**SECTION 23 64 16.16**
**Water-Cooled Centrifugal Water Chillers**

## PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Semi-hermetic, water-cooled, direct-drive centrifugal chillers that shall use HFO-514A.

1.02 SUBMITTALS

A. Acceptable refrigerants on which chiller performance is based are HFO-514A and HFO-513A. All proposals for chiller performance must include an AHRI approved selection method 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.

F. Submit compressor and product data in table form indicating impeller speed (RPM), number of bearings, type of bearings, high speed impeller shaft RPM, sound pressure level per AHRI 575-2008 (dB), number of stages, number of sets of inlet guide vanes, amount of refrigerant charge (lb), and amount of oil required (gal).

1.03 REGULATORY REQUIREMENTS

A. Conform to AHRI Standard 550/590 code for rating and testing of water chillers.

B. Conform to UL 1995 for Safety for Heating and Cooling Equipment.

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 Calculation for each chiller utilizing the following factors as specified by the U.S. Green Building Council based upon equipment life of 25 years:

1. Next Generation Refrigerants

| | R-513A Chillers | R-514A Chillers |
|---|---|---|
| **ODP** | 1 | 1 |
| **GWP** | 573 | 1.75 |
| **Annual Leakage Rate** | 2.0% | 2.0% |
| **End of Life Ref. Loss** | 10% | 10% |

2. Chiller must ship with low-GWP, next generation refrigerant such as R-513A or R-514A.

1.04 DELIVERY, STORAGE, HANDLING AND EQUIPMENT ROOM REQUIREMENTS

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.

C. The chiller shall ship with a dry nitrogen charge to eliminate potential charge loss during delivery and construction. The refrigerant must be shipped separately from the chiller. The refrigerant monitoring system shall be active at the job site prior to the charging of the chiller.

D. The chiller should ship with a full charge of oil.

E. Equipment Room Requirements

1. Follow minimum standards for refrigeration systems as required by the latest revision of ANSI/ASHRAE Standard 15, paying special attention to requirements for air monitoring, ventilation, self-contained breathing apparatus, and leak detection to assure the safety of chiller plant operating personnel.

2. Install proper outside exhaust of chiller refrigerant relief device(s), discharge header(s), and purge unit(s). Route exhaust to the outside of the building and away from all air intakes in compliance with the latest revision of ANSI/ASHRAE Standard 15.

3. Per ASHRAE Standard 147, medium pressure units with relief valves only shall have rupture discs in series with relief valves to minimize refrigerant leakage.
4. Field-install as required a refrigerant monitor that can be calibrated for appropriate refrigerant(s), capable of detecting concentrations of minimum ppm for low-level leak detection to assure the safety of chiller plant operating personnel.
5. Field-install as required suitable audible and visual alarms that activate well below the Acceptable Exposure Level (AEL) of the specific refrigerant(s) to alert persons inside and outside of the equipment room that a refrigerant leak condition exists.
6. Storage: Per ASHRAE Standard 147, positive pressure units must have a pumpdown capability that isolates the refrigerant charge for storage in a suitable vessel. If pump down capability does not exist, then the charge must be removed during long idle periods.

1.05 WARRANTY

A. Provide a standard unit parts and labor warranty for one year from startup or 18 months from shipment, whichever occurs first.

1.06 MAINTENANCE SERVICES

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 for applied chillers for XX year(s) from the 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.

1.07 VERIFICATION OF CAPACITY AND EFFICIENCY

A. 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

### 2.01 SUMMARY

A. Description: Factory-assembled and tested water chiller complete with compressor, evaporator, condenser, controls, starter or variable frequency 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 CenTraVac™ 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. Unit shall be painted in accordance with the manufacturer's standard procedures and practices.

### 2.02 COMPRESSOR AND MOTOR

A. The compressor shall be centrifugal with single or multiple stages.

B. Low or medium pressure refrigerant machines shall be provided when available.

C. Chiller should be able to unload to 25% of design tonnage with constant entering water temperature. The minimum unloading point shall be able to be demonstrated if a factory performance test is required. The machine shall be modified to include hot gas bypass if the minimum load cannot be met.

D. Compressor assembly shall be vibration tested at the factory. Vibration shall not exceed 0.15 inches per second at full load design compressor speed as measured on the motor housing. The test data shall be recorded and provided to the customer for approval.

E. The motor shall be hermetic and either suction or liquid refrigerant cooled. Hot gas motor cooling is not acceptable.

F. If an open motor design is used, then the manufacturer shall provide and install a complete chilled water air handling unit (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.

G. Motors shall have winding 100 ohm platinum RTDs for temperature sensing on each phase. Thermistors and thermal overloads are not acceptable. These temperatures shall be furnished to the unit control panel for monitoring and alarm.

H. Manufacturers with speed increasing transmissions shall not exceed 10,000 RPM compressor speeds and shall annually inspect the gears and all bearings. A report shall be forwarded to the owner each year over the first five years to confirm completion.

I. If the manufacturer uses electronic (i.e. magnetic) bearings a 10 year warranty on all chiller compressor capacitors must be provided

J. The impellers shall be fully shrouded and made of a high strength aluminum alloy. Impellers shall be dynamically balanced and over-speed tested at 1.25 times impeller shaft speed.

2.03 EVAPORATOR (CHILLER BARREL)

A. The evaporator and condenser shall be built in accordance with ANSI/ASHRAE 15-2001 Safety Code for Mechanical Refrigeration and ASME section VIII as applicable.

B. 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. The evaporator tubes must also be removable from both ends to provide easy access for tube cleaning.

   1. The minimum evaporator tube wall thickness, root-to-root across the entire tube length shall be 0.025". It is unacceptable to provide this thickness at the intermediate supports only.

C. The evaporator water piping connections shall be grooved.

D. The evaporator waterboxes shall be standard non-marine type with connections per the schedule.

E. Supply and return head waterboxes shall be designed for a working pressure of 150 psi and shall be factory hydrostatic pressure tested at 150 percent of the design pressure. Provide drain and vent connections in water boxes.

F. No unit insulation is required at the time the chiller is shipped from the factory.

G. Units with multi-stage compressors shall incorporate an interstage flash vessel "economizer". All units with single stage compressors shall have the condensers circuited for liquid subcooling and be provided with a thermometer well to monitor the amount of subcooling.

H. Adjustable or float type refrigerant metering devices and thermal expansion valves shall be inspected and adjusted by the manufacturer at the end of each year for the first five years of operation to assure equivalent reliability and maintenance to a fixed orifice system. A written report shall be forwarded to the owner each year to confirm completion.

2.04 CONDENSER

A. The condenser shall be built in accordance with ANSI/ASHRAE 15-2001 Safety Code for Mechanical Refrigeration and ASME section VIII as applicable.

B. 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. The condenser tubes must also be removable from both ends to provide easy access for tube changeouts or tube cleaning.

1. The minimum condenser tube wall thickness, root-to-root across the entire tube length shall be 0.028". It is unacceptable to provide this thickness at the intermediate supports only.

C. The condenser water piping connections shall be grooved.

D. The condenser waterboxes shall be standard non-marine type with connections per schedule.

E. Supply and return head waterboxes shall be designed for a working pressure of 150 psi and shall be factory hydrostatic pressure tested at 150 percent of the design pressure. Provide drain and vent connections in water boxes.

2.05 REFRIGERANT

A. Acceptable Refrigerants on which chiller performance is based are low-GWP, next generation refrigerants such as R-513A or R-514A.

B. Refrigeration Transfer: Provide service valves and other factory-installed accessories required to facilitate transfer of refrigerant from the chiller to remote systems.

1. See Section 1.04 for additional details on refrigerant shipment.

C. Refrigerant Flow Control: Fixed orifice plates at the entrance and exit of the economizer shall be used to control refrigerant flow.

D. Low pressure chillers: Chillers that operate at low pressures must have a high efficiency purge system to ensure that any potential non-condensable leakage into the vessel is immediately eliminated. The purge run time shall be monitored by the main unit controller to act as a leak detector if required, and must have the following specifications:

1. The manufacturers of low pressure machines must provide a purge system. Acceptable purges are the Trane EarthWise Purge.
2. The purge efficiency must meet ASHRAE Standard 147-2002.
3. The purge shall be capable of operating when the chiller is idle in accordance with ASHRAE Standard 147-2002.

2.06 ELECTRICAL

A. Provide remote mounted Wye-Delta Starter with Circuit breaker.

B. Chiller shall be installed, wired, and functionally tested at the factory before being shipped.

C. Single point power connection - A control power transformer internal to the motor controller/frequency drive and of sufficient size to power all chiller mounted auxiliary loads

shall be supplied. No separate power connection shall be required for chiller mounted equipment. The CPT shall tap from the main power connection.

D. Terminal blocks are numbered to match the wiring diagram must be included.

2.07 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. The chiller manufacturer shall include a pressure, non-mechanical based flow switch that is of the thermal dispersion type for each evaporator and condenser to verify flow through the unit.

D. 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.

E. Display shall consist of a menu driven interface with easy touch screen navigation to organized sub-system reports for compressor, evaporator, condenser, purge and motor information as well as associated diagnostics. The controller shall display all active diagnostics and a minimum of 20 historical diagnostics.

F. The chiller control panel shall provide control of chiller operation and monitoring of chiller modules, sensors, actuators, relays and switches. The chiller control panel shall include controls to safely and efficiently operate the chiller.

G. 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.

H. Capability to connect a laptop to service utility with applicable software from manufacturer and obtain enhanced set-up and diagnostics.

I. 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. Oil tank temperature.
11. Oil tank pressure.
12. Oil pump discharge pressure.
13. Differential oil pressure.
14. Compressor motor current per phase.
15. Compressor motor percent RLA.
16. Compressor motor voltage per phase.
17. kW energy consumption and power factor.
18. Compressor motor winding temperatures per phase.
19. Purge operating mode.
20. Purge operating status.
21. Time until next purge run.
22. Daily pumpout - 24 hours.
23. Average daily pumpout - 7 Days.
24. Purge refrigerant compressor suction temp.
25. Purge liquid temp (chiller condenser saturated refrigerant temperature).
26. Daily pumpout limit/alarm.

J. The chiller control panel shall provide password protection of all setpoints.

K. The controller shall have the ability to display all primary sub-system operational parameters on dedicated trending graphs. The operator must be able to create up to 6 additional custom trend graphs, choosing up to 10 unique parameters for each graph to trend log data parameters simultaneously over an adjustable period and frequency polling.

L. 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.

M. The chiller control panel shall provide leaving chilled water temperature reset based upon return water temperature.

N. The chiller control panel shall be capable of displaying system data in I-P or SI units.

O. 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. Low oil pressure.
6. Low oil temperature.
7. High oil temperature.
8. High motor winding temperatures.
9. High motor current.
10. Starter/VFD function faults.
11. Sensor faults.
12. Unit controls operation.
13. 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. Starter contactor fault protection.
    h. Starter transition failure.

P. The chiller control panel shall provide evaporator freeze protection and low limit control to avoid low evaporator refrigerant temperature trip-outs during critical periods of chiller operation. Whenever this control is in effect, the controller shall indicate that the chiller is in adaptive mode. If the condition exists for more than 30 seconds, a limit warning alarm relay shall energize.

Q. The chiller control panel shall be capable of providing short cycling protection.

R. 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. The variable water-flow compensation capability shall allow control of the leaving chilled water temperature to within +/- 1.0°F (0.6°C) at a water flow rate change of 30% per minute and will stay online at a water flow rate change of 50% per minute.

S. The chiller control panel shall provide hardwire connections for the following binary and analog signals:

1. Compressor Running.
2. Detection by the panel of a fault requiring manual reset.
3. Chiller operation at maximum capacity.
4. Chiller operation in condenser limit mode and thereby requesting condenser water temperature relief.

T. The chiller controller shall communicate directly to Trane Tracer control panel

## PART 3 - EXECUTION

### 3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide for connection to electrical service. Include for connection of oil pump if required.

C. Provide for connection of electrical wiring between starter and chiller control panel, oil pump, and purge unit.

D. Furnish and install necessary auxiliary water piping for oil cooling units if required.

E. Arrange piping for easy dismantling to permit tube cleaning.

F. Provide piping from chiller relief device to outdoors. Size as recommended by manufacturer.

G. Chiller vibration isolation and the base type (i.e. floor pad) will be in accordance with ASHRAE Handbook, 1995, HVAC Applications, Chapter 43 Table 42.

### 3.02 MANUFACTURER'S FIELD SERVICES

A. All Startup, maintenance and monitoring 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.

B. Applied chiller manufacturers shall maintain service capabilities no more than XX miles from the job site.

1. EXECUTIVE COORDINATION - Prestart instructions and coordination is to be provided by senior lead technician or supervisor to:
    a. Review installation checklist with installing contractor.
    b. Review startup procedures and required support.
    c. Review training requirements, timing and logistics with the installing contractor.
2. STARTUP - Provide all labor and materials to perform the startup. This shall be done in strict accordance with manufacturer's specifications and requirements.
    a. Provide a complete log of all operating parameters.
    b. Assure actual performance matches with submittals and computerized selection programs for other than submittal conditions.
    c. Submit a hard copy of the service report and logs.

**END OF SECTION**