

SECTION 23 64 12
PACKAGED WATER CHILLERS – CENTRIFUGAL AND SCREW

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes design, performance criteria, refrigerants, controls, and installation requirements for water-cooled centrifugal chillers.

1.2 REFERENCES

- A. Comply with the following codes and standards: AHRI 550/590.
- B. AHRI 575.
- C. NEC.
- D. ANSI/ASHRAE 15.
- E. OSHA as adopted by the State.
- F. ETL.
- G. ASME Section VIII.

1.3 SUBMITTALS

- A. Submittals shall include the following:
 - 1. Dimensioned plan and elevation view drawings, required clearances, and location of all field connections.
 - 2. Summary of all auxiliary utility requirements such as electricity, water, etc. Summary shall indicate quality and quantity of each required utility.
 - 3. Diagram of control system indicating points for field interface and field connection. Diagram shall fully depict field and factory wiring.
 - 4. Manufacturer's certified performance data at full load plus IPLV or NPLV.
 - 5. Installation and Operation manuals.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the codes and standards in above Section 1.02.
- B. Chiller manufacturer must be ISO Certified.
- C. The chiller shall be tested to job conditions at the manufacturer's plant.

1.5 DELIVERY AND HANDLING

- A. Chillers shall be delivered to the job site completely assembled and charged with refrigerant R134a and be shipped on skids with a weather resistant cover.
- B. Comply with the manufacturer's instructions for rigging and handling equipment. Leave protective covers in place until installation.

1.6 WARRANTY

- A. The chiller manufacturer's warranty shall cover parts and labor costs for the repair or replacement of defects in material or workmanship for a period of one year from equipment startup or 18 months from shipment, whichever occurs first. Warranty support shall be provided by company director.

1.7 MAINTENANCE

- A. Maintenance of the chillers in accordance with manufacturer's recommendations as published in the installation and maintenance manuals shall be the responsibility of the owner.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Basis of Design: Daikin McQuay® Magnitude Model WME, including the standard product features and all special features as required per the plans and specifications.
- B. Equal Products - Equipment manufactured by [ENTER MANUFACTURER NAME HERE] may be acceptable as an equal. Naming these products as equal does not imply that their standard construction or configuration is acceptable or meets the specifications. Equipment proposed "as equal", must meet the specifications including all architectural, mechanical, electrical, and structural details, all scheduled performance and the job design, plans and specifications.

2.2 UNIT DESCRIPTION

- A. Provide and install as shown on the plans a factory assembled, charged, and tested water-cooled packaged centrifugal chiller. Chillers shall have no more than two oil-free, magnetic bearing, semi-hermetic centrifugal compressors (no exceptions). The compressor shall have an integrated variable-frequency drive operating in concert with inlet guide vanes for optimized full and part load efficiency. If two-compressors are used, the evaporator and condenser refrigerant sides and the expansion valve shall be common and the chiller shall be capable of running on one compressor with the other compressor or any of its auxiliaries inoperable or removed.
- B. Each chiller shall be factory run-tested under load conditions for a minimum of one hour on an AHRI certified test stand with evaporator and condenser waterflow at job conditions (excluding glycol applications). Operating controls shall be adjusted and checked. The refrigerant charge shall be adjusted for optimum operation and recorded on the unit nameplate. Units operating with 50-Hz power shall be tested with a 50-Hz power supply. Any deviation in performance or operation shall be remedied prior to shipment and the unit retested if necessary to confirm repairs or adjustments. Manufacturer shall supply a certificate of completion of a successful run-test upon request.

2.3 DESIGN REQUIREMENTS

- A. General: Provide a complete water-cooled, semi-hermetic, oil-free centrifugal compressor water chiller as specified herein. The unit shall be provided according to standards indicated in Section 1.2. In general, unit shall consist of one or two magnetic bearing, oil-free centrifugal compressors, refrigerant, condenser and evaporator, and control systems including integrated variable frequency drive, operating controls and equipment protection controls. Chiller shall be charged with refrigerant HFC-134A. If manufacturer offers a chiller using any HCFC refrigerant, manufacturer shall provide written documentation signed by an officer of the company, assuring refrigerant availability and price schedule for a 20-year period.

- B. The entire chiller system, including all pressure vessels, shall remain above atmospheric pressure during all operating conditions and during shut down to ensure that non-condensables and moisture do not contaminate the refrigerant and chiller system. If any portion of the chiller system is below atmospheric pressure during either operation or shut down, the manufacturer shall include, at no charge:
1. A 20-year purge maintenance agreement that provides parts, labor, and all preventative maintenance required by the manufacturer's operating and maintenance instructions.
 2. A complete purge system capable of removing non-condensables and moisture during operation and shut-down.
 3. The manufacturer shall also include at no charge for a period of 20 years an annual oil and refrigerant analysis report to identify chiller contamination due to vacuum leaks. If the analysis identifies water, acid, or other contaminant levels higher than specified by the manufacturer, the oil and/or refrigerant must be replaced or returned to the manufacturer's original specification at no cost to the owner.
 4. The manufacturer shall include a factory-installed and wired system that will enable service personnel to readily elevate the vessel pressure during shutdown to facilitate leak testing.
 5. A factory mounted, wired, and installed shell pressurization system shall be provided to keep air out of the chiller when the unit is not in service. Electric blanket or hot water circulation systems are both acceptable.
- C. Performance: Refer to chiller performance rating.
- D. Acoustics: Sound pressure for the unit shall not exceed the following specified levels. Sound attenuation shall be provided on the compressor discharge at a minimum with additional acoustic treatment to chiller as required. Sound data shall be measured in dB according to AHRI Standard 575 and shall include overall dBA. Data shall be the highest levels recorded at all load points.

Octave Band							Overall (dBA)
63Hz	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	8000Hz
							75% Load
							50% Load
							25% Load

2.4 CHILLER COMPONENTS

- A. Compressors: The unit shall utilize a magnetic bearing, oil-free, semi-hermetic centrifugal compressor. The levitated shaft position shall be digitally controlled and shall be monitored by X-axis position sensor, Y-axis position sensor, and Z-axis position sensor. The compressor drive train shall be capable of coming to a controlled, safe stop in the event of a power failure by diverting stored power to the magnetic bearing controls system.
1. The motor shall be of the semi-hermetic type, of sufficient size to efficiently fulfill compressor horsepower requirements. It shall be liquid refrigerant cooled with internal thermal sensing devices in the stator windings. The motor shall be compatible with variable frequency drive operation.

2. If unit contains an atmospheric shaft seal, the manufacturer shall provide the following at no additional charge:
 - a. 20 year warranty and all preventive maintenance required to maintain the shaft seal including appropriate disposal of all oil lost through the shaft seal. Such disposal shall be done in a manner consistent with all Federal, state, and local laws pertaining to disposal and documentation of appropriate disposal shall be provided.
 - b. Replacement and re-charging on a semi-annual basis, or more often if required, all oil lost through the shaft seal.
 - c. 20 year refrigerant replacement warranty for any loss of refrigerant that can be directly attributable to the failure of the atmospheric shaft seal.
 3. If the compressor drive motor is an open design the chiller manufacturer shall provide the following at no additional charge:
 - a. A self-contained air conditioning system in the mechanical space sized to handle the maximum heat output the open drive motor. The energy required to operate this air conditioning system shall be added to the chiller power at all rating points for energy evaluation purposes.
 4. If the compressor drive motor uses any form of antifriction bearings (roller, ball, etc) the chiller manufacturer shall provide the following at no additional charge:
 - a. A 20 year motor bearing warranty and all preventative maintenance, including lubrication, required to maintain the bearings as specified in the manufacturer's operating and maintenance instructions.
 - b. At start up a three axis vibration analysis and written report which establishes a baseline of motor bearing condition.
 - c. An annual three axis vibration analysis and written report to indicate the trend of bearing wear.
 5. The chiller shall be equipped with an integrated Variable Frequency Drive (VFD) to automatically regulate compressor speed in response to cooling load and the compressor pressure lift requirement. Movable inlet guide vanes and variable compressor speed acting together, shall provide unloading. The chiller controls shall coordinate compressor speed and guide vane position to optimize chiller efficiency.
 6. The compressor circuit shall be equipped with a 5% impedance line reactor to help protect against incoming power surges and help reduce harmonic distortion.
 7. The compressor shall be vibration tested and not exceed a level of 0.14 IPS.
- B. Evaporator and Condenser:
1. The evaporator and condenser shall be separate vessels of the shell-and-tube type, designed, constructed, tested and stamped according to the requirements of the ASME Code, Section VIII. Regardless of the operating pressure, the refrigerant side of each vessel will bear the ASME stamp indicating compliance with the code and indicating a test pressure

- of 1.1 times the working pressure, but not less than 100 psig. The tubes shall be individually replaceable and secured to the intermediate supports without rolling or expanding to facilitate replacement if required.
2. Chillers containing oil shall include at no additional charge a 20 year parts and labor warranty on all oil system components including:
 - a. Pumps
 - b. Starter
 - c. Piping
 - d. Tank
 - e. Heater
 - f. Cooler
 - g. Controls
 - h. Valves
 3. The evaporator shall be flooded type with wall copper internally and externally enhanced tubes rolled into carbon steel tubesheets. The water side shall be designed for a minimum of 150 psig. The refrigerant side shall be designed for a minimum of 200 psi. Provide intermediate tube supports at a maximum of 24 inch spacing. The heads shall be carbon steel and the tubes shall be carbon steel. Water connections shall be grooved suitable for Victaulic couplings. The evaporator shall have dished heads with valved drain and vent connections. The evaporator shall have right-hand connections when looking at the unit control panel.
 4. The condenser shall have wall internally and externally enhanced tubes rolled into carbon steel. Water connections shall be grooved suitable for Victaulic couplings. The water side shall be designed for a minimum of 150 psig. The refrigerant side shall be designed for a minimum of 200 psi. Provide intermediate tube supports at a maximum of 24 inch spacing. The condenser shall have dished heads with valved drain and vent connections. The condenser shall have right-hand connections when looking at the unit control panel.
 5. Provide sufficient isolation valves and condenser volume to hold the full unit refrigerant charge in the condenser during servicing or provide a separate pumpout system and storage tank sufficient to hold the charge of the largest unit being furnished.
 6. An electronic expansion valve shall control refrigerant flow to the evaporator. Fixed orifice devices or float controls with hot gas bypass are not acceptable because of inefficient control at low load conditions. The liquid line shall have moisture indicating sight glass.
 7. Re-seating type spring loaded pressure relief valves according to ASHRAE-15 safety code shall be furnished. The evaporator shall be provided with single or multiple valves. The condenser shall be provided with dual relief valves equipped with a transfer valve so one relief valve can be removed for testing or replacement without loss of refrigerant or removal of refrigerant from the condenser. Rupture disks are not acceptable. If rupture disks are

- required on negative pressure units to prevent air and moisture ingress, then factory mounted spring loaded pressure relief valves shall be provided in series with the rupture disks to contain the remaining refrigerant in the event of vessel over-pressurization. The space between the rupture disk and the relief valve shall include a suitable telltale indicator integrated into the chiller control system to alert the operator that a potential safety issue exists in the pressure relief system.
8. The evaporator, including water heads, suction line, and any other component or part of a component subject to condensing moisture shall be insulated with UL recognized 3/4 inch closed cell insulation. All joints and seams shall be carefully sealed to form a vapor barrier.
 9. Provide factory-mounted and wired, thermal-dispersion water flow switches on each vessel to prevent unit operation with no or low water flow. Paddle and pressure differential type switches are not acceptable due to high rates of failure and false indications from these types of flow indicators.
- C. Vibration Isolation: Provide neoprene waffle-type vibration isolators for each corner of the unit.
- D. Power Connections: Power connection shall be single point to a factory-mounted disconnect switch.
- E. Chiller Control:
1. The unit shall have a microprocessor-based control system consisting of a 15-inch VGA touch-screen operator interface and a unit controller.
 2. The touch-screen shall display the unit operating parameters, accept setpoint changes (multi-level password protected) and be capable of resetting faults and alarms. The following parameters shall be displayed on the home screen and also as trend curves on the trend screen:
 - a. Entering and leaving chilled water temperatures.
 - b. Entering and leaving condenser water temperatures.
 - c. Evaporator saturated refrigerant pressure.
 - d. Condenser saturated refrigerant pressure.
 - e. Percent of 100% speed (per compressor).
 - f. % of rated load amps for entire unit.
 3. In addition to the trended items above, all other important real-time operating parameters shall also be shown on the touch-screen. These items shall be displayed on a chiller graphic showing each component. At a minimum, the following critical areas must be monitored:
 - a. Compressor actual speed, maximum speed, percent speed.
 - b. Evaporator water in and out temperatures, refrigerant pressure and temperature.
 - c. Condenser water in and out temperatures, refrigerant pressure and temperature.
 - d. Liquid line temperature.
 - e. Chilled water setpoint.
 - f. Compressor and unit state and input and output digital and analog values.

4. A fault history shall be displayed using an easy to decipher, color coded set of messages that are date and time stamped. Time interval scale shall be user selectable as 20 mins, 2 hours, or 8 hours. The alarm history shall be downloadable from the unit's USB port. An operating and maintenance manual specific for the unit shall be viewable on the screen.
5. All setpoints shall be viewable and changeable (multi-level password protected) on the touch screen and include setpoint description and range of set values.
6. Automatic corrective action to reduce unnecessary cycling shall be accomplished through preemptive control of low evaporator or high discharge pressure conditions to keep the unit operating through abnormal transient conditions.
7. Chiller shall be capable of starting with entering condenser water temperatures as low as 40°F (4.4°C). For short periods of time during startup, the chiller shall be able to operate with an entering condenser water temperature lower than the leaving chilled water temperature.
8. Chiller shall be capable of stable operation with varying evaporator flow rate up to 50% per minute.
9. Chiller plant optimization software for multiple chillers shall be provided including automatic control of: at least eight (8) chillers, evaporator and condenser pumps (primary and standby), up to 3 stages of cooling tower fan cycling control and a tower modulating bypass valve or cooling tower fan variable frequency drives.
10. The information communicated between the BAS and the factory mounted unit controllers shall include the reading and writing of data to allow unit monitoring, control and alarm notification as specified in the unit sequence of operation and the unit points list.
11. The factory supplied VFD and controls shall include the following:
 - a. Electronic overload.
 - b. Phase loss protection.
 - c. Under/over voltage protection.
 - d. High short circuit panel rating of 35kA at 460v with a matching circuit breaker.
12. Energy saving software logic shall at a minimum offer the following:
 - a. User programmable compressor soft loading.
 - b. Chilled water reset.
 - c. Demand limit control.
 - d. Staging options lead lag between multiple compressors on a single chiller or on multiple chillers.
 - e. Plotting of historic trends for optimizing efficiency.

2.5 OPTIONAL ITEMS; THE FOLLOWING OPTIONAL ITEMS SHALL BE INCLUDED

- A. OPTION: Pump out unit, with or without storage vessel.
- B. OPTION: Refrigerant monitor.
- C. Standard Factory Run-test.
- D. ARI/ETL/CETL Approval.

PART 3 - EXECUTION

3.1 INSTALLATION – INSTALLING CONTRACTOR TO

- A. Install per manufacturer's requirements, shop drawings, and contract documents.
- B. Adjust chiller alignment on foundations, or sub bases as called for on drawings.
- C. Arrange piping to allow for dismantling to permit head removal and tube cleaning.
- D. Coordinate electrical installation with electrical contractor.
- E. Coordinate controls with control contractor.
- F. Provide all material required for a fully operational and functional chiller.

3.2 START-UP

- A. Factory Start-Up Services: Provide for as long a time as is necessary to ensure proper operation of the unit, but in no case for less than two full working days. During the period of start-up, the start-up technician shall instruct the owner's representative in proper care and operation of the unit.

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