

SECTION 23 6423
AIR-COOLED LIQUID CHILLERS

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Products provided in this section include:
 - 1. Air-cooled chillers between 150 and 500 nominal tons
 - 2. Charge of refrigerant and oil
 - 3. Building automation system (BAS) interface
 - 4. Vibration isolators (alternate)
 - 5. Sound attenuation package(s) (alternate)
- B. Services provided in this section include:
 - 1. Factory functional testing
 - 2. Manufacturer's field services
 - 3. BAS integration
 - 4. Maintenance agreement (base bid and alternate)

1.2 REFERENCES

- A. The references listed below refer to the latest version approved and in effect.
 - 1. Air Conditioning, Heating, and Refrigeration Institute (AHRI)
 - a. AHRI 370: Sound Performance Rating of Large Air-Cooled Outdoor Refrigerating and Air-Conditioning Equipment
 - b. AHRI 550/590: Water Chilling Packages Using the Vapor Compression Cycle
 - 2. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE)
 - a. ASHRAE 15: Safety Code for Mechanical Refrigeration
 - b. ASHRAE 34: Designation and Safety Classifications of Refrigerants
 - c. ASHRAE 90.1: Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings
 - 3. American Society of Mechanical Engineers (ASME)
 - a. ASME SEC 8: Boiler and Pressure Vessel Code
 - 4. American Society for Testing and Materials (ASTM)
 - a. ASTM B-117: Standard Practice for Operating Salt Spray (Fog) Apparatus
 - b. ASTM D-1654: Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
 - 5. International Organization for Standardization (ISO)
 - a. ISO 9001/2: Standard for Manufacturing Quality
 - 6. National Electric Code (NEC)
 - 7. National Electrical Manufacturers Association (NEMA)

- a. NEMA 250: Enclosures for Electrical Equipment
 - b. NEMA AB-1: Molded-Case Circuit Breakers, Molded Case Switches, and Circuit Breaker Enclosures
 - c. NEMA ICS 2: Industrial Control and Systems: Controllers, Contactors, and Overload Relays
 - d. NEMA ICS 6: Industrial Control and Systems: Enclosures
 - e. NEMA KS 1: Enclosed and Miscellaneous Distribution Equipment Switches
 - f. NEMA MG 1: Motors and Generators
8. Occupational Safety and Health Act (OSHA)
 9. Underwriters Laboratories Inc. (UL®)
 - a. UL 508: Industrial Control Equipment
 - b. UL 1995: Heating and Cooling Equipment

1.3 QUALITY ASSURANCE

- A. Conform to all national, state, and local codes.
- B. Conform to Intertek Testing services for the construction of chillers and provide ETL/cETL Listed compliance label.
- C. Comply with UL and UL Canada and include a compliance label by a qualified testing agency.
- D. Chiller components shall be constructed, tested, and stamped in accordance with applicable ASME codes.
- E. Conform to ASHRAE 15: Safety Code for Mechanical Refrigeration.
- F. Conform to NFPA 70: National Electrical Code.
- G. Chiller shall be manufactured in a facility registered to ISO 9001 or ISO 9002.
- H. Chiller performance shall be rated and certified in accordance with AHRI 550/590.
- I. Chiller sound data shall be rated and certified in accordance with AHRI 370.
- J. Chiller painted components shall be capable of withstanding 1,000-hour salt spray test in accordance with ASTM B-117.
- K. Chiller shall be functionally tested at the factory with water flowing through the chiller.
- L. Chiller startup services shall be performed by factory trained personnel.

1.4 SUBMITTALS (SUBMIT WITH BID)

- A. Submittals shall indicate components, dimensions, weights, and point loads, required clearances and location and size of field connections.
- B. Provide product data indicating rated capacities, specialties and accessories, electrical requirements, and wiring diagrams.
- C. Submit complete performance and sound data at full and part load capacities per the table below. In addition, provide full load and part load ratings at AHRI conditions for utility incentive review.

TONS	EVAP FLOW**	AMBIENT AIR TEMPERATURE (AAT)	AAT2	AAT3	AAT4	AAT5	AAT6
100%	100%	105°F	95°F	85°F	75°F	65°F	55°F
90%	100%	105°F	95°F	85°F	75°F	65°F	55°F
80%	100%	105°F	95°F	85°F	75°F	65°F	55°F
70%	100%	105°F	95°F	85°F	75°F	65°F	55°F
60%	100%	105°F	95°F	85°F	75°F	65°F	55°F
50%	100%	105°F	95°F	85°F	75°F	65°F	55°F
40%	100%	105°F	95°F	85°F	75°F	65°F	55°F
30%	100%	105°F	95°F	85°F	75°F	65°F	55°F
20%*	100%	105°F	95°F	85°F	75°F	65°F	55°F
10%*	100%	105°F	95°F	85°F	75°F	65°F	55°F

Notes:

*Or minimum allowable

** Chilled water pressure drops shall be included

- D. Submit manufacturer’s installation and operation instructions and spare parts list.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Comply with manufacturer’s installation instructions for storage, rigging, unloading, and transporting units.
- B. Provide protective covering over entire chiller and piping connections. Protective covering shall remain until chiller is installed.
- C. Unit controls shall be capable of withstanding 110°F storage temperature in the control compartment.

1.6 SPARE PARTS

- A. Provide recommended spare parts list as part of submittal package.

1.7 WARRANTY

- A. Provide warranty under provisions of General Conditions.
- B. Provide one (1) year parts and labor warranty on chiller package including materials, labor, and refrigerant from date of startup or 18 months from shipping, whichever occurs first.
- C. **Alternate Bid 1 – Extended Warranty:** Provide 2nd-5th extended parts and labor warranty including materials, labor, and refrigerant.

1.8 MAINTENANCE SERVICE

- A. Furnish service and maintenance of complete assembly for one (1) year from equipment startup.
- B. **Alternate Bid 2 – Extended Maintenance:** Provide 2nd-5th year extended preventative maintenance agreement as a lump sum cost. Agreement shall start the day the Base Bid warranty expires.

- C. The maintenance agreement shall cover all preventive maintenance and service during regular work hours including but not limited to:
1. Cooling Season Preparation and Inspection
 - a. Check refrigerant and oil levels.
 - b. Check oil sump, oil heaters and temperatures.
 - c. Check and test all operating and safety controls.
 - d. Check the starter/VFD operation including cooling loop.
 - e. Start the chilled water pump.
 - f. Start the chiller and calibrate controls.
 - g. Leak check the unit and identify leak sources for repair.
 - h. Log operating conditions after system and unit stabilized.
 - i. Review operating procedures and Owner's log with operator.
 - j. Check auxiliary equipment operation.
 2. Four Inspections During the Cooling Season (April, June, August, October)
 - a. Inspect chiller and adjust safety controls.
 - b. Inspect condenser coils and clean as needed per manufacturer's instructions.
 - c. Check operation of controls.
 - d. Check oil and refrigerant levels.
 - e. Check operation of lube system.
 - f. Check the oil return system.
 - g. Check operation of motor and starter.
 - h. Record operating conditions.
 - i. Check log and review chiller and system operation with operator.
 - j. Conduct routine maintenance as recommended and required.
 - k. Log and report repairs and parts that are required.
 3. Annual Equipment Shutdown Inspection and Preventative Maintenance
 - a. Check the compressor-motor assembly for the following items and perform tasks as indicated:
 - (1) Record voltages.
 - (2) Meg test and record motor winding resistance.
 - (3) Lubricate motor.
 - (4) Check seals.
 - b. Check the compressor oil system for the following items:
 - (1) Conduct analysis on oil and oil filter at an independent laboratory.
 - (2) Check oil pump, seal, and motor.
 - (3) Cleaning the dirt leg.
 - (4) Check heater and thermostat.
 - (5) Check all other oil system components including cooler, strainer, and solenoid valve where applicable.

- c. Check variable frequency drive (if applicable) and perform the following tasks:
 - (1) Run diagnostic check.
 - (2) Clean contacts or recommend replacement.
 - (3) Check linkage.
 - (4) Meg test the motor.
 - (5) Check all terminals and tighten connections.
 - (6) Check overloads, dash pot oil, and calibrate.
 - (7) Inspect and clean heat rejection device, as required.
 - (8) Dry run starter (or before start-up); check status.
 - (9) Replace VFD system coolant (alternate maintenance only)
- d. Review the control panel for the following items:
 - (1) Run diagnostic check of micro control panel.
 - (2) Check safety shutdown operation.
 - (3) Check all terminals and tighten connections.
 - (4) Check display data accuracy and setpoints.
- e. Check the condenser for the following items:
 - (1) Clean condenser coils per manufacturer's instructions.
- f. Check the cooler for the following items:
 - (1) Check the water flow.
 - (2) Check flow switch operation.
 - (3) Check refrigerant level.
- g. Check the system for the following items:
 - (1) Conduct a leak check and identify leak sources for repairs.
 - (2) Record condition of sight glasses.
 - (3) Check the refrigerant cycle to verify the proper operating balance.
 - (4) Check chilled water heat transfer.
- h. General items included:
 - (1) Repair insulation removed for inspection and maintenance procedures.
 - (2) Clean equipment and surrounding area upon completion of work.
 - (3) Consult with the operator.
 - (4) Report deficiencies and repairs required.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Carrier 30XV
- B. Daikin/McQuay AWW
- C. Trane RTAF
- D. York YCIV/YVAA

2.2 GENERAL REQUIREMENTS

- A. Provide factory-assembled, wired, and tested outdoor air-cooled liquid chiller consisting of screw or scroll compressors, air-cooled condenser, evaporator, thermal expansion valve, refrigeration accessories, variable frequency drives/starters, and control panel.
- B. Control panels, structural elements, electrical boxes, and heavy gauge structural base shall be constructed of heavy gauge structural steel with weather resistant baked on enamel powder or pre-painted prior to assembly.
- C. Chiller performance requirements are summarized below. See Bid Form for additional requirements.

CHILLER TAG	ACC-E2
Refrigeration capacity:	300 tons
Approximate footprint*:	See Exhibit 1
Existing operating weight**:	18,800 lbs.**
Motor voltage:	460/3/60
Existing MCA:	611 amp
Full load power consumption:	As rated
Part load performance:	Min 16.1 EER at AHRI conditions
Evaporator flow rate:	720 gpm
Evaporator fluid:	100% water
Evaporator entering fluid temp:	Based on rating
Evaporator leaving fluid temp:	44°F
Evaporator fouling factor:	0.0001
Evaporator pressure drop†:	20 ft†
Condenser entering air temp:	95°F
Refrigerant type:	R-134a or low GWP equivalent

Notes:

*Existing chillers are mounted on structural steel. If new footprint is significantly different than existing chillers, steel may need to be replaced or modified, adding cost to the project. This will be considered as part of the bid analysis.

**Shipping weights based on existing chillers. Significant deviation from the existing weight may impact cost to the project. This will be considered as part of the bid analysis.

- D. Alternate bids for chiller options are specified in various places throughout this section. These alternates are summarized as below:
 1. **Alternate Bid 1 – Extended Warranty:** Provide 2nd-5th year extended parts and labor warranty including refrigerant.
 2. **Alternate Bid 2 – Extended Maintenance:** Provide 2nd-5th year extended preventative maintenance agreement. See Section 1.9.
 3. **Alternate Bid 3 - Full Louvered Enclosure:** Provide factory installed louvered panels on all sides of chiller covering condenser and compressors.
 4. **Alternate Bid 4 – 2” Restrained Spring Isolators:** Provide 2” deflection restrained spring isolators of quantity and size for specific chiller operating weight.

5. **Alternate Bid 5A – Sound Attenuation Package – Ultra low sound fans:** Provide price for ultra-low sound fans including sound data.
6. **Alternate Bid 5B – Sound Attenuation Package – Full attenuation package:** Provide price for full attenuation package including sound data.

2.3 COMPRESSORS

- A. Compressors shall be field serviceable, direct-drive, semi-hermetic rotary screw type including muffler, temperature-controlled heater, rain-tight control box, suction, and discharge service valves, cast iron housing.
- B. Statically and dynamically balance rotating parts and mount compressor on vibration isolators.
- C. Provide oil pump lubrication system with thermostatically controlled oil heater, oil charging valve, oil level sight glass, oil filter and strainer. Components shall be arranged to ensure adequate lubrication during starting, stopping, power failure, and normal operation.
- D. Provide compressor with variable frequency drive with unloading down to 25% of compressor full load. Microprocessor controls shall modulate capacity and maintain stable operation throughout entire chiller operating range.
- E. Provide variable speed, suction gas-cooled compressor motors, with internal overload protection.

2.4 EVAPORATOR/COOLER

- A. Shell-and-tube heat exchanger of seamless or welded steel construction with removable cast iron or fabricated steel heads, cleanable seamless copper tubes with integral fins rolled or silver-brazed into tube sheets. Plate and frame heat exchangers are not acceptable.
- B. Design, test and stamp refrigerant side for minimum 220 psig working pressure or as required for refrigerant used, and 150 psig waterside working pressure, in accordance with ASME Section 8.
- C. Insulate with minimum 1.5" thick flexible elastomeric foam insulation with maximum thermal conductivity of 0.27 BTU-in/hr-ft²-°F at 75°F mean temperature.
- D. Furnish thermostatically controller heater to provide evaporator freeze protection to -20°F.
- E. Provide water drain and vent connections and thermometer wells for temperature controller and low temperature cutout.
- F. Provide factory installed proof of flow sensor. If not available, provide field installed differential pressure flow switch equal to United Electric Model J21K-150; NEMA 4X; 150 psi DWP; ¼" NPTI pressure connection; 15 amp at 115V; Class B switch SPDT; auto-reset; high- and low-pressure bellows stops; shipped loose for contractor field installation in condenser water and chilled water piping. Flow switches shall be configured for use with variable flow systems.

2.5 CONDENSER

- A. Condenser coils shall be micro-channel type, parallel flow aluminum alloy tubes, fins, and manifolds.
- B. Design, test and stamp refrigerant coils for minimum 450 psig working pressure or as required for refrigerant used, in accordance with ASME Section 8.
- C. **Alternate Bid 3: - Full Louvered Enclosure:** Provide factory installed louvered panels on all sides of chiller covering condenser and compressors. Panels shall be painted to match chiller.

- D. Provide vertical-discharge, direct-drive propeller-type condenser fans with coated wire fan guard on discharge. Fans shall be of low sound design statically and dynamically balanced. Fans and fan hubs shall be of corrosion resistant aluminum or reinforced polymer construction.
- E. Provide high efficiency condenser fan motors with double-sealed, permanently lubricated ball bearings and built-in current and overload protection. Fan motors shall be totally enclosed, air-over (TEAO) with minimum Class F insulation.

2.6 ENCLOSURE

- A. House components in welded steel frame with galvanized steel panels with weather resistant, baked enamel finish.
- B. Cabinet shall be capable of withstanding 1,000-hour salt spray test in accordance with ASTM-B117.

2.7 REFRIGERANT CIRCUIT

- A. Provide refrigerant circuits, factory supplied and piped.
- B. Furnish for each refrigerant circuit:
 - 1. Hot gas discharge muffler
 - 2. Liquid line solenoid valve
 - 3. Replaceable core filter drier
 - 4. Liquid line sight glass and moisture indicator
 - 5. Electronic or thermostatic expansion valve sized for maximum operating pressure.
 - 6. Charging valve
 - 7. Insulated suction line.
 - 8. Liquid line and discharge service valves
 - 9. Evaporator and condenser relief valves
 - 10. Pressure sensors to allow for control panel display of compressor suction, discharge, and oil pressures.
 - 11. Temperature sensors to allow for control panel display of compressor discharge, oil, saturation, condenser subcooling temperatures.
 - 12. Complete operating charge of refrigerant (R-134a, or low GWP alternative) and compressor oil

2.8 ELECTRICAL

- A. Provide NEMA 3R control panel and lockable, hinged, and gasket sealed access door(s). Doors shall be equipped with wind struts. Panel shall contain main power connections, compressor starters, fan motor contactors, current overloads, and factory wiring.
- B. Short circuit withstand rating of the electrical enclosure shall be 65,000 amps in accordance with UL 508.
- C. For each screw compressor, furnish a variable frequency drive. VFDs shall be mounted in the control panel.
- D. Provide single point power connection to chiller with UL approved circuit breaker disconnect factory mounted and wired with external lockable handle.

- E. All exposed power wiring shall be routed through liquid-tight, UV-stabilized conduit.

2.9 CONTROLS

- A. Provide microprocessor-based controls. Operating software shall be stored in non-volatile memory. Field programmed setpoints shall be stored in battery regulated memory.
- B. Provide factory mounted and wired 115V control power transformer with primary and secondary fuses.
- C. Provide the following automatic controls:
 - 1. Adaptive logic to take action to keep chiller operating to extent possible during abnormal operating conditions.
 - 2. Programmable setpoints for chilled water supply temperature, local/remote mode
 - 3. Compressor start/stop, loading/unloading, lead/lag, and anti-recycle.
 - 4. Expansion valve control
 - 5. Condenser fan staging
 - 6. Chilled water pump control and chilled water flow contacts
 - 7. Leaving chilled water temperature control
 - 8. Low ambient operation to 32°F
 - 9. High ambient operation to 115°F
 - 10. Remote temperature reset, current limiting, shutdown, alarms.
- D. Provide multi-line LCD display with access to the following data and functions:
 - 1. Chilled water entering and leaving temperatures.
 - 2. Outside air temperature
 - 3. Component status of compressors, condensers, etc.
 - 4. System pressures including suction, discharge, and oil pressure.
 - 5. System temperatures including suction, discharge, oil, saturation, and condenser subcooling temperature.
 - 6. Compressor data including number of starts, percent full load amps, run time.
 - 7. Evaporator heater status
 - 8. Alarm history and data for past 10 fault shutdowns
- E. Provide the following safeties:
 - 1. For each refrigerant circuit: high or low refrigerant pressures or temperatures, high or low oil pressure, high motor temperature, three phase motor current overload, motor branch circuit protection, control voltage.
 - 2. For chiller: high or low ambient temperature, low chilled water temperature, loss of flow, phase loss, undervoltage, short circuit protection, ground fault protection.

- F. BAS Interface:
1. Provide BACnet interface card to connect to Building Automation System (BAS) to provide (at a minimum) the following points: reset of chilled water supply temperature; reset of current limit; chilled water temperatures; motor amperages; motor voltages; motor kW; refrigerant pressures; oil temperature and pressure; and status messages indicating chiller is ready to start, chiller is operating, chiller is shut down on a safety requiring reset, and chiller is shut down on a recycling safety.
 2. Remote start/stop of the chiller shall be hardwired to the chiller.
 3. Provide and install any additional hardware required.

2.10 RESTRAINED VIBRATION ISOLATORS (ALTERNATE BID 5)

- A. Acceptable Manufacturers
1. Kinetics Noise Control
 2. Mason Industries
 3. Vibro Acoustics
- B. General Requirements
1. Outside Spring Diameter: Not less than 80% of the compressed height of the spring at rated load.
 2. Minimum Additional Travel Distance to Solid: 50% of the required deflection at rated load.
 3. Lateral Stiffness: More than 80% of rated vertical stiffness.
 4. Overload Capacity: Support 200 % of rated load, fully compressed, without deformation or failure.
 5. Operating static deflection: 2".
 6. Materials: Hot dip galvanized housings and cadmium plated spring elements in compliance with ASTM A123.
 7. Springs shall be color coded to indicate load capacity.
- C. Restrained Spring Isolators
1. Freestanding, steel, open-spring isolators with limit-stop restraint
 2. Housing: Steel with resilient vertical limit stops to prevent spring extension due to weight being removed; baseplate with factory drilled bolt holes for bolting to mounting surface, bonded to 1/4" thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation. Vertical limit stops shall be out of contact during normal operation. Horizontal clearance on the sides between the spring assembly and the housing shall be a minimum of 1/2" to avoid bumping and interfering with the spring action.
 3. For equipment located outside, limit stops shall resist wind velocity up to 130 mph.
 4. Restraint: Limit stop as required for equipment. Restraining bolts shall have rubber grommets to provide cushioning in the vertical as well as horizontal directions. The hole through the bushing shall be a minimum of 3/4" larger in diameter than the restraining bolt.
 5. Basis of Design: Mason Industries Type SLR

2.11 SOUND ATTENUATION

- A. Provide sound attenuation package to reduce **sound power** levels of the chiller. Provide octave band sound data as indicated in table below for each scenario bid. Sound attenuation shall consist of a combination of ultra-low sound fans, compressor enclosures, and inlet attenuators.
1. **Alternate Bid 5A – Ultra low-sound fans:** Provide ultra-low sound fans in lieu of standard low sound fans.
 2. **Alternate Bid 5B – Full attenuation package:** Provide complete attenuation package including ultra-low sound fans, compressor blankets, and inlet attenuators. Any equipment de-rate due to attenuation shall be indicated.

SOUND POWER LEVELS (DB RE 10 ⁻¹² WATTS)									
Tag	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	dBA
Existing	97	99	96	96	97	93	84	77	101
ACC-E2									

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Not Applicable.

3.2 MANUFACTURER'S FIELD SERVICES

- A. Provide startup services by factory trained manufacturer's representative in accordance with Conditions of Contract. Services shall include but not be limited to:
1. Inspection of chiller installation to confirm it meets manufacturer's requirements including overall condition of the chiller, shipping brace removal, operational and maintenance clearances, piping connections, electrical connections, vibration isolator installation, controls integration, and field installed accessories.
 2. Provide startup of chiller per manufacturer's operation manual.
 3. Provide calculation of estimated energy efficiency ratio (EER) based on operating conditions available to verify chiller performance.
- B. In conjunction with the Controls Contractor, provide a minimum of four (4) hours of commissioning of the chiller integration to the building automation system (BAS).
1. Verify that control wiring is per manufacturer's requirements.
 2. Verify that chiller is communicating with the BAS.
 3. Verify that all required points have been successfully mapped to the BAS and are calibrated correctly.
 4. Troubleshoot any communication issues.
- C. On completion of installation of vibration isolators, the local vibration isolator manufacturer's representative shall inspect the chiller installation and indicate installation errors or other faults in the system that affect the isolating system performance.

3.3 DEMONSTRATION

- A. Provide a minimum of four (4) hours per chiller of systems demonstration and training by factory-trained manufacturer's representative in accordance with Conditions of Contract. Coordinate with Owner so that all shifts are included in training.

3.4 FIELD INSPECTION AND REPORT

- A. Provide report prepared by manufacturer's representatives for chiller and vibration isolators, stating that systems installed, and services provided under this Section are in accordance with manufacturer's recommendations and are properly operating.

END OF SECTION

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