15545 CHILLED WATER SYSTEM

PART 1: GENERAL

1.01 The Campus Chilled Water System is a district cooling system comprised of two (2) central plants with two chillers and a total of 6,000 tons capacity at Chilled Water Plant 3, seven plate and frame heat exchangers at the Lake Source Cooling (LSC) Chilled Water Plant 4 facility with 18,000 tons capacity, and a 4.4 million gallon chilled water thermal storage tank, all pumping into a common piping system. The chilled water plant and thermal storage tank provide back up for LSC. System temperature differential is critical to the operation of LSC, which is a large non-contact cooling system based on 39-41°F deep Cayuga Lake water (no mechanical refrigeration is used). A higher temperature differential increases the capacity of the facility. The system is operated year round with a campus supply temperature of 43-45°F, and a supply/return pressure differential of 2 to 30 psid depending on the location in the system.

1.02 At each chiller there is a constant volume loop with a dedicated constant speed pump that is separate from the distribution pumps. The LSC facility heat exchangers are in a parallel arrangement, which in turn are in series with the distribution pumps. The number of heat exchangers on-line is dependent on the total chilled water flow through the plant. The plant chilled water pumping is a variable volume, variable head loop out to the campus using variable speed pumps in parallel. The distribution pump speeds are varied to maintain constant differential pressure at various low differential points in the piping system.

The required volume of water from the distribution system for each building is delivered using a variable volume, primary-secondary interface utilizing a temperature controlled two-way mixing valve. The recirculating loop control valve is modulated to maintain a mixed building supply water temperature of 47°F (summer air conditioning) to 48-52°F (winter air conditioning and process cooling).

1.03 The hydraulic separation (primary-secondary interface) at each building is accomplished as shown in the Building Chilled Water System Schematic, Drawing 3.1.2. This separation is a short section of full size pipe and a low pressure, drop line size globe style, silent lift check valve with isolation valves. This section of pipe is referred to as the recirculating loop bypass line.

PART 2: DESIGN GUIDELINES

2.01 GENERAL

A. The designer’s goal should be to design a system that can function as close as possible to variable flow constant temperature rise over the entire load range (all seasons). The designer should attempt to get as high a temperature rise as possible.
B. No chilled water loads over an elevation of 940 feet above sea level shall be piped directly on the system. Loads above this elevation shall be hydraulically separated from the system with a plate heat exchanger.

C. Design pressure for all components shall be at least 150 psig at 100°F.

D. Do not pipe any equipment drains directly to drain. Provide brass hose adapter, cap, and chain on all vents and drains.

E. Do not connect refrigeration systems in general for condenser heat rejection to the campus chilled water system, use air cooled condensers and mechanical room ventilation. The use of campus chilled water for this application should be a last resort.

F. All buildings are to be dielectrically isolated from the distribution system piping because the coated distribution system has cathodic protection to prevent external corrosion. New connections and all major renovations will include the installation of weld connection, monolithic dielectric isolating fittings on the building side of main isolation valves (see Para. 2.08). Contact Planning, Design and Construction for standard specifications on dielectric isolating fittings. No hangers or connections (other than capped vent and drain valves) shall be between the isolating joints and the wall penetration.

G. Major renovations should include replacement of the building isolation valves with epoxy coated high performance butterfly valves.

2.02 COILS

A. All chilled water coils in air handlers shall be sized for the highest rise practical with 47°F entering water temperature. A 15°F rise is the minimum acceptable, 20°F should be investigated for each load. Coils shall be six (6) rows minimum. Air and water shall be piped counterflow. The designer should investigate larger coil face areas in addition to additional rows to improve temperature rise and reduce coil air pressure drops.

B. Fan coils should be selected for a water temperature rise as great as practical (10°F minimum). Low flow coils should be specified, minimum of four (4) rows. Fan coils over 1,000 CFM shall be six row minimum. All control valves shall be interlocked with a wall mounted multi-speed fan switch.

C. All coils shall have non-ferrous headers and tubing.

D. All air handlers with large quantities of outside air (over 20%) shall have blow-through design for the cooling coils to protect the coils from freezing. Draw-through air handlers shall be carefully designed so that air stratification will not cause cooling coil freeze-ups in winter. Provide draining/filling/venting capability for all cooling coils into mechanical spaces to enable freeze protecting coils in winter with glycol solution.
2.03 PUMPING

A. The building chilled water pump head shall be selected with a reasonable safety factor for strainer plugging and future pipe roughness and flow. Providing extra capacity (flow) is acceptable. The building pump head is only necessary for piping, accessories, coils and process heat exchangers within the building loop.

B. Loads with similar pressure drops should be grouped together on a single building loop. More than one building loop can be designed into each building. Process (continuous) loads and air conditioning loads shall be separated into different loops. Design process loops with as high a supply temperature and temperature rise as possible.

If the process chilled water loop services equipment other than fan coil units in the lab spaces, the process loop or the loads must be separated from the campus system via a plate and frame heat exchanger. Do not provide user connection points to campus chilled water.

C. Large air handlers can be designed with “pumped coils.” This entails bringing the distribution piping to each air handler and setting up a dedicated constant volume secondary loop for each air handler coil and controlling the mixing valve on leaving air temperature.

D. Building chilled water pumps will be variable speed to enable pump capacity control with minimum energy usage. Pump speed should be controlled by one or more differential pressure transducers located at remote points in the building piping. Show the transmitter locations on the riser diagram.

E. “Booster” pumps in series shall not be used unless they are variable speed.

F. Provide two 100% pumps instead of multiple smaller pumps.

2.04 CONTROL VALVES

A. Recirculating Loop Valve (2-Way): See Section 15900, Control Valves.

B. Coil valves (Load Control Valves): See Section 15900, Control Valves.

2.05 DRAWINGS

A. All coil schedules shall, as a minimum, include:
   - Entering/leaving air conditions (dB/WB)
   - Entering/leaving water conditions (°F)
   - Water pressure drop (FT)
   - Air volume (CFM)
   - Air pressure drop (in H20)
   - Fins per inch
   - Rows
B. All pump schedules shall, as a minimum, include at design:

- Pump head (FT)
- Pump efficiency (%)
- Motor efficiency (%)
- Drive efficiency (%)
- Pump capacity (GPM)
- Pump spare capacity (GPM)
- Pump speed (RPM)
- Motor size (HP)

C. A complete riser diagram/flow schematic shall be on the drawings with as a minimum:

- All line sizes
- All loads with flows
- Riser flows
- Control valves
- Pumps with design flows and head
- Differential pressure transmitter locations
- Future pump and piping capabilities

2.06 METERING

A. Temperature and flow metering points are to be located as shown on the Building Chilled Water Schematic.

B. Chilled water BTU metering includes a flow meter, two temperature sensors, and a BTU processor, which is connected to the University EMCS. Chilled water meters for piping six inches and greater shall be ultrasonic flow meters as manufactured by Controlotron, and for piping four inches and smaller shall be electromagnetic (mag meters) as manufactured by Danfoss. Temperature sensors shall be RTD as manufactured by JMS Southeast, Inc. The flow meters and temperature sensors shall be coupled to a BTU meter flow processor “FP93” as manufactured by EMCO. The flow processor shall be connected to the University EMCS via Ethernet.

1. Flow meter requirements:

   **Six inch pipe and greater:**
   Flow measurement shall be made with a Controlotron No. 1010AN1 single channel dedicated multi-function flow display computer in a NEMA 4X enclosure. The system shall utilize 101HFNS high precision transducers matched to the piping material, wall thickness and size, and designed for 50°F fluid temperature and 225°F ambient. The transducers shall be mounted with mounting frames and spacer bar for reflect operation. The system shall produce a 5khz flow rate signal output to be wired to the Flow Processor.
Four inch pipe and smaller:
Flow measurement shall be made with a Danfoss Mag 3100 electromagnetic meter with Mag 6000 signal converter. The signal converter should be integrally mounted if the display can be easily read without the use of a ladder, otherwise, remote mounting is required with the Mag 6000 mounted adjacent to the EMCO FP93. The Mag 3100 shall be flanged, standard Neoprene liner, Stainless Steel 316 Ti electrodes, and NEMA 6 enclosure rating. The system shall produce a 10khz flow rate signal output to be wired to the Flow Processor.

Flow meter location:
Install flow meters in a straight unobstructed length of primary return piping one size smaller than the main piping with a minimum of ten diameters upstream and five diameters downstream. Show the flow meter, meter run and bypass piping clearly on the mechanical room floor plan drawings (including line sizes on all piping).

2. Install at the flow metering location an Annubar (Dietrich-Standard) hot tap mounting kit on the bottom of the pipe. The mounting hardware will include a 1-1/4" (one and one fourth inch) thread-o-let and nipple (Model No. MG5), a full port bronze ball valve (minimum opening, 1"), and a brass plug in the ball valve. The Annubar is not included.

3. Temperature measurement shall utilize JMS Southeast Model 3X(X=3TF3)SBK6BZZ312ZIWZ2AX(X=Fully Potted), Resistance Temperature Device. Probe shall have manufacture date stamped on surface. Thermowells shall be JMS model 51AT2CUK ½ inch step shank, 316 stainless steel, .260 bore sized to insert a minimum of 1/3 pipe diameter into flow stream. The junction box shall be a 2 x 4 handy box connected to the thermowell with CPVC nipples from the well to the head. Terminal connections shall be to a termination strip on the back of the handy box so probe can be removed through the front with the handy box cover removed. Provide a spare test well (identical to the sensing well) with brass cap and chain at all sensor locations.

4. Provide a labeled dedicated 110 V supply with surge suppression and local disconnect from an MCC process panel or the DDC to power the FP93 Flow Processor, Controlotron/electromagnetic flow meter, and the communications junction box (labeled duplex receptacle in a 12" x 12" box).

5. The flow signal (frequency) and temperature sensor wiring should be brought to an EMCO FP93 Flow Processor with minimum 18 ga shielded multi-conductor cable. The FP93 (and remote Mag 6000 signal converter, if necessary) shall be mounted inside a labeled “Chilled Water Meter” surface mounted, hinged cover, NEMA enclosure. The FP93 will monitor: delta T, flow, S-temp, R-temp, time, tons, total flow, and total ton-hours. These values will be communicated to the EMCS via a dedicated Cornell phone circuit.
6. Provide an Ethernet jack from the building controls system LAN, or a campus Ethernet jack in the communications junction box.

C. If more than one building loop, or sub meters are required in a single building, multiple FP93 meters can be connected in parallel to one dedicated phone circuit, but many meters may require more than one circuit. Contact the Utilities Department for metering needs beyond one total building meter.

D. Do not disconnect existing chilled water metering until new metering or communications are in place.

2.07 DIRECT BURIED PIPING

A. General:

1. Chilled water piping should be at least 4' (four feet) below grade at all points, but not more than 8' (eight feet). Try to locate the supply on the north or east side.

2. Planning, Design and Construction and CORRPRO Company shall be consulted on what dielectric isolation, bonding, and cathodic protection are required for all piping. CORRPRO Company will need to be hired by the engineer to provide consulting services. CORRPRO Company is the University’s corrosion protection consultant.

3. Three-way valving shall be provided at all ‘T’s in the distribution system in a manhole with storm drain and sump. All new building taps to distribution mains should be made at or above the centerline of the distribution main to keep corrosion products out of the new lines.

4. Isolation valves shall be high performance butterfly valves (see Section 15100, 2.02.c) with ductile iron or carbon steel bodies and factory applied epoxy paint. Include 2" drain and vent valves with brass plugs on both sides of each valve.

5. All piping and valves in manholes shall be coated, insulated with 1" (one inch) of Armaflex, and covered with an embossed aluminum jacket. Use aluminum rivets to attach the jacket.

B. Piping below 8" (eight inch) size:

1. Use ductile iron piping assembled with locking type mechanical joints throughout or HDPE plastic pipe.

2. At all direction changes, concrete thrust blocks shall be used per AWWA. Any exposed steel and all joint hardware shall be fully coated with bitumastic to 24 mils thickness (Koppers-Bitumastic 50 or Porter Coatings-Tarmastic 101) and wrapped in polyethylene before burial. Two forms of restraint are required at all direction changes.
3. Use as an alternate to ductile iron HDPE, 150 psi AWWA rated, with welded joints per the manufacturer’s recommendation. Acceptable pipe manufacturers include Chevron, Plexco pipe; and KWH Pipe LTD. (Canada), Sclairpipe.

C. Piping 8” (eight inches) and larger:

1. All 8” (eight inch) and 10” (ten inch) piping shall be Schedule 40, all 12” (twelve inch) and larger shall be .375” wall A53 ERW pipe.

2. All piping shall be factory coated with an extruded polyethylene jacket by either Energy Coatings (PRITEC 10-60) or Shaw Coatings (Black Jacket). Fittings and weld joints shall be coated with RAYCHEM shrink sleeves or POLYKEN YGIII tape coating. Contact Planning, Design and Construction for standard specifications on coatings (Section 15253 “Below Grade Chilled Water Pipe Coatings”).

3. Provide cathodic protection. Contact Planning, Design and Construction for standard specifications (Section 15254 “Cathodic Protection – Impressed Current Type” or Section 15255 “Cathodic Protection – Galvanic Anode Type”).

D. All water drained from distribution system piping during tie-ins must be drained to sanitary sewer not storm sewer.

2.08 MONOLITHIC DIELECTRIC ISOLATING FITTINGS

A. The fittings shall be designed to provide for the permanent electrical isolation of piping sections. They shall be boltless type, completely factory assembled, designed to be welded into the piping section and have a low regular shaped profile to enhance ease of installation and field coating.

B. Design of fittings shall meet or exceed the requirements of ASME VIII Div. 1, ANSI B31.3, 31.4 and 31.8. The minimum bore of each fitting shall be equal to the standard tolerances of the bore of the pipe. All fittings shall be designed to operate continuously at the pressure ratings listed as follows: ANSI Class 150# fittings at 355 psi. Maximum working temperature range shall be 14°F (-10°C) to 212°F (100°C).

C. The fittings shall be as strong or stronger than the pipe section where the fittings will be installed. Therefore, the fittings will not limit the piping system’s ability to resist forces and moments generated from the operation of the system.
D. The materials used shall be in accordance with the appropriate requirements of ASTM and API codes. All welds shall be butt-weld construction with 100% inspection by ultrasonic magnetic particle and dye penetrant. The dielectric isolation material shall be a thermosetting fiberglass epoxy material. Sealing shall be by two (2) static, self-energized “O” ring seals housed in accurately machined grooves, fully protected from cavitation in full compliance with ASME design codes. Interior and exterior coating shall be a two-part epoxy with a thickness of 12 to 15 mils to within 2" of each end.

E. Hydrostatic testing shall be performed on 100% of fittings to 1.5 times rated operating pressure in accordance to latest ANSI standards. Testing will be conducted between plates or end caps to ensure the most arduous conditions.

F. Dielectric testing shall be performed after the completion of hydrostatic tests on 100% of fittings.

G. Suitably box or crate the fittings to facilitate handling during shipment.

H. The ends of the fittings that do not have an epoxy coating shall be painted inside and outside with dioxide aluminate paint.

I. The monolithic insulating joint shall be “IsoJoint,” Manufactured to ISO9002, under license from Nuova Guingas/Prochind, Formigine (Modena), Italy. Available from:

   Advance Products & Systems, Inc.
   http://www.advprod.com/
   P.O. Box 60399
   Lafayette, Louisiana 70596-0399
   Telephone: 318-233-6116
   Fax: 318-232-3860

2.09 CONTROL LOGIC

A. Chilled water pump logic should include the following:

   1. Pump speed is varied to maintain differential pressure.

   2. Back-up chilled water pumps should come on and alarms should be generated based on low differential pressure or VSD faults.


   4. Use VSD status for pump status instead of pump differential pressure switches.
B. Recirculating loop control valve logic should include the following:

1. The valve is modulated to maintain building mixed supply temperature whenever the pump is on (minimum of 47°F).

2. The temperature should reset to a higher value (minimum 50°F) when the outside air temperature is below 55°F.

3. When the pump is commanded off, the valve shall close. If all pumps trip, the valve shall go to 100%.

4. The logic should provide for a remote master reset temperature from the campus EMCS.