. At the same time add water to the system to replace the water that is being purged down the drain. Continue to do this until the nitrite level is down to 200 to 300 ppm. 300 ppm is preferred. DO NOT do this bleed/fill if there is nobody to monitor the process. This "OK" will be followed up with an e-mail to all interested parties.
   6) Day 6: If the following does not occur as written, all dates below this will be affected. When the nitrite level in the water is between 200 and 300 ppm, contact the university CUP. The university CUP will meet with the contactors water treatment vendor and the contractor at the site and test the water for conductivity and nitrite. If the nitrite is between 200 to 300 ppm, a verbal "OK" will be given that it is acceptable to add the isothiazolin biocide. Circulate the system for 24 hours and then proceed to step #7. This "OK" will be followed up with an e-mail to all interested parties.
   7) Day 7 (24 hours after step #6 has been completed): Add enough of the approved inhibitor (Nitrite) to raise the level of nitrite in the system to a minimum of 600 ppm. Your water treatment consultant will need to calculate the correct amount of chemical needed.
   8) Day 9 (A minimum of 48 hours after step #7 has been completed): Contact the university CUP and/or the university Water Treatment contractor. The university CUP will meet with the contactors water treatment vendor and the contractor at the site and test the water for conductivity and nitrite, and a biological sample will be taken and sent overnight to the lab. If the nitrite is at 600 ppm or higher and the conductivity is elevated, a verbal OK of the nitrite level will be given. If the nitrite level is low, a verbal denial will be given and more nitrite will need to be added. Conductivity will be tested to verify that the conductivity is elevated above city

water conductivity. A sample for biological testing will be taken and sent overnight to the university Water Treatment contractors testing lab. We encourage you to have you water treatment consultant to have biological testing performed on the water. Ensure that the lab that performs the testing will test for aerobic, anaerobics and denitrifying bacteria.

9) Keep the system flowing until it is opened up to the university Chilled Water Distribution system.
10) When the test results become available, we will share them with all interested parties. If the sample passes the biological tests, proceed to the next step. If the sample fails one or more of the tests, we will need to met as a group and discuss re-cleaning and re-treating of the system.
11) Once the system has successfully passed all tests, schedule with the university Outage Coordinator to open the system up to the university Chilled Water Distribution system.

B. Steam and condensate systems
1. Steam lines do not need to be cleaned or passivated prior to being put in-service since steam is oxygen free, and produces a non-corrosive environment. Steam blows on steam mains that are six inches in diameter or larger are required. A steam blow involves performing a series of cyclic brief venting of steam to atmosphere. The objective is to purge loose particulate material from the steam lines. Remove all strainer screens and check for debris. Clean the screens before reinstalling them. The university CUP Operations staff and/or the university Water Treatment contractor will be present to inspect a limited number of screens. Once this is accomplished the steam line may be put into service.
2. The condensate receivers will need to be initially “dumped” down the drain during the first few days of operation. Add tempering water as need to ensure that the condensate going down the drain is less than 160 F. If possible inspect the receiver for evidence of oil or organic contamination prior to putting the receiver in service. In the unlikely event that oil or organic material has contaminated the condensate receiver contact the CUP for consultation. System cleaning would be required prior to interfacing with the bulk condensate system.
3. Once the conductivity of the condensate is less than 20 and the hardness is 0.5 ppm or less, the condensate can be opened into the university Condensate System.

C. Pre-cleaning and passivation of condenser water and cooling tower systems
1. To perform an effective system cleaning and passivation, a phosphate prep is recommended. The use of N-2578 or an equivalent phosphate based cleaner is suggested to perform the procedure. N-2578 is a blend of inorganic phosphate, detergent, dispersants and organic copper corrosion inhibitors. Sufficient product should be added to the system to boost total inorganic phosphate residuals to a level in excess of 500 ppm as PO4. It is important to maintain good biological control during the passivation process. The use of an oxidizing biocide such as bromine or chlorine is not recommended since it will interfere with the passivation process. The use of a non-oxidizing biocide at a heavy dose is recommended during the passivation.
2. For most effective results, system pH must be maintained in the 7.0-7.5 range, targeting 7.25. The procedure will still work with pH as high as 8.0. If system pH rises to 8.5 the pH should be lowered by gradually adding dilute sulfuric acid. Add acid very slowly and check the pH every 30 minutes. When adding acid, gradually lower the pH into the 7.0-7.5 range, targeting 7.25. If pH goes down to 6.5, gradually add soda ash in a slurry form to raise pH into the 7.0-7.5 range, targeting 7.25.
3. DO NOT OPERATE CHILLERS IN THIS SYSTEM DURING THE CLEANING PROCEDURE.
4. When the PH of the system has been stabilized between 7.0 and 7.5, circulate the treated system at design flows through the entire system for a minimum of 8 hours. Purge all strainers in the system every hour during the pre-cleaning process. After 8 hours of circulation, shutdown the pump(s) and drain the entire system.
5. Fill and flush the entire system with city water until the flush water is clear and free of particulate material. Refill the system with city water. Perform cleaning method as follows:

a. Add a 300 ppm dose of N-2593 biocide or an equivalent to the system while circulating. N-2593 is an isothiazolin based biocide
b. Gradually add N-2578 to the system. Recommended dose is 2.5 gallons per 1000 gallons of system capacity. Check system pH and insure the concentration is in the range stated above. Contact the university Water Treatment contractor to confirm total inorganic phosphate levels are above 500 ppm
c. Continue to circulate for 24-48 hours with the system off-line and all legs of the system circulating. Check system pH once every 12 hours. Add anti-foam N-7465 as needed
d. When the cleaning is complete, drain the system several times until system conductivity is within 200 microsiemens of city water. Contact the university Chemical contractor to confirm total inorganic phosphate levels are below 10 ppm. If the phosphate level remains high, continue to drain and flush. Remove all strainer screens and check for debris. Clean the screens before reinstalling them. The university CUP Operations staff and/or the university Water Treatment contractor will be present to inspect a limited number of screens.
e. The system is now ready for normal operation with a properly run chemical treatment program. It is critical bulk water alkalinity is maintained in the 300-400 ppm range, targeting 350 ppm, in the early phases of operation. If sufficient load is not available to concentrate alkalinity we may artificially boost alkalinity into the recommended range by adding soda ash to the system.

6. Recommended ongoing treatment is using N-23208 phosphonate inhibitor, application of N-2593 isothiazolin based biocide at a 150 ppm dose weekly and the use of N-ST-20 bromine based biocide fed daily.

D. An equivalent chemical may be used after it has been approved for compatibility by the university. The contractor's chemical vendor will provide data sheets to the university with the request for approval for an equivalent chemical. Equivalent chemicals cannot be used until they have been approved by the university.

END OF SECTION 23 25 01