

## 236416 CHILLERS

### Part 1 – GENERAL

#### 1.1 Description

A. This section details the guidelines and expectations for the design and installation of chiller systems on Johns Hopkins University Homewood Campus. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein in all cases. However, unless there is adequate written justification and approval from the JHFRE Engineering and Energy Department, it is expected that these guidelines will govern the design and specifications.

B. New chillers shall be connected to the campus main chilled water loop if at all possible. Any deviation from this will require JHFRE approval.

#### 1.2 Submittals

A. Chillers shall be configured in an N+1 arrangement which provide one full duty and one full standby chiller. In addition, a set of headers with valved connections shall be provided for an additional full-size chiller.

B. The chilled water systems shall utilize a variable volume pumping strategy. Pumps shall be configured in an N+1 redundancy arrangement.

C. The chilled water distribution shall be configured in a loop to provide a network that provides chilled water to the HVAC equipment branches to maintain reliability for maintenance, capacity and tie-in purposes. The piping mains shall be sized for the combined capacity of the duty and standby chiller.

#### 1.3 Quality Assurance

A. For a multiple chiller installation, the primary chiller shall be selected on full load efficiency. Secondary and standalone chillers shall be selected on their IPLV rating. The Calculation of Integrated Part Load Value, (IPLV) shall be per ASHRAE standard 550/590 methods. Efficiency, IPLV, for each type of chiller system must meet or exceed the latest ASHRAE Standard 90.1.

B. Verify the Chiller Restarts (both power outage and start-to-start), Lockout Times, Operations (both fully-automatic and manual-by-operator) and Overrides with the manufacture so that a minimum duration restart protocol can be accomplished. A maximum five-minute restart cycle is expected unless otherwise approved by JHFRE. Provide Y-Delta Starters in all machines up to 100 Tons.

C. If a facility is to use a stand-alone chiller and requires continuous chilled water supply, the chilled water systems must be design for N+1 redundancy. The requirement to design the chilled water system for N+1 redundancy will be determined by JHFRE.

D. Any chillers, cooling towers, and/or piping shall be cleaned using flushing methods approved by JHFRE's water treatment contractor (Guardian CSC) in order to remove any fillings, dirt, oil, and other debris or compounds that were used as part of the fabrication/installation process.

E. All installed units must, at a minimum, meet manufacturers' distance requirements. Access points for maintenance should be given additional attention for proper clearance so as NOT to hamper future maintenance of the system.

F. Provide one set of taps (with isolation valves, flanges, covering caps and labels) on chiller primary headers to allow for a temporary connection of a roll-up chiller in case of failure or to assist in future replacement projects. Identify the purpose and include the operating procedure for the taps on the drawings.

#### G. Warranty

1. All chillers shall be provided with a minimum 6-year warranty (Manufacturer's standard 1 year warranty plus an extended warranty for an additional 5 years) which covers the entire chiller unit, including parts, labor, lubricants (excluding lubricants required for routine preventative maintenance), and refrigerant. Include the following additional requirements:

a. Warranty shall be provided direct from the chiller manufacturer to JHU.

b. Repair or replacement of any factory provided chiller component that becomes inoperative as a result of defects in material or workmanship within the warranty period.

c. When the manufacturer determines that a chiller component requires replacement, the manufacturer shall furnish and install the new component at no additional cost to JHU.

d. Upon notification that a chiller component has failed under the terms of the warranty, the manufacturer shall respond in no more than 24 hours. Response shall mean having a manufacturer qualified technician onsite to evaluate the extent of the needed repairs.

## Part 2 – PRODUCTS

2.1 JHU preferred brands: Trane and York

2.2 Chiller Requirements

A. All chillers selected shall be identical products from the same manufacturer and meet the criteria specified below. Chillers shall be capable of unloading down to 15% of the full load.

B. Evaporator performance minimums:

1. Entering Chilled Water Temperature: 55° F

2. Leaving Chilled Water Temperature: 41° F

3. Design Chilled Water GPM/Ton: 1.7

4. Maximum Evaporator Pressure Drop: 30 ft H<sub>2</sub>O

5. Variable evaporator flow (if VFD motors selected)

6. Fouling Factor: 0.00025

## C. Condenser performance:

1. Entering Condenser Water Temperature Range: 65° F – 85° F
2. Leaving Condenser Water Temperature Range: 55° F – 95° F
3. Design Condenser Water GPM/Ton: 3.0
4. Maximum Condenser Pressure Drop: 30 ft H<sub>2</sub>O
5. Fixed Condenser Water Flow
6. Fouling Factor: 0.00025

2.3 Use water cooled condensers for all systems over 300 tons. Large process cooling requirements shall be met by a dedicated cooling system.

2.4 Designers must dictate the usage of the most environmentally friendly refrigerant available for the specified chiller. The brand and model of chiller detailed in the Drawing Schedules must reflect this decision.

## 2.5 Chiller features

A. JHU prefers to not use glycol in chiller systems, but if the situation requires glycol in a building's standalone loop, follow the glycol rules mentioned in this standard for outdoor piping below (Line 3.2).

B. Building management system interface capability with full graphics. See Section 230900, Controls, in the Design Guidelines for details.

C. Variable frequency drives, (VFD), shall be required.

D. Capability for extended operation with 55° F entering condenser water temperature.

E. Marine water boxes shall be installed on condensers on large centrifugal chillers. The boxes shall have either hinged ends or lifting lugs to facilitate removal.

F. Surfaces with an operating temperature lower than 65° F shall be covered with a minimum of ¾" insulation @  $k = 0.28 \text{ btu in/hr ft}^2 \text{ F}$ .

G. Refrigerant isolation valves must be installed on each line at the chiller takeoff point.

H. If a chiller can be installed without being broken down, it shall be shipped pre-charged with refrigerant and oil.

I. Tap on oil system to draw samples for testing to be included.

J. Magnetic drive chillers shall be considered if available. If magnetic drive chillers are available, an economic analysis shall be conducted and presented to JHU to show life cycle cost of magnetic versus conventional drive chillers.

K. Any external piping above ground containing ONLY water should be insulated and double heat traced on separate electrical current with a control that energizes the heat trace below 40° F.

L. All chillers shall be furnished with such features as required to facilitate Refrigerant Recovery. All water-cooled chillers shall have isolation valves in the compressor discharge line and the condensed liquid line to facilitate isolation for transfer of refrigerant between the vessels of the same chiller to allow service to the high or low side without removing the refrigerant charge from the chiller.

M. Outdoor chillers shall be a minimum of 20' from any structure and the acoustical package shall be specified to prevent sound levels from exceeding 65 db.

## 2.6 Water-Cooled Chillers

A. All water-cooled chillers shall conform to American Refrigeration Institute (AHRI) 550/590.

B. Evaluate the use of refrigerants from all perspectives, including the capability and availability for the manufacturer's service technician in case of failures to ensure reliability is maintained.

C. All centrifugal chillers shall be provided with the Variable Frequency Drive feature. Design of marine boxes shall be included in the chiller specification to allow easy access to the chiller tubes without major disruption to the piping arrangement. All piping connections to marine water boxes shall be flanged.

## 2.7 Air-Cooled Chillers

A. All air-cooled chillers shall conform to AHRI 550/590.

B. Air-cooled chillers shall be used for smaller installations or where project requirements justify usage compared to water cooled equipment. Energy efficient equipment shall be used as much as possible given the heavy and consistent loads experienced by JHU. Packaged air-cooled chillers shall be utilized for applications requiring less than or equal to 200 tons of cooling and location is not feasibly connected to the campus central utilities. Where rigging, implementation space and or flexible redundancy/expansion are considerations that may prevent the use of traditional air-cooled chillers, modular type chillers shall be evaluated as an alternative selection. An analysis on the practicality and benefit to using a modular chiller approach shall be provided to the Project Manager for approval no later than the first design submission.

## 2.8 Modular Chillers

A. Modular chillers, for remote new facilities or existing building renovations where rigging, implementation space and/or flexibility/redundancy/expansion are considerations that prevent the use of traditional chillers, consist of a set of modules that operate as independently serviceable parallel chillers in a compact form. Operation shall be staged to optimize chiller efficiency at part loads.

B. All modular chillers shall be integrated with pumping packages for distribution. Each pump package shall have dual pumps (duty/standby) for 100% redundancy with automatic changeover controls. Pump packages shall be factory run tested. All system and pump requirements, such as controls for primary/secondary as well as all devices per standard details for example, shall apply. Each

modular chiller shall be provided with the internal valve package option to allow any one module to be taken offline for service while the chiller remains online.

C. If the total cooling load, including N+1 redundancy, exceeds the available capacity of a single modular chiller assembly, the load shall be split into two or more modular assemblies as needed. As a result, the chilled and condenser water distribution headers shall be sized to accommodate the total flow of all the modular chiller assemblies required to allow for future expansion.

D. A master controller shall be provided by the unit manufacturer that is capable of staging compressors based on load, rotating lead compressor to equalize runtime, and transferring load to another compressor in the event of a compressor fault. Fault conditions shall be recorded and stored for easy recall and troubleshooting. Electrical and Mechanical connections shall be independent for servicing of modules without interrupting operation of other modules.

## Part 3 – EXECUTION

3.1 Equipment with multiple compressors shall have at least two separate refrigerant circuits.

3.2 If connected to outdoor piping, chillers shall be capable of utilizing a water/ethylene glycol mixture consisting of 35–40% concentration by weight, with deionized water, corrosion inhibitors effective for water-based fluids, and additional additives to buffer and neutralize acidic glycol degradation. This shall be supplied and installed by the on-site mechanical contractor. This mixture will protect the equipment down to -5° to -10° F. Only propylene glycol will be used in coolant mixtures used in food service areas or equipment.

3.3 The potable water supply shall NOT be directly connected to any system, piping, or component containing ethylene glycol mixtures. Water shall ONLY be provided to ethylene glycol containing systems by use of air gaps. Air gaps shall be provided by use of rigid piping and not by flexible hoses so as to assure maintenance of proper air gap distance.

3.4 Systems containing only propylene glycol mixtures or water only systems may use a Reduced Pressure Zone Backflow Preventer or air gaps for protecting the makeup water connections.

3.5 Plumbing containing glycol solutions shall be identified as not being potable water along the entire length of piping. Signage shall state the type of glycol used or contained in the system.

3.6 Chiller systems utilizing glycol shall have signage identifying the type of glycol (i.e., propylene glycol or ethylene glycol) that is used for the system, the glycol mixture's concentration, and spill reporting requirements at the makeup water/solution mixing locations.

3.7 Chillers shall be equipped with an internal flow sensor to ensure flow prior to start and after shutdown. The condenser water flow on steam chillers must continue for 30 minutes after chiller shutdown.

3.8 Noise level in a chiller room shall be less than 85 dBA per OSHA 29 CFR 1910.95. Sound attenuation devices shall be installed if noise level exceeds 85 dBA.