SECTION 23 64 16 – water cooled centrifugal chillerS

1. GENERAL
	* + 1. RELATED DOCUMENTS
				1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
				2. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.
			2. SUMMARY
				1. Perform all Work required to provide and install water cooled centrifugal chillers with the tonnage (capacity / capacities) as scheduled on the Drawings with the required trim components, including all related appurtenances to make a complete, functioning and operational system that will supply chilled water for HVAC use. In addition, spare fuses for each chiller are to be provided for electrical and electronic components where fuses are required to maintain chiller operation.
			3. REFERENCE STANDARDS
				1. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.
				2. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.
				3. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

Conform to ANSI/ASME Boilers and Pressure Vessels Code Section VIII, Division 1 for design and fabrication of pressure vessels for manufacture of tubular heat exchangers and heat exchanger shells as applicable.

ARI Standard 550/590 - Standard for Water Chilling Packages using the Vapor Compression Cycle.

ANSI/ASHRAE Standard 15 - Safety Code for Mechanical Refrigeration.

* + - 1. QUALITY ASSURANCE
				1. Factory pressure testing of the chiller condenser and evaporator sections shall be in strict conformance with all applicable sections of the ASME code and shall bear the standard ASME symbol.
				2. All equipment or components of this Section shall meet or exceed the requirements and quality of the items herein specified and as denoted on the Drawings.
				3. Equipment manufacturer shall be a company specializing in manufacture, assembly, and field performance of provided equipment with a minimum of five (5) years of experience.
				4. Where applicable, the manufacturer shall be listed by Underwriter's Laboratories as a manufacturer of packaged pumping systems.
				5. Design and construction of chiller electrical components shall meet UL 465 requirements and shall have labels appropriately affixed.
			2. SUBMITTALS
				1. Product Data:

Drawings indicating components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections.

Indicate equipment, piping and connections, valves, strainers, and thermostatic valves required for complete system.

Capacity ratings shall be data in accordance with ARI 5501590-03.

Provide manufacturer's assurance that equipment will operate over complete range (20 percent – 100 percent rated capacity) without the use of hot gas bypass and without surging.

Part load performance data in accordance with ARI 5501590-03. Plot chiller performance from 100 percent to 10 percent in 10 percent increments with constant entering condenser water temperatures at 86, +80 +75 + 70 + 65 + 60 degrees F for every 10 percent reduction.

Chiller load performance data in accordance with ARI relief with a capacity reduction from 100 percent to 10 percent in 10 percent increments.

* + - * 1. Record Documents:

Submit manufacturer’s installation instructions.

Submit pressure test reports of vessel shell and tube bundle pressure tests.

* + - * 1. Operation and Maintenance Data:

At Substantial Completion, submit operation and maintenance data that includes start-up and shutdown instructions, assembly Drawings, and spare parts lists.

* + - 1. DELIVERY, STORAGE and HANDLING
				1. Deliver, store, protect and handle products to the Project Site under provisions of Division 01 and Division 20.
				2. Protect internals from entry of foreign material by temporary caps on flanged openings.
			2. warranty
				1. Provide breakout price during bid process for the following:

Base Bid for one-year factory warranty.

Coverage shall include five-year compressor warranty and one-year warranty for remaining chiller package as manufactured and delivered to the Project Site including materials and labor.

Alternate bid for five-year factory warranty.

Coverage shall include complete chiller package as manufactured and delivered to the Project Site including all parts, materials and labor for the first year, and parts and material only for the remaining four years.

Warranty period commences upon Owners sign-off of project Substantial Completion.

1. PRODUCTS
	* + 1. GENERAL
				1. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.
			2. Manufacturers
				1. Equipment Procurement Procedure
			3. REFRIGERANTS
				1. Base bid for the proposed chiller using refrigerant: R-134a.
				2. Provide an alternate bid for the proposed chiller using refrigerant: R-123.
			4. COMPRESSORS:
				1. Hermetic drive centrifugal compressor type or open drive compressor type.
				2. Compressors using an unloading system that requires dynamic penetrations through the compressor housing or linkages, or both that must be lubricated and adjusted are acceptable provided the manufacturer provides a five-year inspection agreement consisting of semi-annual inspection, lubrication, and annual change out of any compressor seals.
				3. Hermetic Drive Motors:

Liquid refrigerant cooled with internal thermal overload protection devices embedded in the winding of each phase.

Motors shall be compatible with the starting method specified hereinafter.

* + - * 1. Open Drive Motors:

Open drip-proof, squirrel cage, induction type motors may be provided as an alternative.

If an open drive motor is provided, the manufacturer shall provide a double seal shaft seal and a five-year parts and labor warranty against any shaft seal or other compressor housing penetration leaks.

The manufacturer shall verify in the submittal that the scheduled chiller room ventilation system will accommodate the additional heat and maintain the equipment room at design indoor temperature based on 100 degrees F outdoor ambient ventilation air available.

If additional cooling is required, manufacturer shall be responsible for the supply, installation, wiring and controls of a cooling system. Motors shall be compatible with the specified starting method.

* + - 1. EVAPORATOR AND CONDENSER:
				1. Chiller capacity selection shall be based on a water side fouling factor of 0.00010 in the evaporator tubes and 0.00025 in the condenser tubes. Evaporator and condenser water pressure drops shall not exceed those scheduled on the Drawings. The NPLV rating of the chiller supplied shall not exceed the NPLV value scheduled on the Drawings. Chillers shall be rated in accordance with the latest edition of ARI Standard 550/590 and shall conform to the latest edition of ASHRAE 15 Safety Code.
				2. Shell and tube type using welded steel shells and copper tubes with integral fns, rolled or silver brazed to tube sheets. Tube supports to be at maximum of 4'-0”.
				3. The evaporator shall be designed such that refrigerant liquid is to be distributed evenly across the evaporator and that potential of having liquid refrigerant carryover into the compressor is eliminated.
				4. Refrigerant baffles in the condenser to distribute entering gases and to concentrate non-condensable gases.
				5. Water Pipe Connections:

**[Note to Engineer: There are two (2) types of water connection configurations:**

**Victaulic to flange adaptors**

**Welded steel flanges**

**If it makes no difference, then leave this Specification as written. If it makes a difference, then the Specification needs to be more specific with respect to having Victaulic connections.]**

Evaporator and condenser connections shall be flange pipe connections.

Provide marine water boxes on condenser.

Welded steel arranged to permit inspection of tubes from either end without disturbing water chamber of connecting water piping.

Condenser head covers shall be hinged at both ends of condenser shell.

A magnesium anode of sufficient size to account for electrolysis shall be placed inside of condenser section. The attachment device for magnesium anode shall be a threaded rod with nut and washer. Rods should be welded to inside of head and coated with same material as the inside of the condenser head cover. Nut and washers shall be of plastic material.

Design waterside of evaporators and condensers for 150 PSI working pressure and test not less than 1.5 times maximum working pressure.

Test refrigerant side not less than 1.5 times maximum working pressure and not less than 45 PSI.

Provide taps in water boxes for vents, drains, and control connections.

* + - * 1. Provide condenser and evaporator tubes with minimum tube wall thickness of 0.035 inches.

Evaporator and condenser tubes may be internally enhanced to improve heat transfer efficiency.

* + - * 1. Provide refrigerant over-pressurization safety relief. Re-seating refrigerant pressure relief valves are the preferred option over rupture discs.
			1. CONTROLS
				1. Provide stand-alone direct digital controller for each chiller. Controller shall be microprocessor-based and BACnet compatible with factory packaging and testing of required control components for reliable equipment operation.
				2. The chiller control panel shall provide control of chiller operation and monitoring of chiller sensors, actuator, relays and switches. The panel shall be a complete system for stand-alone chiller control and include controls to safely and efficiently operate the chiller. The panel shall be equipped with building automation system (BAS) interface meeting requirements in Division 25 Controls specifications.
				3. Safeties: The chiller control panel shall monitor such safeties as motor starting and running, time between compressor motor starts, low chilled water temperature, high condenser, refrigerant pressure, low evaporator refrigerant temperature, evaporator and condenser water flows, low oil pressure, high oil temperature, and proper operation of unit controls and sensors.
			2. STARTER
				1. Provide where scheduled on Drawings.

**[Note to Engineer: The Specification is currently written for providing a chiller that operates at 480V / 30ph / 60Hz power. If the chiller uses 4160 volts as a power source, then the star delta starter referred to in the Specification is not applicable. The 4160 volt motor must be connected to a primary reactor, autotransformer starter, or MV-VSD.]**

* + - * 1. Automatic reduced voltage type, star delta closed transition unit mounted.
				2. Accessories / Appearances:

Solid-state single-phase and voltage imbalanced protection.

120-volt control transformer.

Main power, non-fused disconnect.

Purge and oil/refrigerant pump motors shall be 115-volt, single-phase, 60-cycle.

Ammeter in cover, red lined at compressor full load amps.

Additional terminal blocks for machine electrical auxiliaries such as purge unit and oil pump.

Provide power factor correction capacitors for a 95 percent power factor at full load.

* + - 1. VARIABLE SPEED DRIVE
				1. **[NOTE TO ENGINEER: Discuss during design. Default shall be VFD or Solid State Starter, but this isn’t applicable to all design scenarios.]** Provide where scheduled on Drawings.
				2. A variable speed drive shall be factory installed on the chiller. The variable speed drive shall vary the compressor motor speed by controlling the frequency and voltage of the electrical power to the motor. The adaptive capacity control logic shall automatically adjust motor speed and compressor pre-rotation van position independently for maximum part-load efficiency by analyzing information fed to it by sensors located throughout the chiller.
				3. Drive shall be pulse width modulation type utilizing insulated gate bipolar transistors with a power factor of 0.95 or better at all loads and speeds.
				4. The variable speed drive shall be unit-mounted in a NEMA-1 enclosure with all power and control wiring between the drive and chiller factory installed, including power to the chiller oil pump. Field power wiring shall be a single point connection and electrical lugs for incoming power wiring shall be provided. The entire chiller package shall be UL listed.
				5. The following features shall be provided:

A door interlocked circuit breaker, capable of being padlocked.

UL listed ground fault protection.

Overvoltage and undervoltage protection.

3-phase sensing motor.

Overcurrent protection.

Single phase protection

Insensitive to phase rotation.

Over temperature protection.

Digital readout at the chiller unit control panel of:

Output Frequency.

Output Voltage.

Input Kilowatts (kW) and Kilowatt-hours (kWh).

Self-diagnostic service parameters.

* + - * 1. Separate meters for this information shall not be acceptable. A harmonic filter that limits electrical power supply distortion for the variable speed drive to comply with the guidelines of IEEE Std. 519-1992 shall be provided. The filter shall be unit mounted within the same NEMA -1 enclosure and shall be UL listed. The following digital readouts shall be provided at the chiller unit control panel as part of the filter package:

Input kVA.

Total power factor.

3-Phase input voltage.

3-Phase input current.

3-Phase input voltage total harmonic distortion (THD).

3-Phase input current total demand distortion (TDD).

Self-diagnostic service parameters.

* + - 1. REFRIGERANT MONITOR
				1. Provide calibrated, refrigerant monitor for specific refrigerant used, capable of detecting concentrations of 10 ppm for low level detection.
				2. Provide monitor with audible and visual alarms that activate at a valve corresponding to the TL V of the refrigerants in use. The alarm system shall annunciate visual and audible alarms inside the machinery room and outside each entrance to the room.

Monitor shall have the capability of detecting, alarming and controlling from 0-50 ppm. Digital display accuracy shall be within one (1) ppm.

Monitor shall require only minimum maintenance.

Recalibrate no more than once every five (5) years.

Re-zeoring no more than once every week.

Monitor shall be capable of operation in ambient temperatures from 40 to 105 degrees F.

Outputs:

Two (2) analog setpoints and three (3) binary with individual closure setpoints.

Connect one alarm contact to the BAS to indicate alarm condition into the BAS system.

Remaining alarm contacts shall initiate closure of magnetic motor starters to energize the refrigerant purge supply fan and exhaust fan.

* + - * 1. Manufacturers: Bacharach or Johnson Controls re-labeled Bacharach
			1. CHILLER PURGE SYSTEM
				1. Manufacturers of low pressure machines must provide a purge system.
				2. The purge shall operate independently of the chiller and can be operated while the machine circulation water pumps are shutdown. No external water cooling source shall be required.
				3. If the purge system cannot operate when the machine and pump are off, a positive pressure device, such as a belly heater, shall be provided on the evaporator to raise the pressure of the bundle above atmospheric pressure when the machine is off. This will prevent non-condensables from entering the machine. The additional power draw of this device shall be included in the quoted machine efficiency.
				4. Any excess purge requirement will enable a fault indication light at the purge and a contact closure shall be provided for remote annunciation.
				5. The unit indication shall include:

Lights indicating condenser running, fault indication, and sequence operation.

Elapsed time meter (monitor amount of leak rate).

Binary outputs to indicate purging of air from the purge unit and purge shutdown due to excessive operation.

Purge shall be the highest efficiency offered by the manufacturer, but in no case shall it be less than the following:

With the chiller operating at standard operating conditions and with a condensing refrigerant temperature at 80 degrees F, the purge shall be rated for no more than one pound of refrigerant per one pound of non-condensable gases.

* + - 1. PUMP-OUT SYSTEM
				1. Units operating with refrigerant having positive pressure at 75 degrees F (HFC-134a, etc.) shall have the capability of storing the entire refrigerant charge in the condenser or shall be provided with a pump-out system for each machine.
				2. Pump-out systems shall be complete with transfer pump, condensing unit, and tank constructed in accordance with ASME Code for Unfired Pressure Vessels bearing the National Board stamp.
				3. Pump-out systems shall be supplied and warranted by the chiller manufacturer.
			2. HEAD PRESSURE CONTROL
1. EXECUTION
	* + 1. INSTALLATION
				1. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
				2. All installation shall be in accordance with manufacturer’s published recommendations.
				3. Installation shall comply with requirements of ANSI/ ASHRAE 15-2001.
				4. Install piping at condenser and evaporator to avoid interfering with tube cleaning or repair.
				5. Install piping to minimize weight and length of piping sections, which must be removed prior to head removal.
				6. Insulate chiller evaporator and other surfaces subject to sweating in accordance with Section 20 07 16.
				7. Install chillers on isolation pads as specified in Section 20 05 48.
				8. Provide a competent, factory trained representative to completely supervise the installation and to perform all on-Site run-in tests.
			2. testing
				1. Chiller performance must include an ARI approved selection method. Verification of date and version of computer program selection of catalog is available to the Engineer.
				2. Include in the bid price a factory performance test for each chiller under full load conditions in an ARI certified test facility. The manufacturer shall supply a certified test report to confirm performance as specified. Proper ARI certification documents for the test loop shall be made available upon request from the manufacturer for inspection. The performance test shall be conducted in accordance with ARI Standard 550/590-03 procedures and tolerances
				3. Demonstrate stable operation at minimum load during the factory performance test. Machine shall be modified to include hot gas bypass if 20 percent load cannot be demonstrated.
				4. The performance test shall be run with clean tubes in accordance with ARI 550/590-03 to include the following:

A downward temperature adjustment shall be made to the design leaving evaporator water temperature to adjust for the specified fouling of the tubes.

An upward temperature adjustment shall be made to the design entering condenser water temperature to adjust for the specified fouling of the tubes.

There shall be no exceptions to conducting the performance test with clean tubes and with temperature adjustments per items 1 and 2. The manufacturer shall clean tubes, if necessary, prior to the test to obtain a test fouling factor of 0.00010 hr. sq. ft. F /BTU.

* + - * 1. Factory test instrumentation shall be per ARI Standard 550/590-03 and the calibration of all instrumentation shall be traceable to the National Institute of Standards and Technology.
				2. Notify the Owner fourteen (14) calendar days in advance to witness the factory performance test. Include in the bid price, all travel expenses for two (2) Owner’s representatives and to travel to manufacturer's factory to witness the performance test.
				3. A certified test report of all data shall be submitted to the Engineer prior to Substantial Completion. An officer of the manufacturer’s company shall sign the factory certified test report. Preprinted certification will not be acceptable; certification shall be in the original.
				4. The equipment will be accepted if the test procedures and results are in conformance with ARI Standard 550/590-03. If the equipment fails to perform within allowable tolerances, the manufacturer will be allowed to make necessary revisions to manufacturer’s equipment and retest as required. In the event these revisions do not achieve submitted performance, the following penalties will be imposed:

Capacity Test: For each ton below the allowable capacity set forth in ARI 550/590-03 of the design capacity, five hundred fifty dollars ($550.00) per ton will be deducted from the Contract price. Allowable capacity = [1 - tolerance) X design capacity]; tolerances per ARI 550/590-03, Section 5.4.

Power Consumption Test: The power consumption penalty for all load points shall be based upon tolerances set forth in ARI 550/590-03.

The Power Consumption Penalty (P.C.P.) will be calculated based upon the following formula; P.C.P. = Measured kW - (Measured Tons X Allowable kW/Ton\*) X $1,150/kW. \*Allowable kW/ton = (1 + Tolerance) X Design kW/Ton]; tolerance per ARI 550/590-03, Section 5.4.

Total Performance Penalty: The total performance penalty will be the sum of the Capacity Penalty and Power Consumption Penalty.

Dollar currency rate is based on the year the Contract is awarded to the chiller manufacturer.

* + - * 1. Equipment manufacturer shall not invoice for the centrifugal chillers until successful completion of the performance test or acceptance of penalty deduction from the Contract.

END OF SECTION 23 64 16