

SECTION 236416.16 - AGILITY CENTRIFUGAL WATER-COOLED CHILLERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Semi-hermetic, direct drive, multi-stage, water-cooled centrifugal chiller with single compressor.

1.2 SUBMITTAL

- A. Acceptable refrigerants on which chiller performance is based are R-513A or any refrigerant that has a GWP less than 700. All proposals for chiller performance must include an AHRI approved selection for the specified refrigerants.
- B. Submit drawings indicating assembled dimensions, operating weight, load distribution, and required service and access clearances.
- C. Submit product data indicating options and specialties, electrical requirements, and wiring diagrams and connections. Indicate accessories, valves, strainers, and thermostatic valves required for the complete system.
- D. Submit rigging, installation, and startup procedures. Include operations and maintenance data for both the chiller and starter or variable-speed drive. Include location, size, and type of field piping connections.
- E. Submit performance data indicating energy input versus cooling load output from 100 to 25 percent of full load with constant entering condenser water temperature.

1.3 REGULATORY REQUIREMENTS

- A. Conform to AHRI Standard 550/590 code for rating and testing of water chillers.
- B. Conform to UL 60335 2-40 - Standard for Heating and Cooling Equipment, Safety Standard. In the event the unit is not UL approved, the manufacturer shall, at manufacturer expense, provide for a field inspection by an UL representative to verify conformance to UL standards. If necessary, contractor shall perform modifications to the unit to comply with UL, as directed by the UL representative.
- C. Conform to ANSI/ASME SECTION VIII Boiler and Pressure Vessel Code for construction and testing of centrifugal chillers as applicable.
- D. Conform to latest revision of ANSI/ASHRAE STANDARD 15 code for construction and operation of centrifugal chillers.
- E. Unit shall bear the AHRI Certification Label for the specific type of water chiller as applicable.
- F. Chiller manufacturer shall provide LEED-NC EA Credit 4. Calculation for each chiller shall be based on the factors as specified by the U.S. Green Building Council based upon equipment life of 25 years:

- G. Chiller must be Environmental Product Declaration (EPD) certified. An Environmental Product Declaration (EPD) is a comprehensive, internationally harmonized report created by a product manufacturer that documents the ways in which a product, throughout its lifecycle, affects the environment. Underwriter's Laboratories certifies that all information in the EPD is accurate.
- H. The chiller shall comply with ASHRAE 90.1 2022 minimum efficiency requirements for energy efficiency.

1.4 DELIVERY AND HANDLING

- A. Comply with manufacturer's installation instructions for rigging, chiller loading, local transportation requirements, unloading, storage, and final setting.
- B. Protect chiller and controls from physical damage. Leave factory shipping covers in place until installation. The entire unit must be shrink wrapped with an environmentally recyclable material standard. The material shall include an imbedded desiccant to minimize/eliminate internal moisture

1.5 WARRANTY

- A. Provide a standard unit parts and labor warranty for one year from startup or 18 months from factory shipment, whichever occurs first.
- B. A quote for a 10-year parts, labor, and refrigerant quality warranty covering all chiller components, to include starter and drive, must be supplied by the manufacturer to provide a comparative value of confidence in reliability. This quote must be of the manufacturer's warranty; third party insurance/warranty quotes are not acceptable.
- C. Chiller manufacturer shall provide whole unit parts, whole unit labor, and refrigerant quality warranties for a period of 10 years from start-up. The warranty must be provided by the manufacturer; third party insurance/warranty coverage is not acceptable. The chiller manufacturer shall provide an original factory warranty certificate for each chiller listing as a minimum chiller model, serial number, and warranty information as specified. Payment shall not be released until the owner receives original certificates. Warranty coverage is per the factory, not local sales offices. Validated service and scheduled maintenance performed by acceptable servicing companies per manufacturer required.

1.6 MAINTENANCE SERVICE

- A. All inspections and service of units shall be accomplished by factory trained and authorized servicing technicians.
- B. All labor for leak checking the chiller according to the manufacturer's IOM and documentation must be included.
- C. In conjunction with and supporting Factory warranty OEM shall furnish complete factory authorized service and maintenance of Applied Chillers for XX years from Date of Substantial Completion. All work shall be done by manufacturer's commercial warranty agent.
- D. OEM shall provide and report quarterly, semiannual, and annual maintenance in compliance with or better than ASHRAE Standard 180-2008.

- E. Include maintenance items as recommended in manufacturer's operating and maintenance data.
- F. Submit copy of service call work orders and summary report to the Owner, including description of work performed, operating performance status and noted exceptions.

1.7 VERIFICATION OF CAPACITY AND EFFICIENCY

- A. All proposals for chiller performance must include an AHRI approved selection method. Verification of date and version of computer program selection or catalog is available through AHRI.
- B. Performance Tolerances:
 - 1. The following allowable tolerances must be followed:
 - a. The tolerance on allowable capacity must be as defined by AHRI Standard 550/590.
 - b. The IPLV/NPLV and full load tolerances are as defined by AHRI Standard 550/590, and the tolerances at full load and all part load test points must also be as defined by AHRI Standard 550/590 if applicable.

PART 2 - PRODUCTS

2.1 SUMMARY

- A. Description: Factory-assembled and tested water chiller complete with compressor, evaporator, condenser, controls, variable speed drive, interconnecting unit piping and wiring, indicating accessories, and mounting frame. Performance shall be per specification section 3.03 schedule
- B. The contractor shall furnish and install centrifugal water chillers as shown and scheduled in the plans and specifications. The units shall produce the specified tonnage per the scheduled data in accordance with the latest revision of AHRI 550/590. The unit shall bear the AHRI certification label as applicable.
- C. Base bid shall be Trane Agility chiller with approved alternate being [York, Daikin, Carrier]. Job awarded on basis of specified machine. Alternate will be considered after the job is awarded.
- D. Chiller shall be as manufactured by Trane.
- E. Unit shall be painted in accordance with the manufacturer's standard procedures and practices.
- F. Chiller shall be equipped with bolt together construction to allow for quick disassembly and reassembly.
- G. Unit shall include ice making option that allows for lower evaporator leaving solution temperatures.

2.2 COMPRESSOR AND MOTOR

- A. The compressor shall be centrifugal with multiple stages.
- B. Chiller should be able to unload to 100.00 % of design tonnage with constant entering water temperature. The machine shall be modified to include hot gas bypass if the minimum load cannot be met
- C. If magnetic bearings are used, the chiller must provide backup power to the magnetic bearings with a UPS system that provides power conditioning, to completely isolate the magnetic bearing system from utility power, enabling error-free operation during surges, sags, spikes, and other power anomalies. The on-board UPS system shall keep the controller powered for 1 minute during the power outage in order to allow for rapid restart after a power outage. If capacitor backup is to be used, additional warranty must be carried.
- D. The motor shall be hermetic and either suction, interstage, or liquid refrigerant cooled. Hot gas motor cooling is not acceptable. If an open motor design is used, then the manufacturer shall provide and install a complete chilled water AHU with a capacity equal to 0.9% of the chiller's tonnage to serve the chiller area, which must be completely operational and include all wiring and automatic temperature controls. The open motor chiller manufacturer must also increase chiller size by an equivalent tonnage with no increase in specified full load kW, and shall list, on the submittal, additional maintenance requirements due to alignment, refrigerant shaft seal, coupling and bearings. Additionally, if an open drive motor is provided, a motor-compressor shaft seal leakage containment system shall be provided with the following inclusions:
 - 1. An oil reservoir shall collect any oil and refrigerant that leaks past the seal.
 - 2. A float device shall be provided to open when the reservoir is full, directing the refrigerant/oil mixture back into the compressor housing.
 - 3. Manufacturer shall warrant the shaft seal, reservoir, and float valve system against leakage of oil and refrigerant to the outside of the chiller for a period of 10 years from initial start-up, including parts and labor to replace a defective seal and any refrigerant required to trim the charge to original specifications. Inspections shall be performed a minimum of once a year. See Section 1.05 for more information in warranty.
- E. The impellers shall be fully shrouded and made of a high strength aluminum alloy.

2.3 EVAPORATOR AND CONDENSER

- A. The evaporator and condenser shall be built in accordance with ANSI/ASHRAE 15 Safety Code for Mechanical Refrigeration and ASME section VIII as applicable.
- B. The evaporator tubes shall be internally and externally enhanced with a 0.75" outer diameter. The tubes shall be securely supported at intermediate supports and physically expanded into both ends of the tube sheets.
- C. The condenser tubes shall be internally and externally enhanced with a 0.75" outer diameter. The tubes shall be securely supported at intermediate supports and physically expanded into both ends of the tube sheets.
- D. The evaporator tubes must be removable from both ends to provide easy access for tube cleaning. The minimum evaporator tube wall thickness, root-to-root across the entire tube length shall be 0.025".

- E. The minimum condenser tube wall thickness, root-to-root across the entire tube length shall be 0.028".
- F. The evaporator water piping connections shall be Victaulic.
- G. The condenser water piping connections shall be Victaulic.
- H. Provide evaporator water box designed for 150 psig maximum waterside working pressure. Waterside shall be hydrostatically tested at 1.5 times design working pressure.
- I. Provide condenser water box designed for 150 psig maximum waterside working pressure. Waterside shall be hydrostatically tested at 1.5 times design working pressure.
- J. The evaporator and condenser shall both have a flow turndown of XX:YY
- K. The evaporator water boxes shall be standard non-marine type with connections per the schedule.
- L. The condenser water boxes shall be standard non-marine type with connections per the schedule.
- M. Insulation will be 3/4" insulation and cover all low-temperature surfaces to include the evaporator, water boxes, suction elbow, and economizer if applicable
- N. Units with multi-stage compressors shall incorporate an interstage 'economizer'. All units with single stage compressors shall have the condensers circuited for liquid subcooling and controlled through the use of condenser liquid level control
- O. Adjustable or float type refrigerant metering devices and thermal expansion valves (TXV) shall be inspected and adjusted by the manufacturer annually for the first five years of operation to assure equivalent reliability to an electronic expansion valve (EXV) system. A written report shall be forwarded to the owner each year over the first five years to confirm completion of calibration.

2.4 REFRIGERANT CIRCUIT

- A. All units shall have 1 refrigerant circuit with a single compressor. If manifolded compressors are provided, then individual compressor warranties must be provided for each compressor motor.
- B. An electronically controlled expansion valve (EXV) is provided to maintain proper refrigerant flow.

2.5 CONTROLS

- A. The chiller shall be controlled by a unit mounted, stand-alone Direct Digital Control (DDC) system. A dedicated chiller microprocessor control panel is to be supplied with each chiller by the chiller manufacturer.
- B. Enclosure shall be unit mounted NEMA 250 Type 1.
- C. A color, touch sensitive liquid crystal display (LCD) shall be unit mounted and a minimum of 12.1" diagonal. The display shall be fully adjustable in height and viewing angle. Animated

graphical representations of chiller subsystem operation shall be used to enhance the user interface.

- D. Display shall consist of a menu driven interface with easy touch screen navigation to organized sub-system reports for compressor, evaporator, condenser and motor information as well as associated diagnostics. The controller shall display all active diagnostics and a minimum of 20 historical diagnostics. Touch-screen display shows data in either inches and pounds (I-P) or standard international (SI) units, and in one of twenty-seven available languages. Animated color graphics indicate the status of the chiller. User IDs and passwords allow for additional security for different levels of user access. Chiller controls shall unload chiller automatically to prevent it from exceeding its limits and to keep the chiller online under the following conditions: (a) the condenser pressures at or near the high condenser limit setting; (b) the saturated evaporator temperatures at or near the low refrigerant temperature cutout setting; (c) the variable frequency drive heat sink temperature at or near cutout temperature
- E. Control authority must be capable of handling at least four conditions: Off, local manual at the chiller, local automatic at the chiller and automatic control through a remote source.
- F. Capability to connect a laptop to service utility with applicable software from manufacturer and obtain enhanced set-up and diagnostics.
- G. The front of the chiller control panel shall display the following in clear language, without the use of codes, look-up tables, or gauges:
 - 1. Run time
 - 2. Number of starts
 - 3. Current chiller operating mode
 - 4. Chilled water set point and set point source
 - 5. Electrical current limit set point and set point source
 - 6. Entering and leaving evaporator water temperatures
 - 7. Entering and leaving condenser water temperatures
 - 8. Saturated evaporator and condenser refrigerant temperatures
 - 9. Evaporator and condenser refrigerant pressure
 - 10. Compressor motor current per phase
 - 11. Compressor motor percent RLA
 - 12. kW energy consumption and power factor
 - 13. Compressor motor winding temperatures per phase
- H. The chiller control panel shall provide password protection of all setpoints.
- I. The chiller control panel shall provide individual relay outputs to start/stop the evaporator and condenser water pumps. The condenser water pump relay output can be used to enable the cooling tower temperature controls.
- J. The chiller control panel shall provide leaving chilled water temperature reset based upon return water temperature.
- K. The chiller control panel shall be capable of displaying system data in I-P or SI units.
- L. The chiller manufacturer shall include a pressure, non-mechanical based unit mounted flow switch that is of the thermal dispersion type for the condenser to verify flow through the unit.
- M. The chiller manufacturer shall include a pressure, non-mechanical based unit mounted flow switch that is of the thermal dispersion type for the evaporator to verify flow through the unit.

- N. Safeties - the chiller control panel shall provide the following safeties:
1. Low chilled water temperature
 2. Low evaporator refrigerant temperature or pressure
 3. High condenser refrigerant pressure
 4. Evaporator and condenser water flow status
 5. High motor winding temperatures
 6. High motor current
 7. AFD function faults
 8. Sensor faults
 9. Unit controls operation
 10. The chiller control panel or starter shall incorporate advanced motor protection to safeguard the motor throughout the starting and running cycles from the adverse effects of:
 - a. Current phase loss
 - b. Current phase unbalance
 - c. Current phase reversal
 - d. Under/Over voltage
 - e. Motor current overload
 - f. Distribution fault protection with auto restart consisting of three-phase current sensing devices that monitor the status of the current
 - g. AFD communication-control failure
- O. The chiller control panel shall be capable of providing short cycling protection.
- P. The chilled water controller of each chiller shall include variable water-flow capability to allow the chiller to respond quickly to accelerating or decelerating water, and have the following features:
1. It shall allow control of the leaving chilled water temperature to within $\pm 1.0^{\circ}\text{F}$ (0.3°C) at a water flow rate change of 10% per minute and will stay online at a water flow rate change of 30% per minute.
- Q. The chiller, upon power loss restoration, must be able to start the compressor within 45 seconds. The chiller time to load up to 80% shall be no longer than 180 seconds from compressor restart.
- R. The chiller control panel shall provide a relay output that shall energize whenever the compressor is running.
- S. The chiller control panel shall provide an alarm relay output that shall energize whenever a fault requiring manual reset is detected by the panel.
- T. The chiller control panel shall provide a relay output that shall energize whenever the chiller is operating at maximum capacity.
- U. The chiller control panel shall provide a head relief request relay output to indicate that the chiller is in condenser limit mode and thereby requesting condenser water temperature relief.
- V. The chiller control panel shall provide an analog [2 - 10VDC] [4 - 20mA] output signal that shall indicate the Compressor Motor Percent RLA.

- W. The chiller control panel shall allow for an analog input for a chilled water setpoint and an electrical current limit set point. These setpoints can be in the form of 4-20 mA or 2-10 Vdc signals from a remote source (i.e. generic building automation system).
- X. The chiller control panel shall provide an analog output signal that shall indicate the condenser refrigerant pressure or condenser/evaporator differential refrigerant pressure.
- Y. The chiller controller must be able to communicate directly to a building automation system using BACnet protocol (MSTP-RS 485/IP).

2.6 VARIABLE SPEED DRIVE (VSD), UNIT MOUNTED

- A. The water chiller shall be furnished with an variable speed drive (VSD) as shown on the drawings. The VSD shall be factory mounted on the chiller and shipped completely factory assembled, wired and tested. The VSD shall be refrigerant cooled or glycol/air cooled. If a condenser water-cooled VSD is supplied, the manufacturer shall supply factory installed dual water filters with a bypass valve and pressure differential switch factory wired to the chiller control panel to indicate that a filter has clogged and requires service. The pressure differential switch shall also provide a separate dry contact which can be connected to the BAS system as a means of notifying operating personnel of the need to service the filters. If the condenser cooling circuit includes an intermediate heat exchanger, it must be of the brush cleanable shell and tube style. Braze plate heat exchangers which cannot be field cleaned are not acceptable.
- B. The VSD will be specifically designed to interface with the centrifugal water chiller controls and allow for the operating ranges and specific characteristics of the chiller. The VSD control logic shall optimize chiller efficiency by coordinating compressor motor speed and compressor inlet guide vane position to maintain the chilled water setpoint while avoiding surge. If a surge is detected, VSD surge avoidance logic will make adjustments to move away from and avoid surge at similar conditions in the future.
- C. The VSD efficiency shall be 97% or better at full speed and full load. Fundamental displacement power factor shall be a minimum of 0.96 at all loads.
- D. The VSD shall be solid state, microprocessor based pulse-width modulated (PWM) design. The VSD shall be voltage and current regulated. Output power devices shall be IGBTs.
- E. Power semi-conductor and capacitor cooling shall be from a combination of liquid cooled heatsink and air flow.
- F. The VSDs shall each be furnished in a metal enclosure having as minimum a short circuit withstand rating of 65,000 amps per UL 508A. It will include three phase input lugs plus a grounding lug for electrical connections, output motor connection via factory installed bus bars and all components properly segregated and completely enclosed in a single metal enclosure.
 - 1. Enclosure shall include a padlockable, door-mounted circuit breaker with a minimum AIC rating of 65,000 amps.
 - 2. The entire chiller package shall be UL/CUL listed.
- G. The VSD panel shall be tested to ANSI/UL Standard 508A and shall be listed by a Nationally Recognized Testing Laboratory (NRTL) as designated by OSHA.
- H. Input shall be nominal 480. V, three phase, 60. Hz AC power.

- I. Line voltage tolerance +/-10% and line frequency tolerance +/-1%.
- J. The VSD shall include the following features:
 - 1. All control circuit voltages are physically and electrically isolated from power circuit voltage.
 - 2. Soft start, adjustable linear acceleration, controlled ramp-down to stop.
 - 3. Insensitivity to incoming power phase sequence.
 - 4. Adjustable current limiting and U.L. approved electronic motor overload protection.
 - 5. Output line-to-line short circuit protection.
 - 6. Line-to-ground short circuit protection.
 - 7. Protection from phase loss at AFD input.
 - 8. Protection from output phase reversal/imbalance.
 - 9. Protection from over/under-voltage.
 - 10. Protection from over-temperature.
- K. The following VSD status indicators shall be available to the unit controller to facilitate startup and maintenance:
 - 1. DC Bus voltage.
 - 2. Output/load amps.
 - 3. Fault.
- L. Service Conditions:
 - 1. Operating ambient temperature of 14°F - 104°F (-10°C - 40°C).
 - 2. Room ambient up to 95% relative humidity.
 - 3. Elevation to 3300 feet (1000 meters). For every 300 feet (90 meters) above 3300 feet, the rated output current shall be decreased by 4% up to 9900 feet.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide for connection to electrical service. If oil pump is electric include the connection of the electrical to the oil pump.
- C. Provide elastomeric isolation pads to reduce vibration transmission.
- D. On units without unit mounted starters provide for connection of electrical wiring between starter and chiller control panel, oil pump, and purge unit.
- E. Furnish and install necessary auxiliary water piping for oil cooling units and purge condensers.
- F. Arrange piping for easy dismantling to permit tube cleaning.
- G. Provide piping from chiller relief valve to outdoors. Size as recommended by manufacturer.

3.2 MANUFACTURER'S FIELD SERVICES

- A. All Startup, functions shall be performed by a manufacturer's commercial agent to confirm (in writing) that equipment has been correctly installed and passes specification checklist prior to equipment becoming operational and covered under OEM warranty.
 - 1. Included OEM Factory Startup:
 - a. Centrifugal, Rotary Screw, Scroll Chillers
- B. Applied Chiller manufacturers shall maintain service capabilities no more than [100] [250] miles from the jobsite.
- C. The manufacturer shall furnish an alternative price for [1] [5] [10] years.
- D. The manufacturer shall furnish complete submittal wiring diagrams of the package unit as applicable for field maintenance and service.

END OF SECTION 236416.16