DESIGN GUIDELINE 230050
CHILLED WATER SYSTEMS

General

The designer shall consult with the U-M Design Manager and Plant Operations before making decisions on chilled water system type and configuration.

Related Sections

U-M Design Guideline Sections:
230051 – Water Chillers
230052 – Cooling Towers
SID 4.6 - University Provided Utilities
Sustainability 3.2 Energy Conservation

U-M Master Specification Sections:
232116 – Hydronic Piping Specialties
236416 – Centrifugal Water Chillers
236500 – Cooling Towers
230900 – Mechanical Systems Controls
232513 – Chemical Water Treatment – Closed Loop
232516 – Chemical Water Treatment – Open Loop Systems

Chiller Plant Sizing, Redundancy, Diversity, Future Growth, Emergency Power

Calculate systems loads based on connected load (total of scheduled load at design condition) and peak diversified load (anticipated or measured actual peak load within a building or system that reflects diversity between loads). Base system sizing on peak diversified load (PDL). Consider potential need for future growth when calculating PDL.

Consider need for system and equipment redundancy. For critical laboratory and animal facilities and for multiple building chiller plants provide plant with multiple chillers to provide "N-1 redundancy" (capacity that can meet PDL with largest chiller, pump or cooling tower out of service). For single building chiller plants, the design shall provide at least, sufficient redundancy for the critical portion of the facility.

For building areas such as vivaria or certain hospital areas, requiring cooling operation during power outage, consider providing a smaller chiller connected to emergency power.

Redundant pumping shall be considered normal for all installations. For multiple chillers, design systems to provide a single redundant condenser water pump and a single redundant chilled water pump that can be manually valved into service for the other pumps of the same service.

Chilled Water Configuration

In general, design systems with constant volume primary chilled water (through evaporator), with a decoupled variable flow secondary, with distribution based on two-way valve control of cooling coils. The decoupler pipe shall be sized to handle the full flow of the largest chiller. Chiller staging shall be via decoupler flow volume. For chiller plants of less than 1000 tons aggregate, serving a single building, variable volume primary systems may be considered with the approval of the U-M Project Coordinator, given a proper volume-controlled bypass arrangement is provided to maintain minimum chilled water flow at the evaporator.

For multiple building chilled water plants, design should normally indicate primary pumping, secondary distribution variable pumping and tertiary building pumping. The tertiary design should indicate a decoupled pumping arrangement with a modulating valve in the secondary return leg, which will maintain the tertiary at +1°F above the distribution temperature. For plants that serve newer buildings, design for a minimum distribution temperature differential ("delta T") of 15° F (eg. 44F CHWS/ 59F CHWR). For plants serving existing buildings, the existing coil performance must be considered when defining system temperatures.

Design for Maintenance

Design piping and machine placement so that complete machine overhaul, including motor replacement, may be performed without the removal of permanent piping. Provide permanent steel rail hoistways or other approved measures for this purpose.

Where possible, locate chiller plant to minimize future work that will be required to replace the chiller.

Design for Cleaning/Flushing

Design system (include appropriate connections, etc.) such that, during construction, pipe cleaning and flushing can be conducted without contamination of the chiller. Design shall require provision of conical startup strainers at the chiller inlets and fine mesh pump startup strainers. Design shall incorporate temporary bypasses of cooling coils to avoid fouling coils during flushing and cleaning.

Water Treatment

Refer to U-M master specifications and guidelines. For systems over 400 tons, the design shall include chemical bulk storage adequate for a two month supply of chemical treatment and shall indicate a piping system for filling from a convenient grade-level loading area. Bulk systems shall be provided with double- wall storage vessels or other approved packaged base containment method. For smaller systems using 55 gallon chemical barrels, design shall include containment via a low, beveled curb that will allow wheeled hand truck passage along its length for barrel movement.

Strainers and Filtration

Basket strainers shall be provided for all cooling tower systems. In addition, provide coalescing type solids separators. Provide combination coalescing solids separator/air separators on the chilled water system. Sidestream separators shall be sized for at least one third of the full system flow.

Free Cooling and Winter Cooling

Where there is a significant winter chilled water load, consider "free cooling" (making winter chilled water utilizing a cooling tower and a plate-frame heat exchanger). Provide life cycle calculations in accordance with the Special Instructions to Designers (SID-J) Energy Conservation section. In addition to energy savings, free cooling can minimize low load short cycling. Filtration and wet-bulb approach controls shall be part of such a system.

Winter-operated cooling towers and outdoor piping shall be winterized in accordance with the Design Guildeline section 230052 - Cooling Towers. Heat-trace systems shall be DDC controlled and monitored; separate programmable controllers are not permitted. Where winter chilled water demand is less than that practical for free cooling, provide a smaller indoor air cooled chiller with remote condenser connected in parallel with the larger chillers.

Drained Condenser Water Piping

If condenser water piping is intended to be drained down during off-season, consider the use of non-ferrous piping (stainless steel schedule 10 or other) for that section of piping to be drained to eliminate off-season corrosion of empty piping. Make provisions in the design (sight glasses and testing ports) so that risers within the building may be tested to insure treated water is present year-around.

Chiller Room Noise and Vibration

Consider noise and vibration criteria in mechanical room and adjacent area. Specify machine noise and vibration limits, and specify testing procedures. Evaluate the need for noise and vibration abatement to achieve acceptable noise levels.

Controls

Use of U-M standard control diagrams and sequences is preferred.

Chillers enable, start/stop functions, sequencing, cooling tower operation and secondary pumps shall be controlled by the Building Automation System (BAS). Use of proprietary chiller or pump control packages is not permitted. Generally, primary chilled water pumps and condenser water pumps are started and stopped by the associated chiller, but where redundant pumps are provided, using BAS to start pumps can be considered.

The design shall indicate manual selector switches, providing digital inputs to BAS, located at an auxiliary panel near the chillers for the following functions:

- Select lead/lag chillers sequence.

- Where BAS starts the pumps, to functionally connect the backup pump with the applicable chiller.

Cooling tower filter or separator blow down valves shall be controlled as the first stage of tower blowdown via the water treatment panel.

Generally, absorption chillers system design shall provide fixed constant condenser water temperature per design setpoint. Centrifugal systems design shall provide condenser water temperature reset; the chiller control panel shall generate a standard 4-20ma linear reset signal output to the BAS. BAS will reset condenser water setpoint, indexed against outside air wet bulb temperature.

Water cooled chillers or chiller groups shall have full-sized condenser water three-way valve bypasses of the cooling tower. Two way valves may only be utilized where specifically approved. The valve shall be controlled by the BAS with pneumatic controlled back up. For combination absorption and centrifugal chiller plants, separate three way bypasses shall be designed to provide higher fixed temperature to absorption and resetable lower temperature to centrifugals.

Control of water treatment shall be by the specified water treatment controller, which will report conductivity to the BAS.

Metering

Metering required:

- Cooling tower make-up water metering and cooling tower blow-down metering shall be in accordance with the City of Ann Arbor requirements and these standards. Meter cooling tower makeup water separately from the building service.
- For a chilled water plant serving multiple buildings, all utilities and services serving the generation of chilled water shall be metered separately from the building in which it resides.
- Each separate building using central plant chilled water shall have chilled water BTU load metering via a magnetic flow meter in conjunction with a BTU meter and sensors with matched calibration in accordance with the U-M Master Specification section 230900 - Mechanical Systems Controls.