

## SECTION 15686 - CENTRIFUGAL CHILLERS - AIR COOLED

## PART 1 - GENERAL

## 1.1 SUMMARY:

- A. This Section specifies packaged, air cooled, hermetic centrifugal water chillers.
- B. This Section specifies the installation requirements for the Owner furnished centrifugal water chillers. Refer to Division 1 for requirements for Owner furnished equipment.

## 1.2 SUBMITTALS:

- A. Each manufacturer shall describe in writing, how their company is addressing the CFC legislation issue. Provide equipment capable of accepting a substitute refrigerant. The equipment provided shall provide the scheduled capacity when the substitute refrigerant is used. Each company shall identify the substitute refrigerant proposed, the nominal equipment capacity reduction effects, (if any), performance in KW/TON, the refrigerant change out procedure and long term maintenance effects the new refrigerant has on the equipment.
- B. Product Data: Submit product data, including rated capacities, weights (shipping, installed, and operating), furnished specialties and accessories; and installation and start-up instructions.
- C. Shop Drawings: Submit manufacturer's assembly type shop drawings indicating dimensions, weight loadings, required clearances, methods of assembly of components, and location and size of each field connection.
- D. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to units. Submit manufacturer's ladder type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
- E. Record Drawings: At project closeout, submit record drawings of installed systems products in accordance with requirements of Divisions 1 and 15.
- F. Maintenance Data: Submit maintenance data and parts list for each centrifugal chiller, control, and accessory; including "trouble-shooting" maintenance guide. Include this data and product data in maintenance manual; in accordance with requirements of Divisions 1 and 15.
- G. Quality Control Submittals:
  - 1. Submit certification of compliance with ASME, UL, AND ASHRAE fabrication requirements specified in Quality Assurance below.
  - 2. Submit certification of compliance with performance verification requirements specified in PART 2 of this Section.
  - 3. Submit quality control reports specified in PART 3 of this Section.

## 1.3 QUALITY ASSURANCE:

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of centrifugal chillers, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

- B. Machine Experience: At time of submission of bid or proposal, chiller model proposed must have acquired minimum of 2 years experience on each of 10 field installations, each machine having acquired minimum of 2,400 operating hours.
- C. Regulatory Requirements:
  - 1. ASHRAE Compliance: Fabricate and install centrifugal chillers to comply with ASHRAE 15 "Safety Code for Mechanical Refrigeration".
  - 2. UL Compliance: fabricate centrifugal chillers to comply with UL 465 "Central Cooling Air Conditioners".
  - 3. ASME Compliance: fabricate and stamp centrifugal chillers to comply with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
- 1.4 DELIVERY, STORAGE, AND HANDLING:
  - A. Deliver chillers as a complete factory assembled unit with protective crating and covering.
  - B. Ship chillers in a deep vacuum in one of two pieces, depending upon size.
  - C. Store, on site, in a dry/clean environment or properly covered until the equipment is put into operation.
- 1.5 SEQUENCING AND SCHEDULING:
  - A. Coordinate the size and location of concrete equipment pads for on-grade installations. Cast anchor bolt inserts into pad.
  - B. Coordinate the installation of roof curbs and equipment supports, and roof penetrations.
  - C. Concrete, reinforcement, and formwork requirements are specified in Division 3.
  - D. Roof specialties are specified in Division 7.
- 1.6 WARRANTY:
- 1.7 MAINTENANCE SERVICE:

## PART 2 - PRODUCTS

- 2.1 MANUFACTURERS:
  - A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
    - 1. Centrifugal Chillers:
      - a. Trane Co., The
      - b. York
- 2.2 UNIT DESCRIPTION:
  - A. Packaged, factory-assembled, piped, wired, and charged hermetic type centrifugal chillers consisting of centrifugal compressor, compressor motor, motor starter, evaporator, air cooled

condenser, weather-tight equipment enclosure, controls and panels including gages and indicating lights, auxiliary components, and accessories.

- B. Provide auxiliary condensers of capacity scheduled for heat-recovery units.

### 2.3 COMPONENTS:

#### A. Compressor:

1. Shaft and Impeller Assembly: carbon or forged steel shaft with cast high strength aluminum alloy impellers, designed and assembled for no critical speeds within operating range; and statically and dynamically balanced.
2. Casing: fine grain cast iron with gasket sealed casing joints.
3. Drive Assembly: gear transmission integral with compressor and lubricated through compressor lubrication system.
  - a. Gear Assembly: gears and journal bearings babbitt lined and pressure lubricated; provide inspection openings, to facilitate bearing inspection and replacement without disassembly or removal of compressor casing or impeller.
4. Lubrication System: forced circulation type, with positive displacement submerged pump and replaceable oil filter; complete with an automatic oil heater designed to separate refrigerant from oil, and oil cooler if required for proper performance. System shall provide positive pressure lubrication of journals, bearings and seals (if any), during start-up, operation, and coast-down of chiller, including power interruptions. On two compressor units provide redundant oil pump.
5. Motor and Accessories: hermetically sealed, continuous duty, single speed, squirrel cage, induction type; full load operation of the motor shall not exceed nameplate rating; rotor shaft shall be heat treated carbon steel and designed such that the first critical speed is well above the operating speed. Provide for removal of the stator for service or replacement without breaking the main refrigerant piping connections.
6. Compressor Motor Starters: Provide factory mounted and wired starters. Starters shall be a star-delta closed transition type, of sizes, ratings, and electrical characteristics scheduled; with a NEMA 1 enclosure. Provide starters with an electronic protection system to monitor and protect against three-phase overload, overload during starting, phase unbalance, and over and under voltage. Field wiring and electrical connections are specified in Division 16.

#### B. Evaporator:

1. Shell and Water Boxes: fabricated from welded carbon steel plate. Provide 150 psig maximum working pressure water boxes and nozzle connections. Provide suitable tappings in the water boxes and nozzles for control sensors, gages, and thermometers.
2. Water Heads: fabricated steel water heads with integral water connections.
3. Tube Sheets: fabricated of thick carbon steel sheets welded to the shell and drilled for tubes. Include intermediate tube support sheets as required to prevent tube vibration.
4. Tubes: individually replaceable, finned, seamless copper tubes; removable from either end of the heat exchanger without affection strength and durability of the tube sheets and without causing leakage in adjacent tubes. Expand ends of tubes in tube sheets

and intermediate tube support sheets for tight fit to prevent vibration of tubes. Provide suitable baffles or distributing plates in condenser tubes to evenly distribute refrigerant discharge gas on heat transfer tubes.

5. Pressure Limiting and Pressure Relief Devices: Manufacturer's standard complying with ASHRAE 15.

C. Condenser:

1. Coil: aluminum fin mechanically bonded to 5/8 inch OD seamless copper tubing. Subcooler circuit standard. Factory tested to 375 psig air-under-water.
2. Fan and Motor: vertical discharge, low speed, belt driven, propeller type fans; cycle to maintain head pressure. Form orifices to allow close tip clearance.

D. Auxiliary Condenser:

1. Shell and Water Boxes: fabricated from welded carbon steel plate. Provide 150 psig maximum working pressure water boxes and nozzle connections. Provide suitable tappings in the water boxes and nozzles for control sensors, gages, and thermometers.
2. Water Heads: fabricated steel water heads with integral water connections.

2.4 ACCESSORIES:

- A. Purge System: designed to evacuate non-condensable gases and water vapor from the system and for condensing, separating, and returning refrigerant to the system. Provide all necessary devices to automatically isolate purge system from chiller.

2.5 CONTROLS AND SAFETIES:

A. Refrigerant Flow Control Devices:

1. Provide refrigerant flow control devices between evaporator and condensers (and elsewhere as required) to regulate refrigerant flow at volume and pressure required to maintain evaporator liquid refrigerant at level sufficient to keep cooler heat transfer tubes adequately wetted through full range of chiller operation.
2. Design devices to permit chiller operation at scheduled conditions, and to allow condenser entering water temperature to decrease to minimum permissible temperature or 1 deg. F (0.5 deg. C) above return chilled water temperature.

B. Capacity Control:

1. Designed and fabricated to regulate evaporator leaving water temperature. Design for capacity modulation, from full load to scheduled minimum load capacity under normal operating conditions, without overshooting and without hunting at scheduled throttling range.
2. Provide variable guide vanes to provide stable operation without surge, cavitation, or vibration from 100 to 10 percent of full load capacity, without hot-gas bypass.
3. Provide diffuser blocks, designed to operate at part load condition to minimize part load stall, to maintain compressor stability at any load condition.

## C. Safety Controls:

1. Design cutouts to operate independently and factory wire to control panel. Design controls to stop compressor motor in event of low refrigerant pressure or temperature in evaporator; high condenser pressure, high compressor discharge temperature, low evaporator leaving water temperature (freeze-stat), high motor temperature, high bearing temperature, low oil pressure, high oil temperature, compressor motor overcurrent or over voltage, or power interruption. Design each cutout to require manual re-starting of compressor.
2. Include anti-recycle timer, factory wired to control panel, limiting compressor motor restarts at scheduled time intervals.

## D. Operational Controls:

1. Provide controls to ensure that compressor will start only under unloaded condition.
2. Provide sequencing controls to ensure lubrication of compressor motor bearings and seals (if any). Sequence as follows:
  - a. Run lubrication system oil so that compressor motor bearing is lubricated before start-up,
  - b. Start compressor motor,
  - c. Provide lubrication during coast-down after compressor motor shut-down.
3. Provide modular electronic, solid state, or (if the building control system allows) pneumatic controls.
4. Design controls to automatically restart compressor after power failure interruptions, provided minimum time between starts has been compiled with.

E. Diagnostics: Provide a diagnostic module capable of indicating all lockout conditions specified above, plus recording the elapsed time (pre-alarm to alarm), the operating conditions of the compressor motor (amperes), refrigerant temperatures and pressures, and chilled and condenser water temperatures (entering and leaving) at the time of lockout.

## F. Control Panel:

1. Factory-mounted and wired. Provide gages or meters to indicate low refrigerant pressure in evaporator, high condenser pressure, and low oil pressure.
2. Provide switches and push-buttons designed to permit indicated operations including the following:
  - a. Manual and automatic operation of oil pump.
  - b. Manual and automatic operation of oil separator heater.
3. Provide pilot lights or visual flag switches for indicated operations and cutouts including the following:
  - a. Oil pump operation.
  - b. Low chilled water temperature cutout.

- c. Low water flow cutout.
  - d. Oil separator heater operation.
  - e. Low evaporator refrigerant pressure or temperature cutout.
  - f. High condenser pressure cutout.
  - g. High motor winding temperature cutout.
  - h. Low oil pressure cutout.
  - i. Motor overload cutout.
- 4. Provide elapsed time meter designed to automatically record total chiller operating time, in hours.
  - 5. Provide electrical interlock to prevent chiller operation when chilled water pump is not operating.

#### 2.6 INSULATION:

- A. Insulate evaporators and other cold surfaces to prevent condensation, with ambient humidity of 75 percent and dry- bulb temperature of 90 deg. F (32 deg. C), no air movement. Use the manufacturer's standard insulation material.

#### 2.7 EQUIPMENT ENCLOSURE:

- A. All components except air cooled condenser and starter shall be housed in a weather-tight insulated metal equipment enclosure to protect equipment and provide tempered environment for service. All starters and disconnects shall be located in their own separate, weather-tight enclosure. Lighted equipment enclosure shall have a 120-volt convenience outlet and electric unit heater for freeze protection to -20 deg. F ambient. High ambient units shall have a fan-coil unit instead of a unit heater. All enclosures shall be galvanized steel with factory finish.

#### 2.8 FACTORY FINISH:

- A. Chiller manufacturer's standard factory finish.

#### 2.9 SOURCE QUALITY CONTROL:

- A. Test and Inspect: centrifugal chillers in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
- B. Performance Verification:
  - 1. Rate centrifugal chillers in accordance with ARI 550 "Standard for Centrifugal or Rotary Water-Chilling Packages".
  - 2. Provide a Coefficient Of Performance (COP) for centrifugal chillers not less than prescribed by ASHRAE 90A "Energy Conservation in New Building Design".

## PART 3 - EXECUTION

## 3.1 INSTALLATION:

- A. Install chillers in accordance with manufacturers installation instructions.
- B. Install chillers plumb and level, firmly anchored, and maintain manufacturer's recommended clearances for servicing and maintenance.
- C. Coordinate installation of roof curbs and equipment supports, and required roof penetrations.

## 3.2 PIPING CONNECTIONS:

- A. Piping installation requirements are specified in other sections of Division 15. The Drawings indicate the general arrangement of piping, fittings, and specialties. The following are specific connection requirements:
  - 1. Install piping adjacent to machine to allow servicing and maintenance.
  - 2. Chilled Water Piping: Connect inlet to evaporator with controller bulb well, shutoff valve, thermometer, strainer, flow switch, pressure gage, and union or flange. Connect outlet to evaporator with shutoff valve, balancing cock, thermometer, pressure gage, and union or flange.
  - 3. Auxiliary Condenser: Provide bypass valve to bypass water flow around auxiliary condenser when centrifugal chiller compressor is not operating.

## 3.3 FIELD QUALITY CONTROL:

- A. Provide the services, to include a written report, of a factory authorized service representative to supervise the field assembly of the components, installation, and piping and electrical connections.

## 3.4 DEMONSTRATION:

- A. Provide the services of a factory authorized service representative to provide start-up service and to demonstrate and train the Owner's maintenance personnel as specified below.
- B. Start-up Service:
  - 1. Evacuate, dehydrate, vacuum pump and charge with specified refrigerant, and leak test in accordance with manufacturer's instructions. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
  - 2. Perform lubrication service, including filling of reservoirs, and confirming that lubricant is of quantity and type recommended by manufacturer.
  - 3. Do not place chillers in sustained operation prior to initial balancing of mechanical systems for interface with chillers.
- C. Training:
  - 1. Train the Owner's maintenance personnel on start-up and shut-down procedures, troubleshooting procedures, and servicing and preventative maintenance schedules and procedures. Review with the Owner's personnel, the data contained in the Operating and Maintenance Manuals specified in PART 1 of this Section and in Division 1.

2. Schedule training with Owner through the Architect/Engineer with at least 7 days prior notice.

END OF SECTION 15686