GUIDE SPECIFICATIONS –
ARCTIC-COOL WATER-COOLED CHILLERS

GENERAL

1.1 SUMMARY

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

1.2 REFERENCES

Compliance is with the following codes and standards:
AHRI 550/590
ANSI/ASHRAE 15
ASME Section VIII
ETL Listed
ANSI UL 1995
CSA C22.2 No. 236 (Canada)

1.3 SUBMITTALS

Submittals shall include the following:

A. Dimensioned plan and elevation drawings, including required service clearances and location of all field piping and electrical connections.

B. Electrical and water quality requirements during operation, standby and shutdown.

C. Control system diagram showing points for field interface and connection to external BMS systems. Drawings shall show field and factory wiring.

D. Installation and Operating Manuals.

E. Manufacturers certified performance data as per AHRI at full load and IPLV or NPLV.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Compliance with the standards in Section 1.2.

1.5 DELIVERY AND HANDLING

A. Chillers shall be delivered to the job site completely assembled (unless otherwise specified).

B. Compliance with the manufacturer’s instructions for transportation and rigging.

1.6 WARRANTY and MAINTENANCE

A. The chiller manufacturer’s warranty shall be for a period of one year from date of equipment start up or 18 months from the date of shipment, whichever occurs first.

B. The warranty shall include parts and labor costs for the repair or replacement of parts found to be

defective in material or workmanship.

C. Maintenance of the chiller equipment while under warranty is mandatory and shall be the responsibility of the purchaser. Local factory-certified service contractors are available in most localities for assistance as necessary.

Optional:

1. Extended chiller parts and labor warranty.

2. 2-5-year compressor parts.

PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Arctic-Cool or approved equal by performance and number of Danfoss Turbocor compressors

B. Manufacturers must provide as a minimum the number of compressors indicated on schedule for maximum unloading and provide AHRI-Certified products only.

2.2 PRODUCT DESCRIPTION

A. Provide and install as shown on the plans, a factory assembled water-cooled packaged chiller.

B. Each unit shall include one or more Turbocor magnetic bearing and variable-speed centrifugal compressors. Integrated variable frequency drive shall operate with inlet guide vanes. Chillers shall operate with HCF-134a or other refrigerant not subject to phase-out by the Montreal Protocol and the U.S. EPA Phase-out schedule.

C. The compressor(s), evaporator, condenser, and expansion valve shall be configured to operate as a single refrigerant circuit unless otherwise specified. The chiller unit compressors shall be designed for mechanical and electrical isolation to facilitate service and removal.

2.3 DESIGN REQUIREMENTS

A. Unit shall consist of one or more magnetic bearing oil-free centrifugal compressors with integrated variable frequency drive, refrigerant flooded evaporator, water cooled condenser, and operating controls with equipment protection.

B. Performance: Refer to schedule for specific operating conditions.. All ratings are measured at standard AHRI entering condenser water temperatures and without utilizing hot gas bypass.

D. Chiller shall be equipped for single-point power connection, unless otherwise specified.

E. In order to allow for variable chilled water flow and to facilitate chilled water pump energy savings the evaporator shall be designed to allow the flow rate to be reduced to the minimum flow rate specified on each project performance selection..

F. The condenser shall be designed to allow the flow rate to be reduced to the minimum flow rate specified on each project performance selection, in order to allow for variable condenser water flow and to facilitate condenser water pump energy savings.

G. Minimum entering condenser water temperature shall be 11.1 °C (20°F) above the leaving chilled water temperature.. The chiller shall be designed to operate with condenser water temperature to the minimum conditions, independently of condenser water flow rate and chilled water flow rate.

H. Each compressor shall be electrically and mechanically isolated so that if a compressor fails or needs service, it can be serviced or removed from the chiller without disabling the other compressors or the chiller, and allowing the chiller to remain in operation with the other compressor(s) on-line.

I. The chiller shall be provided with at least the number of compressors shown on the schedule. Manufacturers bidding chillers with a lesser number of compressors than shown on the schedule or provided in this section, shall provide (2) chillers at half the scheduled capacity and flow rates. It will be the manufacturer's responsibility to coordinate space and piping requirements with the contractor.

K. Positive Pressure Operation - 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 shutdown.
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.

Optional:

1. Multiple point power connection, single point is standard.

2. Low profile designs with staggered or side-by-side, evaporator and condenser, based on capacity.

2.4 CHILLER COMPONENTS

A. Compressors:

1. Compressors shall be of semi-hermetic centrifugal design and operate oil-free with two-stages of compression, magnetic bearings, movable inlet guide vanes and integrated variable frequency drive system.

2. Automatically positioned and controlled inlet guide vanes shall operate with compressor speed controls.

3. The compressor shall be capable of coming to a controlled stop in the event of a power failure. The

unit shall be capable of initializing an automatic restart in the case of a power failure.

4. Each compressor shall have integrated microprocessor control capable of capacity and safety control.

5. Each compressor shall be installed with individual suction, discharge and motor cooling refrigerant line isolation valves. Chillers without discharge line isolation valves that rely on non-return valves in the discharge line for compressor removal shall not be accepted.

6. Each compressor shall have an individual disconnect switch. The compressor shall have mechanical and electrical isolation to allow the chiller to operate when a compressor is removed from the machine, on chillers that are provided with more than one compressor.

Optional:

1. EMI filters installed for each compressor.

2. Vibration isolation pads.

B. Evaporator:

1. The evaporator shall be shell-and-tube flooded type with refrigerant in the shell and water inside the tubes. Heat exchangers shall be designed, constructed, tested and stamped in accordance with the requirements of ASME Code, Section VIII Code Case 1518-5. Heat exchanger tubing shall have a copper wall thickness of 0.64 mm (0.025 in.). The water sides shall be designed for a minimum of 1000 kPa (145 psig) or as specified. The water connections for the evaporator and condenser shall be either grooved suitable for Victaulic couplings or flanged as detailed herein. Vents and drains shall be provided. The refrigerant side of each vessel shall bear the ASME Code stamp, code case section VIII. Vessels shall pass a test pressure of 1.1 times the working pressure but be not less than 689 kPa (100 psig). Provide intermediate tube supports spaced to enable equal liquid and gas flow across multiple compressor suction ports.

2. The evaporator shall be provided with spring loaded reseating-type pressure relief valves according to ASHRAE-15. Rupture disks are not acceptable.

3. To ensure effective liquid droplet removal, prevent liquid damage to compressors, and equalize suction pressure across evaporators with multiple compressors, a perforated plate designed for vapor disengagement shall be installed inside the evaporator above the tubing.

4. Tubes shall be individually replaceable and have internally and externally enhanced surfaces designed for refrigeration duty. Tubes shall have smooth full tube wall landings at the tube-sheet ends and at intermediate tube supports. Tubing without full wall thickness landings shall not be accepted. Tubes shall be mechanically roller expanded into steel tube sheets containing a minimum of three concentric grooves.

5. Minimum evaporator exiting water temperature shall be 3.3°C (38°F), unless otherwise specified and accepted by the chiller manufacturer.

6. Factory-mounted and wired water flow switches shall be provided on the evaporator in order to prevent unit operation with no water flowing through the heat exchangers.

Optional:

1. Available in 0.71 mm (0.028 in) and 0.89 mm (0.035 in) wall thicknesses.

2. Wall available in 90-10 cupro-nickel.

3. Marine water boxes.

4. Epoxy-coating of inside surfaces of water boxes and tube sheets.

5. Water side vessel design for of 2068 kPa (300 psi) operation.

6. Factory-installed ¾" insulation, (1 ½ inch optional), on evaporator, water boxes, suction piping, and compressor end-bell.

C. Condenser:

1. Condenser shall be shell-and-tube type with refrigerant in the shell and condenser water in the tubes. Heat exchangers shall be designed, constructed, tested and stamped in accordance with the requirements of the ASME Code, Section VIII Code Case 1518-5. They shall have a copper wall of 0.64 mm (0.025 in.) wall. The water circuit shall be designed for a minimum of 1000 kPa (145 psig) or as specified. The water connections for the evaporator and condenser shall be grooved suitable for Victaulic couplings or flanged. Vents and drains shall be provided. The refrigerant side of each vessel shall bear the ASME Code stamp, code case section VIII. Vessels shall pass a test pressure of 1.1 times the working pressure but not be less than 689 kPa (100 psig). Provide intermediate tube supports spaced to enable equal liquid and gas flow across multiple compressor suction ports.

2. The condenser shall be provided with dual relief valves equipped with a transfer valve so one valve can be removed for testing or replacement without loss of refrigerant or removal of refrigerant from the vessel. Rupture disks are not acceptable.

3. Tubes shall be individually replaceable and have internally and externally enhanced surfaces designed for refrigeration duty. Tubes shall have smooth full tube wall landings at the tube-sheet ends and at intermediate tube supports. Tubing without full wall thickness landings shall not be accepted. Tubes shall be mechanically roller expanded into steel tube sheets containing a minimum of three concentric grooves.

4. Minimum entering condenser water temperature shall be 11.1°C (20 °F) above leaving chilled water temperature.

5. Factory-mounted and wired water flow switches shall be provided on the condenser in order to prevent unit operation without water.

Optional:

1. Available in 0.71 mm (0.028 in.) and 0.89 mm (0.035 in.) wall thicknesses.

2. Tube material available in 90-10 cupro-nickel.

3. Marine water boxes.

4. Epoxy-coating of inside surfaces of water boxes and tube sheets.

5. Water side vessel design for of 2068 kPa (300 psi) operation.

Optional:

1. Load balancing valves shall be provided for capacity control and additional temperature stability.

2. The chiller shall be equipped with a load balance valve to channel discharge gas from the outlet of the compressor to the evaporator, in order for the ramp up or further unloading during a high-pressure ratio application.

E. Prime Mover:

1. A permanent-magnet, synchronous hermetically sealed motor of sufficient size shall be provided to effectively meet compressor horsepower requirements. The motor shall include soft-start capabilities with an in-rush current of no more than 10amps The motor shall be liquid refrigerant cooled with internal thermal overload protection devices embedded in the winding of each phase.

2. Compressor motor and chiller unit shall include variable-frequency speed controls to match cooling load demand to compressor speed and inlet guide vane position.

3. Each compressor shall be equipped with an AC line reactor and individual disconnect.

F. Chiller Controls

The controller fitted to the oil-free centrifugal chiller package shall be an embedded real- time microprocessor device that utilizes control software written specifically for chiller applications. User operation shall be accomplished using a panel mounted color touch-screen interface. The status of the compressors and all system parameters including compressor alarms and temperature trends shall be viewable.

Controller features must include the following:

1. 10 inch touch screen operator interface.

2. Chiller documentation shall be viewable via touch panel in pdf format.

3. Operator interface shall be capable of connecting directly to compressors via serial communication protocol and displaying compressor information using Turbocor compressor monitoring / commissioning software.

4. The chiller control panel shall contain a minimum of three processors, all control functionality shall be carried out on a dedicated real time processor, and data shall be served to a remote graphical user interface via an open Ethernet protocol. Proprietary protocols between any pc based and micro based processor are strictly prohibited.

5. Chiller controls shall be BacNet capable via MSTP or IP.

6. Complete configuration of native BAS communications via Modbus RTU, Modbus TCP/IP, BacNet MSTP and BacNet IP shall be made via standard chiller controller graphical user interface.

7. Chiller control shall be capable of controlling more than 2 (up to eight) Turbocor compressors on up to eight individual refrigerant circuits serving the same chilled water stream.

8. Chiller control panel user interface shall be capable of remote control via an internet connection, without the use of any third-party gateway device or additional hardware or software.

9. Real time chiller control processor shall be capable of e-mailing a predefined list of recipients, should a fault occur. E-mail shall include details of fault, possible reason for fault, attachment of a monthly data log of 195 or more compressor and chiller variables at a minimum of 30 second intervals, and indication of fault severity.

10. Ability to place all outputs in a manual state (hand, off, auto) via graphical user interface.

11. Alarm screen shall be capable of filtering faults into specific categories such as compressor, chiller and system faults in order to provide rapid diagnosis, and separation of failure modes.

12. Multiple compressor staging algorithm shall operate at the optimized power curves of each compressor simultaneously and shall reset automatically every second during operation. Compressor staging methods that operate using simple incremental percent of demand shall not be accepted.

13. Continuous data logging for operational trending and bin analysis shall be exportable to “CSV” format.

14. Built-in stepper motor controls for EXVs.

15. Controls lockup protection.

16. Three levels of alarm safety for minimum chiller down time.

17. Chiller control software shall employ an active fault avoidance algorithm to reduce chiller capacity and / or power level in the case of the chiller approaching within 10% of any trip limit value such as suction pressure, discharge pressure, chiller amp limit, leaving chilled water temperature limit, etc...

18. Real time data trending viewable via touch panel.

19. Controls shall identify within 60 seconds, a compressor that is not starting or ramping-up properly. Upon this identification, the compressor shall be disabled, the remaining compressors shall be operated in an optimized manner, and an alarm shall be sent to alert the operator.

Optional:

1. BMS interface module for the interface with BacNET MSTP, BacNET IP or LonTalk FT10.

EXECUTION

3.1 INSTALLATION

A. Install per manufacturer’s IOM documentation, shop drawings, and submittal documents.

B. Arrange piping to enable dismantling and permit head removal for tube cleaning.

C. Coordinate electrical installation with electrical contractor.

D. Coordinate controls and BMS interface with controls contractor.

E. Provide all material required for a fully operational and functional chiller.

3.2 START-UP

A. Units shall be factory or field charged with HFC-134a refrigerant.

B. Factory Start-Up Services: Provide factory supervised start-up on-site for a minimum of two working days and ensure proper operation of the equipment. During the period of start-up, the factory authorized technician shall instruct the owner's representative in proper care and operation of the equipment.