

**SECTION 23 64 00
PACKAGED WATER CHILLERS**

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Centrifugal water-cooled chillers, complete with accessories.

1.2 RELATED WORK

- A. Section 00 72 00, GENERAL CONDITIONS.
- B. Section 01 00 00, GENERAL REQUIREMENTS.
- C. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- D. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- E. Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
- F. Section 23 21 23, HYDRONIC PUMPS.
- G. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
- H. Section 23 21 13, HYDRONIC PIPING.
- I. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT.

1.3 DEFINITION

- A. Engineering Control Center (ECC): The centralized control point for the intelligent control network. The ECC comprises of personal computer and connected devices to form a single workstation.
- B. BACNET: Building Automation Control Network Protocol, ASHRAE Standard 135.
- C. Ethernet: A trademark for a system for exchanging messages between computers on a local area network using coaxial, fiber optic, or twisted-pair cables.
- D. FTT-10: Echelon Transmitter-Free Topology Transceiver.
- E. LonMark: An association comprising of suppliers and installers of LonTalk products. The Association provides guidelines for the implementation of the LonTalk protocol to ensure interoperability through Standard implementation.
- F. LonTalk: An open standard protocol developed by the Echelon Corporation that uses a "Neuron Chip" for communication.
- G. LonWorks: Network technology developed by the Echelon Corporation.

1.4 QUALITY ASSURANCE

- A. Refer to Paragraph, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION, and comply with the following.
- B. Refer to PART 3 herein after and Section 01 00 00, GENERAL REQUIREMENTS for test performance.
- C. Comply with ARI requirements for testing and certification of the chillers.
- D. Refer to paragraph, WARRANTY, Section 00 72 00, GENERAL CONDITIONS, except as noted below:
 - 1. A 5-year motor/transmission/compressor warranty shall be provided based upon the RPM of the compressor as follows:

Compressor RPM	Warranty Term
0-5000	1 year from start up
5001-10,000	5 years from start up
10,001 and above	5 years plus annual oil analysis
 - 2. A 5-year parts and labor warranty shall be provided on any reciprocating compressor.
- E. Refer to OSHA 29 CFR 1910.95(a) and (b) for Occupational Noise Exposure Standard.
- F. Refer to ASHRAE Standard 15, Safety Standard for Refrigeration System, for refrigerant vapor detectors and monitor.

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Refrigeration Institute (ARI):
 - 210/ 240-03 Unitary Air Conditioning and Air-Source Heat Pump Equipment
 - 370-01 Sound Rating of Large Outdoor Refrigerating and Air-Conditioning Equipment
 - 495-99 Refrigerant Liquid Receivers
 - 550/590-03 Standard for Water Chilling Packages Using the Vapor Compression Cycle
 - 560-00 Absorption Water Chilling and Water Heating Packages
 - 575-94 Methods for Measuring Machinery Sound within Equipment Space

- C. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):
 - 15-02 Safety Standard for Mechanical Refrigeration Systems
 - 3-96 Guidelines for Reducing Emission of Halogenated Refrigerants in Refrigeration and Air-Conditioning Equipment and Systems
- D. American Society of Mechanical Engineers (ASME):
 - 1998 ASME Boiler and Pressure Vessel Code, Section VIII, "Rules for Constructive Pressure Vessels"
- E. American Society of Testing Materials (ASTM):
 - C 534-03..... Preformed, Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
 - C 612-04..... Mineral-fiber Block and Board Thermal Insulation
- F. National Electrical Manufacturing Association (NEMA):
 - 250-03 Enclosures for Electrical Equipment (1000 Volts Maximum)
- G. National Fire Protection Association (NFPA):
 - 70-05 National Electrical Code
- H. Underwriters Laboratories, Inc. (UL):
 - 1995-99 Heating and Cooling Equipment

1.6 SUBMITTALS

- A. Submit in accordance with Specification Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data.
 - 1. Centrifugal water chillers, including motor starters, control panels, and vibration isolators, and remote condenser data shall include the following:
 - a. Rated capacity.
 - b. Pressure drop.
 - c. Efficiency at full load and part load without applying any tolerance indicated in the ARI 550/590/Standard.
 - d. Refrigerant
 - e. Accessories.
 - f. Installation instructions.
 - g. Startup procedures.

- h. Wiring diagrams, including factory-installed and field-installed wiring.
 - i. Noise data report. Manufacturer shall provide noise ratings. Noise warning labels shall be posted on equipment.
 - j. Refrigerant vapor detectors and monitors.
- C. Maintenance and operating manuals for each piece of equipment in accordance with Section 01 00 00, GENERAL REQUIREMENTS.
- D. Run test report for all chillers.
- E. Product Certificate: Signed by chiller manufacturer certifying that chillers furnished comply with ARI requirements. The test report shall include calibrated curves, calibration records, and data sheets for the instrumentation used in factory tests.
- F. Provide seismic restraints for refrigeration equipment to withstand seismic forces.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL WATER COOLED CHILLERS

- A. General: Chiller shall be factor-assembled and-tested, complete with evaporator, condenser, compressor, motor, starter, oil heater and cooler, economizer or intercooler, purge system (if required), refrigerant piping, instrumentation and control piping, operating and safety controls mounted on the chiller, and other auxiliaries necessary for safe and proper operation of the unit. Chiller operation shall be fully automatic. Provide the capacity as shown on the drawings. Part load and full load efficiency ratings of the chiller shall not exceed those shown on the drawings.
- B. Applicable Standard: Chillers shall be rated and certified in accordance with ARI Standard 550/590. Chillers with ARI certification program shall be ARI stamped.
- C. Hermetic or open: Chillers shall be open or hermetically sealed, using one of the refrigerants, HCFC-123, HFC-134a or HCFC-22.
- D. Compressor (Centrifugal Type): Direct drive oil free two-stage semi-hermetic centrifugal compressor, having statically and dynamically balanced impeller. Impeller shaft shall be heat-treated carbon steel of sufficient rigidity to prevent whip or vibration at variable operating speed. Shaft main bearings shall be of journal type with bronze or babbitt line steel cartridge, aluminum alloy one-piece insert type, or rolling element type with an AFBMA L 10 life of a minimum of 200,000 hours. Rolling element bearings shall be rated in accordance with AFBMA 9 or AFBMA 11 as applicable. Casing shall be cast iron or steel plate with split sections gasketed and bolted together. The beaming system shall be homo- polo magnetic type.
- E. Capacity control shall be by means of variable compressor operating speed movable inlet guide vanes in the compressor suction to modulate the chiller capacity from 100 to 10 percent of full unit rated capacity without unstable compressor operation. The inlet guide vanes shall be electrically or pneumatically operated upon the actuation of temperature or pressure sensor.
- F. Evaporator: Brazed plate constructed of 316 stainless steel, constructed and tested and stamped in accordance with UL 1995 Code for working pressure produced by refrigerant used and water system installed, but not less than 650 psig waterside working pressure. Performance shall be based on a water velocity not less than 1 m/s (3 fps) nor more than

4 m/s (12 fps), and fouling factor of $0.0000176 \text{ m}^2 \text{ degrees C}$ ($0.0001 \text{ hr. sq. ft. degrees F/Btu}$). Removable marine water box shall be constructed of steel. Design working pressure shall be 2070 kPa (300 psig); pressure tested at 150 percent of working pressure. Water nozzle connections shall be grooved.

- G. Condenser: Braze plate constructed of 316 stainless, constructed, tested, and stamped in accordance with applicable portions of UL 1995 Code, where applicable for working pressure produced by the refrigerant used and water system installed, but not less than 650 psig. Performance of condenser shall be based on a water velocity not less than 1 m/s (3 fps) nor more than 4 m/s (12 fps), and a fouling factor of $0.000044 \text{ m}^2 \text{ degrees C}$ ($0.00025 \text{ hr. sq. ft. degrees F/Btu}$). Removable marine water box shall be constructed of steel. Design working pressure shall be 2070 kPa (300 psig); pressure tested at 150 percent of working pressure. Water nozzle connections shall be grooved.
- H. Insulation: Evaporator, suction piping, compressor, and all other parts subject to condensation shall be insulated with 40 mm (1.5 inch) minimum thickness of flexible-elastomeric thermal insulation, complying with ASTM C534.
- I. Economizer: Provide if required by manufacturer. Flash gas shall be piped from economizer to inlet of intermediate stage impeller wheel.. Provide a refrigerant flow control system (float valve or multiple orifice system) to automatically regulate flow of liquid refrigerant through economizer. If external-type economizer is used, such economizer shall be constructed and tested in accordance with Section 8 of ASME Boiler and Pressure Vessel Code for working pressures produced by refrigerant used, unless exempt by Section U-1 of the code.
- J. Motor Load Limiter: Provide a sensing and control system, which will limit maximum load current of compressor motor to a manually selectable percentage of 40 percent to 100 percent of full load current. System shall sense compressor motor current and limit it by modulating inlet guide vanes at the compressor, overriding other controls in their ability to increase loading, but not overriding their ability to reduce loading.
- K. Purge System: Required for refrigerants with vapor pressure less than 100 kPa (14.7 psig). Factory-mounted purge unit, complete with necessary, piping, operating and safety controls and refrigerant service valves to isolate the unit from the chilling unit. Purge unit shall be air, water, or refrigerant cooled. When in operation, purge system shall function automatically to remove, water vapor, and condensable gases from refrigeration system and to condense, separate, and return to system any refrigerant present therein. Purge system shall be manually or automatically started and stopped, and shall be assembled as a compact unit. As an option, a fully automatic purge system that operates continuously while main unit is operating may be furnished. Such purge system shall provide a means to signal operator of occurrence of excessive purging indicating abnormal air leakage into unit. The purge system shall be of high efficiency in recapturing the refrigerant at all load and head conditions and with capability to operate when the chiller is off. The purge unit shall be UL listed.
- L. Isolation Pads: Provide Vibration Isolation for a critical facility.
- M. Spring Isolators: Per Specification Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
- N. Service valves shall be provided to facilitate refrigerant reclaim/removal required during maintenance.
- O. Controls: Chiller shall be furnished with unit mounted, stand-alone, microprocessor-based controls in NEMA 1 enclosure, factory wired with a single point power connection and

separate control circuit. The control panel provide chiller operation, including monitoring of sensors and actuators, and shall be furnished with light emitting diodes or liquid-crystal display keypad.

1. Following functions shall display as a minimum:
 - a. Date and Time.
 - b. Operating set point temperature and pressure.
 - c. Operating hours.
 - d. Operating or alarm status.
 - e. Chilled water temperature-entering and leaving.
 - f. Condenser water temperature-entering and leaving.
 - g. Refrigerant pressure-condenser and evaporator.
 - h. Chiller diagnostic codes.
 - i. Current limit set point.
 - j. Number of compressor starts.
2. Control Functions:
 - a. Manual or automatic startup and shutdown time schedule.
 - b. Control set points for entering and leaving chilled temperatures.
 - c. Condenser water temperature.
 - d. Current/demand limit.
 - e. Motor load limit.
3. Safety Controls: Following conditions shall shut down the chiller and require manual reset to start:
 - a. High condenser pressure.
 - b. Loss of flow-condenser or chilled water.
 - c. Low chilled water temperature.
 - d. Low evaporator refrigerant temperature.
 - e. Sensor malfunction.
 - f. Power fault.
 - g. Extended compressor surge.

- h. Communication loss between the chiller and its control panel. A signal must be transmitted to Energy Control Center, if provided, for this communication loss and for any abnormal.
- 4. Leaving chilled water temperature reset shall be based on return water temperature 4-20 MA or 0-10 VDC signal from a building automation system.
- 5. Chillers shall be pre-wired to terminal strips for interlocked to other equipment.
- 6. Auxiliary hydronic system and the chiller(s) shall be electronically interlocked to provide time delay and starting sequence as indicated on control drawings.
- 7. The chiller control panel shall utilize the following components to automatically take action to prevent unit shut down due to abnormal operating conditions which will perform as follows.
 - a. High pressure switch that is set to 20 psig (adjustable setting) lower than factory pressure switch that will automatically unload the compressor to help prevent a high pressure condenser control trip. One switch is required for each compressor and indicating light shall also be provided.
 - b. Motor surge pressure that is set at 95% of compressor RLA that will automatically unload the compressor to prevent an over current trip. One protector is required for each compressor and indicating light shall also be provided.
 - c. Low pressure switch that is set at 5 PSIG above the factory low pressure switch that will automatically unload the compressor to help prevent a low evaporator temperature trip. One switch is required for each compressor and indicating light shall also be provided.
 - d. In all the above cases, the chiller will continue to run, in an unloaded state and will continue to produce some chilled water in an attempt to meet the cooling load. However, if the chiller reaches the trip-out limits, the chiller controls will take the chiller off line for protection, and a manual reset is required. Once the "near trip" condition is corrected, the chiller will return to normal operation and can then produce full load cooling.
- 8. With variation of +/-10% of design flow per minute, chiller shall be able to maintain +/-0.5 degrees F leaving water temperature control. The chiller must be able to withstand a +/- 30% change in flow rate per minute without unit trip. Variations in the primary flow allow for optimal system efficiency, but the chiller must be able to maintain temperature control to help ensure occupant comfort.
- 9. The chiller control panel shall provide +/-0.5 degrees F leaving water temperature control during normal operation. The chiller shall provide multiple steps leaving chilled water temperature controller to minimize part load energy use and optimize leaving chilled water temperature control. If manufacturer is unable to provide at least several steps of unloading, hot gas bypass shall be required to minimize loss of leaving water temperature control.
- 10. The chiller control panel shall provide a 2-minute stop-to-start and 5 minute start-to-start solid state timer. If the anti-recycle timers are longer than 5 minutes, then hot-gas bypass shall be provided to limit loss of leaving chilled water temperature control in low-load conditions.

- P. Motor: Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION. Compressor motor furnished with the chiller shall be in accordance with the chiller manufacturer and the electrical specification Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT. Starting torque of the motor shall be suitable for the driven chiller machine.

Q.

2.2 REFRIGERANT MONITORING AND SAFETY EQUIPMENT

- A. General: Provide refrigerant monitoring sensor/alarm system and safety equipment as specified here. Refrigerant sensor and alarm system shall comply with ASHRAE Standard 15.
- B. Refrigerant monitor shall continuously display the specific gas (refrigerant used) concentration; shall be capable of indicating, alarming and shutting down equipment; and automatically activating ventilation system. On leak detection by refrigerant sensor(s), the following shall occur:
1. Activate machinery (chiller) room ventilation.
 2. Activate visual and audio alarm inside and outside of machinery room, with beacon light(s) and horn sounds equipment room and outside equipment room door(s). Shut down combustion process where combustion equipment is employed in the machinery room.
 3. Notify Engineering Control Center (ECC) of the alarm condition.
- C. Refrigerant monitor shall be capable of detecting concentration of 1 part per million (ppm) for low-level detection and for insuring the safety of operators. It shall be supplied factory-calibrated for the apparent refrigerant.
- D. Monitor design and construction shall be compatible with temperature, humidity, barometric pressure, and voltage fluctuations of the machinery room operating environment.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, piping and electrical to verify actual locations and sizes before chiller installation and other conditions that might affect chiller performance, maintenance, and operation.
- B. Equipment locations shown on drawings are approximate. Determine exact locations before proceeding with installation.

3.2 EQUIPMENT INSTALLATION

- A. Install chiller on concrete base with isolation pads or vibration isolators.
1. Concrete base is specified in Section 03 30 00, CAST-IN-PLACE CONCRETE

2. Vibration isolator types and installation requirements are specified in Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT
 3. Anchor chiller to concrete base according to manufacturer's written instructions and for seismic restraint on vibration isolators.
 4. Charge the chiller with refrigerant, if not factory charged.
 5. Install accessories and any other equipment furnished loose by the manufacturer, including remote starter, remote control panel, and remote flow switches, according to the manufacturer written instructions and electrical requirements.
 6. Chillers shall be installed in a manner as to provide easy access for tube pull and removal of compressor and motors etc.
- B. Install refrigerant monitoring and safety equipment in accordance with ASHRAE Standard 15.
- C. Install thermometers and gages as recommended by the manufacturer and/or as shown on drawings.
- D. Piping Connections:
1. Make piping connections to the chiller for chilled water, condenser water, and other connections as necessary for proper operation and maintenance of the equipment.
 2. Make equipment connections with flanges and couplings for easy removal and replacement of equipment from the equipment room.
 3. Extend vent piping from the relief valve and purge system to the outside.

3.3 STARTUP AND TESTING

- A. Engage manufacturer's factory-trained representative to perform startup and testing service.
- B. Inspect, equipment installation, including field-assembled components, and piping and electrical connections.
- C. After complete installation startup checks, according to the manufacturers written instructions, do the following to demonstrate to the VA that the equipment operate and perform as intended.
1. Check refrigerant charge is sufficient and chiller has been tested for refrigerant leak.
 2. Verify proper motor rotation.
 3. Verify pumps associated with chillers are installed and operational.
 4. Verify thermometers and gages are installed.
 5. Verify automatic tube cleaning system is installed and functional.

6. Operate chiller for run-in-period in accordance with the manufacturer's instruction and observe its performance.
 7. Check and record refrigerant pressure, water flow, water temperature, and power consumption of the chiller.
 8. Test and adjust all controls and safeties. Replace or correct all malfunctioning controls, safeties and equipment as soon as possible to avoid any delay in the use of the equipment.
 9. Prepare a written report outlining the results of tests and inspections, and submit it to the VA.
- D. Engage manufacturer's certified factory trained representative to provide training for 16 hours for the VA maintenance and operational personnel to adjust, operate and maintain equipment, including self-contained breathing apparatus.

END OF SECTION 23 64 00