

SECTION 23 64 16
CENTRIFUGAL WATER CHILLERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Chiller package
- B. Charge of refrigerant and oil
- C. Controls and control connections
- D. Chilled water connections
- E. Condenser water connections
- F. Auxiliary water connections
- G. Starters
- H. Electrical power connections

1.2 REFERENCES

- A. ASHRAE 15 - Safety Code for Mechanical Refrigeration Systems
- B. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings
- C. ASME BPVC SEC 8 - Boiler and Pressure Vessel Code
- D. UL 1995 - Heating and Cooling Equipment
- E. AHRI 550/590 – Standard for Performance Rating of Water-Chilling and Heat Pump Water-Heating Packages Using the Vapor Compression Cycle

1.3 SUBMITTALS

- A. Submit shop drawings under provisions of Section 01 33 00.
- B. Submit shop drawings indicating components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections.
 - 1. Indicate equipment, piping and connections, valves, strainers, and thermostatic valves required for complete system.
- C. Submit product data under provisions of Section 01 33 00.
- D. Submit product data indicating rated capacities, weights, specialties and accessories, electrical requirements and wiring diagrams.
- E. Submit written certification that non-manufacturer furnished components of package meet the manufacturer's requirements.
- F. Submit manufacturer's installation instructions under provisions of Section 01 33 00.
- G. Submit performance data indicating energy input versus cooling load output from 0% to 100% of full load at specified and minimum condenser water temperature.

1.4 OPERATION AND MAINTENANCE DATA

- A. Submit operation data under provisions of Section 01 77 00.
- B. Include start-up instructions, maintenance data, parts lists, controls, and accessories.
 - 1. Include trouble-shooting guide and installation manual.
 - 2. Provide expanded breakdown of machine including parts list and number, factory generated service repair manuals and complete as-built wiring diagram of machine and controls.
- C. Submit maintenance data under provisions of Section 01 77 00.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in the manufacture of the products specified in this Section with minimum five years documented experience.

1.6 REGULATORY REQUIREMENTS

- A. Conform to AHRI 550/590 code for testing and rating of centrifugal chillers.

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- B. Conform to UL 1955 code for construction of centrifugal chillers.
 - C. Conform to ASME BPVC SEC 8 for construction and testing of centrifugal chillers.
 - D. Conform to ASHRAE 15 code for construction and operation of centrifugal chillers.
 - E. Provide certification of inspection for conforming authority having jurisdiction approval.
 - F. Mechanical equipment rooms where chiller components containing refrigerants shall meet all requirements of the FBC-M, Chapter 11, including but not limited to design, installation, construction, ventilation, refrigerant detection with alarms, safety equipment, system pressure testing, and refrigerant leak testing.
- 1.7 DELIVERY, STORAGE, AND HANDLING
- A. Deliver products to site under provisions of Section 01 60 00.
 - B. Store and protect products under provisions of Section 01 60 00.
 - C. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
 - D. Protect units from physical damage.
 - 1. Leave factory-shipping covers in place until installation.
- 1.8 WARRANTY
- A. Provide 10-year warranty under provisions of Section 01 77 00.
 - B. Warranty coverage is for complete chiller package as manufactured and delivered to site including materials and labor.
- 1.9 COMMISSIONING
- A. Commissioning of a system or systems specified in this section is part of the construction process.
 - B. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Owner's Representative and the Commissioning Authority.
 - 1. The chiller shall be 4 point performance tested on an AHRI certified factory test loop in accordance with AHRI 550/590. If the chiller manufacturer is not able to test the unit in their facility, the contractor shall coordinate with a qualified AHRI certified third party testing company to perform testing per the specifications.
 - a. Testing shall be conducted at 100%, 75%, 50% and 25% of design load and at specified entering condenser water temperatures for each condition.
 - b. A certified test report of all data shall be submitted to the Contracting Officer and the District prior to completion of the project.
 - C. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure.
 - D. Refer to Section 01 77 00 - Contract Closeout, for substantial completion details.
 - E. Refer to Section 01 91 00, Commissioning, for detailed commissioning requirements.
- 1.10 MAINTENANCE SERVICE
- A. Furnish service and maintenance of chillers for period of one year from Date of Substantial Completion in accordance with manufacturer's instructions. Maintenance and service to be provided by chiller OEM.
 - B. Provide factory generated start-up reports to Owner upon commissioning of each chiller, along with manufacturer's recommended periodic service reports.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Trane
- B. Carrier

- C. York
- D. Daikin

2.2 MANUFACTURED UNITS

- A. Provide factory assembled and tested, packaged, water cooled, liquid chillers consisting of centrifugal compressors, compressor motor, condenser, evaporator, refrigeration accessories, instrument and control panel including gages and indicating lights, all optional auxiliary components and accessories, and motor starters.
 - 1. Construction and ratings shall be in accordance with AHRI 550/590.
 - 2. Chiller shall have the capability to unload to 25% of design tonnage with constant entering water temperature. The chiller loading capabilities shall be demonstrated at the time of the factory performance test. The chiller shall be modified to include hot gas bypass if the minimum load cannot be met.
 - 3. On loss of power the chiller's compressor must have the capability to restart within 70 seconds, and reach 80% load within 240 seconds.
- B. Units shall have Energy Efficiency Rating (EER) not less than prescribed by ASHRAE 90.1.
- C. The Engineer shall refer to FPL Commercial/Industrial HVAC Trade Ally Program Standards and select chillers with KW/ton or EER ratings that qualify for incentive rebate payments from FPL, and the Contractor shall supply and install units meeting these minimum requirement.
 - 1. For cooling loads, exceeding 600 tons of refrigeration and for high schools the engineer shall design the central chiller plant to facilitate stable 1 to 3 hour operation at partial loads ranging from 3.6% to 18% of the total design-cooling load.
 - 2. The alternatives may include two or three water-cooled centrifugal and/or screw compressor chillers.
 - 3. For air-cooled chillers refer Section 23 64 10 and for rotary (screw compressor) chillers refer to Section 23 64 26.
- D. Design chiller plant to deliver chilled water at temperature not exceeding 44°F.
 - 1. Use chilled water-fouling factor of not less than 0.00025 for condenser water EWT at 85°F with condenser fouling factor of not less than 0.00025.

2.3 COMPRESSORS

- A. Compressor Casing: Cast iron, horizontally or vertically split with machined passages, leak tested with refrigerant trace gas to 45-psig.
 - 1. Provide sight glass for monitoring compressor rotation and oil level.
- B. Impellers: Direct drive multi-stage, in-line design, fully shrouded, statically and dynamically balanced, over speed tested to 20% over operating speed, mounted on heat treated forged or rolled steel shaft, nonferrous, labyrinth seals between stages.
- C. Guide Vanes: Modulating radial blade dampers, with externally mounted operator, suitable for capacity reduction to 10% of specified load without hot gas bypass when supplied with design entering water quantity and design temperature of water entering condenser.
- D. Bearings: Roller bearings, self-aligning, pressure lubricated.
- E. Motor: Shall be a hermetically sealed single speed low slip induction type 3,600-rpm max.
- F. Lubrication:
 - 1. Direct drive, positive displacement oil pump, with oil cooler, pressure regulator, oil filters, thermostatically controlled oil heater, and motor controls ¼ HP minimum motor.
 - 2. Interlock to start before chiller motor and run after motor shutdown.
 - 3. Provide sight glass for monitoring oil level.
 - 4. Provide cut off valves before and after oil filter.

G. Refrigerant: The unit shall be factory pre-charged and all chillers in the chiller plant shall use the same EPA approved refrigerant.

H. Compressor motor shall be rated 3-phase 480 Volt.

2.4 EVAPORATOR

A. Provide condensers of shell and tube type, seamless or welded steel construction with cast iron or fabricated steel heads, seamless copper tubes or red brass tubes with integral fins, rolled into tube sheets.

1. Space tube support sheets approximately 2.5'.

2. Smooth bore tubes, extra thick

B. Design and stamp refrigerant side for working pressure and test refrigerant side at design pressure.

1. Test and stamp water side for 150 psig working pressure in accordance with ASME BPVC SEC. 8.

C. Provide baffles to ensure even distribution of incoming gas and to concentrate non-condensable gases.

D. Equipment manufacturer shall provide epoxy coating of tube sheets and end bells.

1. Use one of the following two-pack high solids epoxy phenolic or high molecular weight reactive polymer coating materials:

a. Heresite CSE 6100,

b. Jotamastic 80,

c. Belzona 1321

2. All above products have common characteristics:

a. They are manufactured and stored as two components mixed prior to application, component A (base as a powder or paste material) and component B (solvent, curing agent/solidifier or highly reactive polymer)

b. The product can be applied by spray, brush, or by immersion to obtain the prescribed coverage and the dry film thickness (6 to 15 mills or 150 to 375 microns).

c. Coating materials solidify and cure within 24 hours from application.

d. Equipment manufacturer shall include a 10-year warranty for the coating materials to provide high corrosion resistance to Water Treatment chemicals.

i) See specification 23 25 00, protection against galvanic corrosion and erosion damage of the coated substrate metals.

E. Construction and materials shall conform to ASME BPVC SEC 8.

2.5 CONDENSERS

A. Provide condensers of shell and tube type, seamless or welded steel construction with cast iron or fabricated steel heads, seamless copper tubes or red brass tubes with integral fins, rolled into tube sheets.

1. Space tube support sheets approximately 2.5'

2. Smooth bore tubes, extra thick

B. Design and stamp refrigerant side for 45 psig working pressure, test refrigerant side at; design, test and stamp waterside for 150 psig working pressure; in accordance with ASME BPVC SEC. 8.

C. Provide baffles to ensure even distribution of incoming gas and to concentrate non-condensable gases.

D. Equipment manufacturer shall provide epoxy coating of tube sheets and end bells.

1. Use one of the following two-pack high solids epoxy phenolic or high molecular weight reactive polymer coating materials:

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- a. Heresite CSE 6100,
 - b. Jotamastic 80,
 - c. Belzona 1321
2. All above products have common characteristics:
- a. They are manufactured and stored as two components to be mixed prior to application. Component A (base as a powder or paste material) and component B (solvent, curing agent/solidifier or highly reactive polymer)
 - b. The product can be applied by spray, brush, or by immersion to obtain the prescribed coverage and dry film thickness (6 to 15 mills or 150 to 375 microns).
 - c. Coating materials solidify and cure within 24 hours from application.
 - d. Equipment manufacturer shall include a 10-year warranty for the coating materials to provide high corrosion resistance to Water Treatment chemicals.
 - i) See specification 23 25 00, protection against galvanic corrosion and erosion damage of the coated substrate metals.
- E. Construction and materials shall conform to ASME BPVC SEC 8.
- 2.6 PURGE SYSTEM
- A. Provide high efficiency purge system consisting of motor driven compressor, electrically heated oil separator, and baffled drum, for the automatic removal of non-condensable and water vapor.
 - B. System shall automatically discharge non-condensable.
 1. Provide for manual blow-off of water vapor.
 2. Provide sight glass for monitoring purge condenser drum.
- 2.7 CONTROLS – Provided by the chiller manufacturer including translator/interface module compatible with Owner’s Energy Management Control System (EMCS) hardware and software, see design drawings with controls schematics and sequence of operations for details.
- A. On or near chiller, mount steel control panel containing solid state, fully automatic operating, and safety controls.
 - B. Provide the minimum shown but not limited to safety controls arranged so that operating any one will shut down machine and require manual reset:
 1. High refrigerant (condenser) pressure
 2. Low refrigerant (evaporator) temperature
 3. Low refrigerant (evaporator) pressure
 4. High bearing temperature
 5. Motor winding temperature
 6. Motor overload
 7. Low chilled water temperature
 8. Low oil pressure (differential pressure switch)
 - C. Provide the following safety controls arranged so that operating any one will shut down machine and automatically reset:
 1. Chilled water flow switch
 2. Condenser water flow switch
 3. Phase protection and delay start
 - D. Provide the following devices on control panel face of each chiller.
 1. Machine off, auto switch
 2. A machine selector switch allowing load, unload, hold, or automatic operation.
 3. Sequential start pilot light
 4. Operating pilot light

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5. Condenser pressure gage
 6. Evaporator pressure gage
 7. Oil pressure gage
 8. Oil pump pilot light
 9. Oil pump switch (manual or automatic)
 10. Purge drum pressure gage
 11. Purge pump pilot light
 12. Purge pump switch (manual-off-auto)
 13. Purge oil separator heater pilot light
 14. Purge oil separator heater switch
 15. Evaporator low temperature cutout pilot light
 16. Evaporator low-pressure cutout pilot light
 17. Condenser high-pressure cutout pilot light
 18. Demand limit switch
 19. Motor driven elapsed run time meter
 20. Start counter
- E. Provide the following operating controls:
1. Solid state, chilled water temperature controller which controls electronic guide vane operator within throttling range setting of 0.8°F and features adjustable load rate. Locate temperature sensor in leaving chilled water.
 2. Adjustable thirty minute off timer prevents compressor from short cycling.
 3. A demand limit device allowing for manual setting of maximum current infinitely between 40% and 100% of full load amperes.
 4. Provide a condenser water-temperature sensor.
- F. Provide self-diagnostic digital display module with microprocessor to indicate faults.

2.8 STARTER

- A. Provide unit mounted steel NEMA 1 type enclosure, containing Star Delta closed transition starter, factory wired and tested.
- B. Design the enclosure for bottom cable entry with front access.
1. Door, interlocked with circuit breaker, shall accommodate padlock.
- C. Mount the following devices within enclosure:
1. Disconnect switch on line side with fuses.
 2. A high interrupting capacity circuit breaker with ground fault protection.
 3. Pilot relays to start and stop compressor on signal from chiller control panel.
 4. Electronic overload provides overload protection, protects compressor motor from distribution system irregularities, phase protection with manual or automatic reset, and provides motor current signal to chiller-capacity control module.
 5. Control power transformer.
 6. Fused control circuits for control circuit, oil pump motor, oil heater, and purge control unit.
 7. Contactor interlocks for communication between starter and control panel.
 8. Capacitors one per phase, to correct power factor to minimum 95%.
 9. Fused disconnect and starter for oil pump.
- D. Provide the following devices on starter door:
1. A starter fault-trip indicator and reset control.
 2. Overload trip indicator and reset control.
 3. Distribution fault trip indicator and reset control.

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4. Ground fault trip indicator and reset control.
- E. Provide chiller sequencing panel:
 1. For optimizing multiple chiller operation.
 2. Chiller manufacturer shall make panel.
- 2.1 REFRIGANT MONITOR
 - A. Monitor system shall meet ASHRAE 15
 - B. Monitor shall have minimum sensitivity of 1ppm
 - C. Monitor shall have minimum of 4 sensing ports with locations determined by the Engineer.
 - D. Monitor shall be capable of sensing more than one type of refrigerant during operation.
 - E. Monitor shall be capable of initiating required alarms.
 - F. Monitor shall sample continuously.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide for connection to electrical service.
 1. Refer to Section 26 05 19.
 2. Include for connection of oil pump to separately fused circuit.
- C. Provide for connection of electrical wiring between starter and chiller control panel, oil pump, and purge unit, refer to Section 26 05 19.
- D. Align chiller on concrete foundations, sole plates, and sub-bases.
 1. Level, grout, and bolt in place.
- E. Install units in vibration isolation; refer to Section 23 05 48.
- F. Provide evaporator connections to chilled water piping.
 1. Refer to Section 23 21 13.
 2. On inlet, provide thermometer well for temperature controller, thermometer well and thermometer, strainer, 1½" threaded weld-o-let for flow switch, flexible stainless steel corrugated pipe connector, pressure gage, and shut-off valve, ball valve type.
 3. On outlet, provide thermometer well and thermometer, corrugated stainless steel flexible pipe connector, pressure gage, and shut-off valve.
- G. Furnish and install necessary auxiliary water piping for oil cooling units and purge condensers with strainers and cut-off valves.
- H. Insulate Evaporator and any other cold surfaces in accordance with manufacturer's instructions. Minimum 1.5" thick closed cell insulation covering all components subject to sweating. Insulation k value-0.28.
- I. Provide condenser connection to condenser water piping.
 1. Refer to Section 23 21 13.
 2. On inlet, provide thermometer well and temperature limit controller, thermometer well and thermometer, strainer, 1¼" (minimum) weld-o-let and flow switch, flexible pipe connector, pressure gage, and shut-off valve.
 3. On outlet, provide thermometer well and thermometer, flexible pipe connector, pressure gage, and shut-off valve.
- J. Arrange piping for easy dismantling and clearance to permit tube cleaning and removal.
- K. Provide piping from chiller rupture disc to outdoors.
 1. Size as recommended by manufacturer, with removable flexible connection at disc.
- L. Locate chillers to align with exterior doors for tube pull.

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- M. A minimum clearance of 3' must be maintained between chiller and nearest external system component and 6' between any two chillers or manufacturer's commendations whichever is greater.
 - N. Provide clearance above the top of chiller highest component as recommended by unit's supplier.
 - O. Provide a trolley I-beam lifting structure built over chillers.
 - 1. Chiller supplier shall specify the recommended clearances and trolley lifting capacity to allow service and removal of heaviest chiller components.
 - P. Locate control panels facing each other for dual chillers.
 - 1. Three or more chiller panels will face same direction.
- 3.2 MANUFACTURER'S FIELD SERVICES
- A. Prepare and start systems under provisions of Section 01 60 00.
 - B. Provide services of factory-trained representative to leak test, refrigerant pressure test, evacuate, dehydrate, charge, startup, calibrate controls, and instruct Owner on operation and maintenance to Owner's satisfaction.
 - C. Supply initial charge of refrigerant and oil.
 - D. Contractors' startup shall be scheduled and documented in accordance with the commissioning requirements.
 - 1. Refer to Section 01 91 00, Commissioning, for further details.
- 3.3 OPERATIONAL DATA
- A. Start-up and demonstrate system operation and verify specified performance, refer to Sec 23 08 00.
 - B. Provide equipment schedule on the drawings to include the following data:
 - 1. Manufacturer
 - 2. Model Number
 - 3. Cooling Capacity
 - 4. Refrigerant
 - 5. Unit EER
 - 6. Evaporator
 - a. Water Flow
 - b. Entering Water Temperature
 - c. Leaving Water Temperature
 - d. Pressure Drop
 - e. Fouling Factor
 - 7. Condenser
 - a. Water Flow
 - b. Entering Air Temperature
 - c. Leaving Water Temperature
 - d. Pressure Drop
 - e. Fouling Factor
 - 8. Heating Recovery Condenser (if applicable)
 - a. Water Flow
 - b. Entering Water Temperature
 - c. Leaving Water Temperature
 - d. Pressure Drop
 - e. Fouling Factor
 - 9. Compressor

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- a. Maximum Power Input
- b. Starter Type

3.4 FUNCTIONAL PERFORMANCE TESTING

- A. System Functional Performance Testing is part of the Commissioning Process.
 - 1. The Contractor shall perform Functional Performance Testing and the Commissioning Authority shall witness and document the test.
 - 2. Refer to Section 01 91 00, Commissioning, for functional performance tests and commissioning requirements.
- B. Systems Readiness Checklists shall be completed and submitted for each piece of equipment included in this section.
- C. Include the functional performance testing of HVAC pumps as part of the Chilled Water System Functional Performance testing.

3.5 DEMONSTRATION AND TRAINING

- A. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner's Representative.
 - 1. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems.
 - 2. Schedule the instruction in coordination with the Owner's Representative after submission and approval of formal training plans.
 - 3. Refer to Section 01 91 00, Commissioning, for further contractor training requirements.
- B. Provide demonstration and training for all equipment covered by this section and installed in this project.

END OF SECTION