

SECTION 15744

CENTRIFUGAL CHILLERS

PART 1 DESIGN DIRECTIVE

1.1 QUALITY ASSURANCE

- A. 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. Comply with ASHRAE 15 for chiller leak monitoring, testing, and installation.
- C. Fabricate centrifugal chillers to comply with UL 465 "Central Cooling Air Conditioners".
- D. Chiller shall comply with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 and be stamped accordingly.
- E. Chiller performance shall be rated in accordance with Air Conditioning & Refrigeration Institute (ARI) standard 550.
- F. Prior to shipment the chiller automated-controls test shall be executed to check for proper wiring and ensure correct controls operation.
- G. Comply with NFPA 70.

1.2 DELIVERY, STORAGE, AND HANDLING

- A. Store chillers to prevent damage and protect from weather, dirt, fumes, water, and debris in a clean dry place.
- B. Handle chillers in accordance to manufacturer's written rigging and installation instructions for transportation, unloading, and setting in final location.
- C. Unit shall be shipped with firmly attached metal plates that indicate name of manufacturer, chiller model number, chiller serial number, and refrigerant used.

1.3 DESIGN CRITERIA

- A. All chillers shall use refrigerant 134a.
- B. Provide a Coefficient of Performance (COP) for centrifugal chillers not less than 10.0.
- C. Part load conditions shall be accommodated via a variable frequency drive.
- D. Chillers shall be equipped with open communications protocol such as Lon Works, Modbus, or BACnet.

**PART 2 PRODUCTS**

**2.1 MANUFACTURERS**

- A. Subject to compliance with requirements, provide centrifugal chillers from one of the following:
1. Carrier A/C Group; Carrier Corp.
  2. McQuay Group, Snyder-General
  3. Trane Co.,
  4. York International.

**2.2 UNIT DESCRIPTION**

- A. Packaged, factory-assembled, centrifugal type chillers consisting of centrifugal compressor, compressor motor(s), motor starters, variable speed drive, evaporator, condenser, controls and panels including gages and indicating lights, auxiliary components, and accessories.

**2.3 COMPONENTS**

- A. Compressor:
1. The rotor assembly shall consist of a heat treated alloy steel drive shaft and impeller shaft with a lightweight, high strength, cast aluminum impeller.
  2. Casing shall be fine grain cast iron with gasket sealed casing joints.
  3. Open drive type compressors preferable. The journal and thrust bearings shall be fabricated of aluminum alloy, precision bored, and axially grooved. For an open drive the seal shall consist of a spring loaded ring assembly using O-rings and carbon rings with stress relieved collars. The seal shall be oil flooded at all times and pressure operated during compressor operation.
  4. The gears shall be shall be helical with crowned teeth designed so that more than one tooth is in contact at all times. Gears shall be integrally assembled in the compressor rotor support and shall be film lubricated. Each gear shall be individually in its own jurnal and thrust bearings to isolate it from impeller and motor forces. Provide inspection openings for the gears and bearings without needing to disassemble or remove any major components.
  5. Lubrication system shall be force fed to all bearings by an oil pump that operates prior to startup, continuously during operation and coast-down. A reservoir mounted high shall provide lubrication during coast down in case of power failure. A thermostatically operated heater shall be provided that can maintain the oil at appropriate temperature for the condition to prevent refrigerant from mixing with the oil. The oil shall be filtered through an externally mounted, easily replaceable, 1/2 micron filter. The oil shall be cooled using a refrigerant cooled oil cooler. Both the refrigerant and oil piping to the cooler shall be provided with isolation valves for service. An automatic oil return system shall recover any oil that has migrated to the evaporator. All oil piping shall be factory installed.
  6. Motor shall be open or hermetically sealed, variable speed, controlled by variable frequency AC power from the control system as a part of the capacity reduction controls. The motor shall comply with DC Standard, 'ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT'. The VFD shall be 12-pulse and

an IEEE 519-1992 harmonic analysis shall be done as part of the submittal package with a follow-up weeklong measured harmonic analysis to verify performance.

7. If no VFD, provide separate motor starters for field mounting and wiring. Starters shall be a wye-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.

**B. Evaporator and Condenser:**

1. Shell and water boxes shall be fabricated from rolled carbon steel plates with welded seams. Provide 150 psig maximum working pressure water boxes and nozzle connections. The refrigerant side shall be rated and tested for suitable pressure for the refrigerant. Provide vents and drains in water boxes to permit tube cleaning. Fabricate steel water heads with integral water connections bolted to shell of vessel. Provide water piping stub-outs, flanged connections, 150 psig raised face flanges.
2. Tube sheets shall be fabricated of thick carbon steel sheets welded to the shell and drilled for tubes.
3. Tubes shall be high efficiency, externally and internally enhanced, individually replaceable, finned, seamless copper tubes. Tubes shall be removable from either end of the heat exchanger without affecting strength and durability of the tube sheets and without causing leakage in adjacent tubes. Provide suitable baffles or distributing plates in condenser tubes to evenly distribute refrigerant discharge gas on heat transfer tubes.

**C. Pressure Limiting and Pressure Relief Devices: Manufacturer's standard complying with ASHRAE 15 and ASME Code for Unfired Pressure Vessels.**

**D. Provide refrigerant charging transfer connections, pressure relief device on the evaporator to prevent excessive pressure in refrigerant side, and means to sense refrigerant pressure or temperature.**

**2.4 ACCESSORIES**

- A. Purge system shall be 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.
- B. Pump-out system shall include compressor and drive, oil separator, filter drier, water cooled condenser, piping, wiring, motor starter, and an external refrigerant storage vessel large enough to hold the entire refrigerant charge of the largest chiller in the plant. The unit shall come with necessary valves and hoses to replace and destill refrigerant.
- C. Electric chillers shall include a receiver tank sized for full charge.

**2.5 CONTROLS AND SAFETIES**

- A. Refrigerant flow shall be controlled by a variable orifice. The variable orifice shall automatically adjust to maintain proper refrigerant levels in the condenser and evaporator. This shall be controlled by monitoring refrigerant liquid level in the condenser assuring optimal subcooler performance.
- B. Capacity control shall be designed and fabricated to regulate evaporator leaving water temperature. Design for capacity modulation, from full load to scheduled minimum load capacity. Modulating hot gas bypass shall be provided and programmed to be used in very low load conditions and sudden load changes. The hot gas bypass shall be programmed to not operate in normal conditions, hurting efficiency.
- C. 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.
- D. Variable speed drive that meets the specifications in section 16.
- E. Design safety controls cutouts to operate independently and factory wire to control panel. Design controls to stop compressor motor in event of any condition that will jeopardize the chiller.
- F. Provide operational controls to ensure that compressor will start only under unloaded condition. Provide sequencing controls to ensure lubrication of compressor motor bearings and seals (if any).
- G. Provide a diagnostic module capable of indicating all lockout conditions specified above, plus recording the elapsed time (pre-alarm to alarm), the operating conditions for the compressor motor (amperes), refrigerant temperatures and pressures, and chilled and condenser water temperatures (entering and leaving) at the time of lockout.
- H. Each unit shall be provided with a factory-mounted and wired control panel. The control center shall use easy to understand English language with numeric data in English units. The panel shall provide digital programming of essential set points. These set points shall be, but not limited to, percent current limit, pull down demand limiting, seven day time clock fro starting and stopping, pumps, tower, and remote reset.
- I. Provide pilot lights or visual flag switches for indicated operations and cutouts including the following:
  - 1. Oil pump operation
  - 2. Low chilled water temperature cutout
  - 3. Low water flow cutout
  - 4. Oil separator heater operation
  - 5. Low evaporator refrigerant pressure or temperature cutout
  - 6. High condenser pressure cutout
  - 7. High motor winding temperature cutout
  - 8. Low oil pressure cutout
  - 9. Motor overload cutout
- J. Provide elapsed hourly time meter designed to automatically record total chiller operating time.
- K. Provide electrical interlock to prevent chiller operation when condenser water or chilled water pumps are not operating.

2.6 VIBRATION CONTROL

- A. Refer to DC Standard, 'SEISMIC RESTRAINT AND VIBRATION CONTROL' for requirements.

2.7 INSULATION

- A. Insulate evaporators and other cold surfaces with elastomeric insulation, to prevent condensation, with ambient humidity of 75 percent and dry-bulb temperature of 90°F no air movement.

2.8 SOURCE QUALITY CONTROL

- A. Test and inspect centrifugal chillers in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

PART 3 EXECUTION

3.1 FACTORY FIELD SERVICES

- 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.
- B. 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.
- C. Evacuate, dehydrate, vacuum pump and charge with specified refrigerant. Leak test in accordance with manufacturer's instructions. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
- D. Perform lubrication service, including filling of reservoirs with manufacturer approved lubricant
- E. Do not place chillers in sustained operation prior to initial balancing of mechanical systems for interface with chillers.
- F. Schedule training with Owner through the Engineer with at least 7 days prior notice. Train the Owner's maintenance personnel on start-up and shut-down procedures, troubleshooting and servicing procedures, and preventative maintenance schedules and procedures. Review with the Owner's personnel the data contained in the Operating and Maintenance Manuals.

END OF SECTION 15744