

General

All supplied chillers shall be rated in conformance with the latest AHRI Standard 550/590 and shall conform to the latest ANSI/ASHRAE Standard 15 Safety Code for Mechanical Refrigeration. The condenser and evaporator shall also conform to GB Standard for mechanical refrigeration.

Compressor

The chiller system is equipped with high-efficiency centrifugal-type compressors, providing optimal cooling performance. To ensure redundancy and reliability, each chiller unit is outfitted with a minimum of two compressors (if offering series counterflow), offering backup functionality in case of individual compressor failure. In the event of such a failure, the remaining compressor(s) are designed to seamlessly take over operation, capable of independently sustaining the system at 50% of its total design capacity.

Moreover, the compressors are housed within semi-hermetic enclosures, affording both robust protection and serviceability. These enclosures meet a minimum IP22 rating, safeguarding against the ingress of solid objects and providing adequate protection against water splashes or drips. Additionally, stringent measures are in place to control compressor vibration, with levels kept below 3.81 mm/second. This ensures smooth and reliable operation while mitigating the risk of mechanical issues or component failure due to excessive vibration.

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. Multiple movable inlet guide vanes and variable compressor speed shall provide unloading. The chiller controls shall coordinate compressor speed and guide vane position to optimize chiller efficiency.

Each compressor circuit shall be equipped with a line reactor to help protect against incoming power surges and help reduce harmonic distortion.

Lubrication System

The chiller shall be provided with a fully factory installed forced feed lubrication system consisting of a positive displacement oil pump complete with its own electric motor, oil cooler, strainer/filter, oil pressure relief valve, external oil heater element, oil separator and all accessories as at the optimum pressure, temperature and viscosity to all moving contact surfaces. An oil pressure fail safe device shall ensure proper lubrication to all bearings during normal operation, start up and coast down. The oil pressure safety device shall be interlocked to the compressor/motor start-up circuit and shall shut

down the machines should the oil pressure drop below minimum requirements. The lubricating system oil cooler shall be refrigerant cooled.

Chiller Capacity Control

The automatic capacity control system shall consist of but not be limited to the inlet guide vanes, movable diffusers, control motor, temperature controller and sensors. Each chiller unit shall be equipped for automatic modulation from 100% to 10% of design load using electric/electronic control circuits, with constant entering condenser water temperature at 29.5°C. A modulating temperature controller shall sense the leaving chilled water temperature at the chiller's exit and transmit the branch line pressure to the compressor suction guide vane actuator through a pilot positioner. The guide vanes shall close immediately in the event of the compressor shut down and shall be fully closed at start up.

Chiller Efficiency

The chillers shall have input power cooling capacity (IKW/RT) performance of not higher than that as specified in the design requirements when tested in accordance with AHRI Standard 550/590. The rating and efficiency claimed shall be certified by AHRI.

The chiller shall have the efficiency of not more than 0.51kW/RT when the chiller is running at 60%-part load to 100% full load condition.

The Contractor shall be required to submit for the chillers offered, computer selection printouts of their part load performance characteristics (from 10% - 100% at every 10% interval) at the stated standard conditions. The selection printouts for part load shall be based on constant entering condenser water temperature for every 10% reduction in load. These printouts shall be supplied by the chiller authorized representative.

Evaporator and Condenser

- i. 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 GB Standard. The tubes shall be individually replaceable and secured to the intermediate supports without rolling.
- ii. The evaporator shall be flooded type with 0.635mm wall copper tubes rolled into carbon steel tubesheets. The water side shall be designed for a minimum of 150 psig (1034.21 KPa). The heads 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.
- iii. The condenser shall have 0.635mm wall copper 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 (1034.21 KPa). The condenser shall have dished heads with valved drain and vent connections.

iv. 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.

v. 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.

vi. 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.

vii. 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 OR 1 1/2 inch closed cell insulation. All joints and seams shall be carefully sealed to form a vapor barrier.

viii. Provide factory-mounted and wired, thermal-dispersion water flow switches on each vessel to prevent unit operation with no or low water flow.

Chiller Control Panel

i. The unit shall have a microprocessor-based control system consisting of a minimum 12-inch VGA touch-screen operator interface and a unit controller.

ii. The touchscreen 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:

- Entering and leaving chilled and condenser water temperatures
- Evaporator and condenser saturated refrigerant pressures
- Percent of 100% speed (per compressor)
- % of rated load amps for entire unit

iii. In addition to the trended items above, all other important real-time operating parameters shall also be shown on the touchscreen. These items shall be displayed on

a chiller graphic showing each component. At a minimum, the following critical areas must be monitored:

- Compressor actual speed, maximum speed, percent speed
- Evaporator water in and out temperatures, refrigerant pressure and temperature
- Condenser water in and out temperatures, refrigerant pressure and temperature
- Liquid line temperature
- Chilled water setpoint
- Compressor and unit state and input and output digital and analog values

iv. A fault history shall be displayed using an easy to decipher, color coded set of messages that are date and time stamped. 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 and downloadable.

v. All setpoints shall be viewable and changeable (multi-level password protected) on the touch screen and include setpoint description and range of set values.

vi. 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.

vii. The chiller shall be capable of sequencing up to two other similar chillers and automatic control of: 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.

viii. Optionally, the factory mounted controller(s) shall support operation on a BACnet® or Modbus® network via one of the data link / physical layers listed below as specified by the successful Building Automation System (BAS) supplier.

- Modbus
- BACnet MS/TP master (Clause 9)
- BACnet IP, (Annex J)
- BACnet ISO 8802-3, (Ethernet)

ix. 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.

- x. All communication from the chiller unit controller as specified in the points list shall be via standard BACnet objects. Proprietary BACnet objects shall not be allowed. BACnet communications shall conform to the BACnet protocol (ANSI/ASHRAE135-2001). A BACnet Protocol Implementation Conformance Statement (PICS) shall be provided along with the unit submittal.
- xi. The chiller shall be able to maintain operation during a momentary power loss event lasting up to 5 seconds when operated at standard AHRI load and lift conditions. The chiller shall be able to ride through this momentary power loss event without shutting down. Chillers not able to maintain operation during momentary power loss events lasting up to 5 seconds shall include a properly sized thermal storage tank to maintain temperature stability in the system.
- xii. The chiller shall be equipped with the capability to restart and reach full load quickly in the event of a power interruption without UPS. The first compressor shall be capable of restarting in less than 30 seconds after power is restored and shall reach 80% load within 300 seconds. Chillers not able to restart or load within this time frame shall include a properly sized thermal storage tank to maintain temperature stability in the system.

Motor

The motor shall be dip-proof, squirrel-cage, induction type continuously rated, and motor windings specifically insulated. The motor shall be of high efficiency type.

Refrigerant Test

The equipment when installed and set running, shall have the following checks carried out immediately and after which to be carried out at three (3) monthly intervals:

- i. Oil to be analyzed and its acid number determined.
- ii. Refrigerant to be analyzed to determine its moisture content and acid number.

The Contractor shall arrange for these tests to be carried out at an approved independent testing laboratory. In the event that the equipment during the 12 months Maintenance & Servicing Period, having moisture content in excess of oil acid number by 0.05, the Contractor will shall be required to evacuate the system, dehydrate and recharge with new oil and refrigerant.

The cause of the deterioration of the oil and high moisture content shall be investigated and defects rectified.

Installation, Testing & Start-Up Requirements

The contractor shall be required to guarantee and verify the input power cooling capacity performance and part load performance characteristics of the chiller offered by factory tests carried out in accordance with the requirements of AHRI Standard 550.

Complete and detailed test reports shall be submitted to the M&E Engineer for verification and approval before chillers are to be dispatched from the factory. Equipment not complying with the performance as specified shall be rejected.

The Contractor shall include in his Contract Tender Price, for factory witness testing of the chillers by the Employer's Representative, the M&E Engineer and his representative, (Project Manager's representative) or an appointed independent testing authorities (to be decided by the M&E Engineer). The testing shall allow for at least 4 points verification (100%, 75%, 50% & 25%) of the part load characteristics.

Technical Specifications

Items	Specifications
Nominal Capacity (RT)	
Refrigerant	HFO Refrigerant with Global Warming Potential of less than 10 (i.e R1233zd)
Evaporator Entering Temperature (° C)	
Evaporator Leaving Temperature (° C)	
Condenser Entering Temperature (° C)	
Condenser Leaving Temperature (° C)	
Chiller Efficiency @ 100% (kW/RT)	
Electrical Supplies	
Motor	
Controller Power	
Starter	
Shell and Tube heat exchange technical standards	
1) Design	Pressure vessel design comply to GB Standard.
2) Material	Comply to GB Standard
3) Welding	Comply to GB Standard
4) Pressure rating for evaporator and condenser tubes	Design working pressure: 10 bar Max working pressure: 10 bar Quality Control: Supplier to test and inspect heat exchangers to 1.25 times of working pressure as per GB Standard.
5) Fouling factors	Evaporator tubes: 0.000018 m ² K/W Condenser tubes: 0.000044 m ² K/W
6) Evaporator flow rate	
7) Condenser flow rate	

