SECTION 236413 - ABSORPTION WATER CHILLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Packaged, water-cooled, single-effect absorption chillers.
2. Heat-exchanger, brush-cleaning system.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.

C. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by ARI 560 and referenced to ARI standard rating conditions.

D. NPLV: Nonstandard part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by ARI 560 and intended for operating conditions other than the ARI standard rating conditions.

1.4 PERFORMANCE REQUIREMENTS

A. Condenser-Fluid Temperature Performance:

1. Startup Condenser-Fluid Temperature: Chiller shall be capable of starting with an entering condenser-fluid temperature of 55 deg F and providing stable operation until the system temperature is elevated to the minimum operating entering condenser-fluid temperature.
2. Minimum Operating Condenser-Fluid Temperature: Chiller shall be capable of continuous operation over the entire capacity range indicated with an entering condenser-fluid temperature of 65 deg F.
3. Make factory modifications to standard chiller design if necessary to comply with performance indicated.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, furnished specialties and accessories.

1. Performance at ARI standard conditions and at conditions indicated.
2. Performance at ARI standard unloading conditions.
3. Minimum evaporator flow rate.
4. Absorbent capacity of chiller.
5. Refrigerant capacity of chiller.
6. Fluid capacity of evaporator and condenser.
7. Fluid capacity of generator.
8. Characteristics of safety relief devices.
9. Minimum entering condenser-fluid temperature.
10. Performance at varying capacities with constant design condenser-fluid temperature. Repeat performance at varying capacities for different condenser-fluid temperatures from design to minimum in 5 deg F increments.

Retain first paragraph below if applying for LEED certification.

B. LEED Submittals:

1. Product Data for LEED-NC Prerequisite EA 2: Documentation indicating that units comply with ASHRAE 90.1-2004.
2. Product Data for LEED-NC Prerequisite EA 3: Documentation indicating that refrigerants comply.
3. Product Data for LEED-NC Credit EA 4: Documentation indicating that equipment and refrigerants comply.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, load distribution, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.
3. Insulated Surface Diagrams: Indicating cold and hot surfaces requiring insulation with area tabulated for each.

D. Coordination Drawings: Floor plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural supports.
2. Piping roughing-in requirements.
3. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
4. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.

E. Certificates: For certification required in "Quality Assurance" Article.

F. Source quality-control reports.

G. Startup service reports.

H. Operation and Maintenance Data: For each chiller to include in emergency, operation, and maintenance manuals.

I. Warranty: Sample of special warranty.

1.6 QUALITY ASSURANCE

A. ARI Rating: Rate chiller performance according to requirements in ARI 560.

B. ASHRAE Compliance:

1. ASHRAE 15 for safety code for mechanical refrigeration.
2. ASHRAE/IESNA 90.1-2004.

C. ASME Compliance: Fabricate and label chiller pressure vessels to comply with applicable portions of ASME Boiler and Pressure Vessel Code.

D. Comply with NFPA 70.

E. Comply with requirements of UL and UL Canada, and include label by a qualified testing agency showing compliance.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Ship chillers factory charged with nitrogen.

B. Ship absorbent and refrigerant in chillers or in containers separate from chillers.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of chillers that fail in materials or workmanship within specified warranty period.

1. Extended warranties include, but are not limited to, the following:

a. Complete chiller.
b. Parts and labor.
c. Loss of absorbent and refrigerant for any reason.

B. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carrier Corporation; a United Technologies company.
2. YORK; a Johnson Controls company.

2.2 MANUFACTURED UNIT

A. Description: Factory-assembled and -tested, hermetic-design chiller complete with absorber, evaporator, condenser, generator, solution heat exchanger, controls, absorbent solution pump with motor, refrigerant pump with motor, purge unit with motor, motor controllers, rupture disk, interconnecting unit piping and wiring, indicated accessories, and mounting frame.

Retain subparagraph below if limited space is available for installation.

1. Disassemble chiller into major assemblies as required by the installation after factory testing and before packaging for shipment.

B. Absorbent and Refrigerant:

1. Absorbent: Lithium bromide solution with corrosion inhibitor.
2. Refrigerant: Deionized or distilled water.
3. Performance Enhancer: Heat and mass transfer enhancer to improve performance.

2.3 PUMPS

A. Hermetically sealed, self-lubricating, and fitted with self-adjusting, spring-loaded, wear-compensating tapered carbon bearings.

B. Pump motor assembly shall be designed to operate for not less than 50,000 hours between inspections.

C. Pump motors cooled, and bearings lubricated, either by fluid being pumped or by a filtered supply of liquid refrigerant.

D. Pump suction and discharge equipped with isolation valves.

E. Separate and dedicated pumps for absorbent solution and refrigerant.

1. Absorbent solution and refrigerant flow-control method shall be manufacturer's choice to comply with operating requirements indicated.

F. Purge System: Unit mounted and factory wired, equipped with controls and a pump to automatically remove noncondensable vapors.

1. Purge Pump Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

a. Enclosure: Totally enclosed.

2.4 HEAT-EXCHANGER SHELLS

A. Configuration for Single-Effect Chillers: Two shells; one shell consists of the absorber/evaporator and the other shell consists of the condenser/generator.

B. Construction: Fabricated from continuously welded carbon-steel sheet or plate, or from seamless pipe.

C. Design Pressure and Temperature Rating: Comply with applicable requirements in ASME Boiler and Pressure Vessel Code.

D. End Tube Sheets: Carbon-steel plates continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.

E. Intermediate Tube Sheets: Carbon-steel plates installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.

F. Generator/Condenser Shell Pressure Relief Device: Manufacturers standard rupture disk complying with requirements in ASHRAE 15 and in applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

2.5 ABSORBER

A. Nozzle or Dispersion Trays: Designed to evenly distribute absorbent solution over tubes. Constructed of brass, stainless steel, or another material that will not corrode.

B. Tubes:

1. Individually replaceable, straight tubes expanded into tube sheets. Replaceable from either end and without damage to tube sheets and other tubes.
2. Material: 95/5 Copper-nickel alloy.
3. Minimum Wall Thickness: 0.028 inch.
4. External Finish: Manufacturer's standard.
5. Internal Finish: Smooth.

C. Water Boxes:

1. Carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
2. Marine type for water box with piping connections.

    a. Water boxes and marine water-box covers shall have lifting lugs or eyebolts.
    b. Hinged marine water-box covers.

3. Nozzle Pipe Connections: Grooved for mechanical-joint coupling.
4. Thermistor or RTD temperature sensor factory installed in each nozzle.
5. Fit each water box with 1-inch drain connection at low point and vent connection at high point, each with threaded plug.

D. Absorber/Condenser Crossover Piping: Factory installed piping connecting fluid connection of absorber discharge to condenser inlet.

2.6 EVAPORATOR

A. Nozzle or Dispersion Trays: Designed to evenly distribute refrigerant over tubes. Constructed of brass, stainless steel, or another material that will not corrode.

B. Refrigerant Holding Pan: Stainless steel.

C. Tubes:

1. Individually replaceable, straight tubes expanded into tube sheets. Replaceable from either end and without damage to tube sheets and other tubes.
2. Material: 90/10 Copper-nickel alloy.
3. Minimum Wall Thickness: 0.028 inch.
4. External Finish: Manufacturer's standard.
5. Internal Finish: Enhanced.

D. Water Boxes:

1. Carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
2. Standard type for water box with piping connections.

    a. Water boxes shall have lifting lugs or eyebolts.

3. Nozzle Pipe Connections: Grooved for mechanical-joint coupling.
4. Thermistor or RTD temperature sensor factory installed in each nozzle.
5. Fit each water box with 1-inch drain connection at low point and vent connection at high point, each with threaded plug.

2.7 CONDENSER

A. Refrigerant Holding Pan: Stainless steel.

B. Tubes:

1. Individually replaceable, straight tubes expanded into tube sheets. Replaceable from either end and without damage to tube sheets and other tubes.
2. Material: Copper or copper-nickel alloy.
3. Minimum Wall Thickness: 0.028 inch.
4. External Finish: Manufacturer's standard.
5. Internal Finish: Smooth.

C. Water Boxes:

1. Carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
2. Marine type for water box with piping connections.

    a. Water boxes and marine water-box covers shall have lifting lugs or eyebolts.
    b. Hinged marine water-box covers.

3. Nozzle Pipe Connections: Grooved for mechanical-joint coupling.
4. Thermistor or RTD temperature sensor factory installed in each nozzle.
5. Fit each water box with 1-inch drain connection at low point and vent connection at high point, each with threaded plug.

2.8 GENERATOR FOR SINGLE-EFFECT CHILLERS

A. Tubes:

1. Individually replaceable, straight tubes expanded into tube sheets. Replaceable from either end and without damage to tube sheets and other tubes.
2. Material: 90/10 copper-nickel alloy.
3. Minimum Wall Thickness: 0.035 inch.
4. External Finish: Manufacturer's standard.
5. Internal Finish: Smooth.

B. Water Boxes:

1. Carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
2. Standard type water box.
3. Water boxes shall have lifting lugs or eyebolts.
4. Nozzle Pipe Connections: Welded, ASME B16.5, raised-face flange.
5. Thermistor or RTD temperature sensor factory installed in each nozzle.
6. Fit each water box with 1-inch drain connection at low point and vent connection at high point, each with threaded plug.

2.9 SOLUTION HEAT EXCHANGER

A. Description: Shell-and-tube or brazed-plate heat exchanger; integral part of chiller to increase cycle efficiency by preheating the weak solution on its way to the generator while precooling the strong solution returning from the generator.

2.10 FACTORY-APPLIED INSULATION

A. Factory-Applied Insulation on Cold Surfaces:

1. Closed-cell, flexible elastomeric thermal insulation complying with ASTM C 534, Type I for tube and Type II for sheet materials.

a. Thickness: 3/4 inch.

2. Adhesive: As recommended by insulation manufacturer.
3. Factory apply insulation over all cold surfaces of chiller capable of forming condensation. Components shall include, but not be limited to, evaporator shell and end tube sheets; evaporator water boxes including nozzles; refrigerant pump; cold surfaces of motor; and cold piping.

a. Apply adhesive to 100 percent of insulation contact surface.
b. Before insulating steel surfaces, prepare surfaces for paint, and prime and paint as indicated for other painted components. Do not insulate unpainted steel surfaces.
c. Seal seams and joints to provide a vapor barrier.
d. After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.

2.11 ELECTRICAL

A. Factory installed and wired, and functionally tested at factory before shipment.

B. Single-point, field-power connection to nonfused disconnect switch. Minimum withstand rating shall be as required by electrical power distribution system, but not less than 42,000 A.

1. Branch power circuit to each motor, dedicated electrical load, and controls.

a. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
b. NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit-trip set point.

2. NEMA ICS 2, Class A, full-voltage, nonreversing motor controller, hand-off-auto switch, and overcurrent protection for each motor.
3. Control-circuit transformer with primary and secondary side fuses.

C. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.

D. Wiring Outside of Enclosures: Factory installed in metal raceway except make terminal connections with not more than a 24-inch length of liquidtight or flexible metallic conduit.

2.12 CONTROLS

A. Control: Standalone and microprocessor based, with all memory stored in nonvolatile memory so that reprogramming is not required on loss of electrical power.

B. Enclosure: Unit mounted, NEMA 250, hinged or lockable.

C. Operator Interface: Multiple-character digital or graphic display with dynamic update of information and with keypad or touch-sensitive display located on front of control enclosure. In either imperial or metric units selectable through the interface, display the following information:

1. Date and time.
2. Operating or alarm status.
3. Operating hours.
4. Outdoor-air temperature if required for chilled-water reset.
5. Temperature and pressure of operating set points.
6. Entering and leaving temperatures of chilled and condenser water.
7. Refrigerant temperature.
8. Solution concentration and temperature.
9. Indication of solution and purge-pump operation.
10. Generator shell pressure.
11. Number of starts.
12. Number of purge cycles.
13. Steam demand limit.
14. Inlet steam pressure and temperature.
15. Steam valve actuator potentiometer position (percentage).

D. Control Functions:

1. Manual or automatic startup and shutdown time schedule.
2. Automatic cycle to prevent crystallization.
3. Entering and leaving chilled-water temperatures and control set points. Chilled-water temperature shall be reset based on return-water temperature.
4. Condenser-fluid temperature.

LEED-NC Credit EA 5 requires measurement of performance according to International Performance Measurement and Verification Protocol. If pursuing Credit EA 5, retain first subparagraph below along with satisfying other requirements. See Evaluations.

5. Cooling provided and heating energy used within programmable time periods, minimum monthly.

E. Capacity Control: Automatically controls input flow rate of heat source to maintain chilled-water temperature set point for cooling loads ranging from 10 to 100 percent.

F. Control Valve Package: Factory-furnished, for field installation, control valve package suitable for energy source indicated.

1. Body: Cast-iron, carbon-steel, or stainless-steel body with flanged connections.
2. Type: V-notch ball constructed of stainless steel.
3. Rating: Pressure and temperature rating to match heat exchanger.
4. Shutoff: Capable of bubble-tight shutoff against maximum system pressure.
5. Size: Determined by chiller manufacturer.
6. Modulation: Two-way.
7. Turndown: As required to achieve stable control through the indicated operating range.
8. Actuator: Electric powered from chiller control panel and installed on valve.

G. Safety Shutdowns:

1. Crystallization.
2. Low refrigerant temperature.
3. Loss of chilled- or condenser-water flow.
4. Low leaving chilled-water temperature, 2 deg F below set point.
5. First-stage generator low-solution level.
6. First-stage generator high temperature or pressure.
7. Power failure.
8. Solution pump overloads.
9. External auxiliary safety shutdown.
10. High solution concentration.
11. Incomplete dilution cycle.
12. High inlet steam pressure and temperature.

H. Warning Conditions: Control panel shall close warning contacts and generate a message when one of the following operating conditions is detected:

1. Low refrigerant temperature.
2. High generator temperature or pressure.
3. High entering generator-water temperature (single-stage generator only).
4. High or low entering condenser-water temperature.
5. Solution temperature sensor failure.
6. Low chilled-water flow.

I. Trending: Capability to trend analog data of up to five parameters simultaneously over an adjustable period and frequency of polling.

J. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: view only; view and operate; and view, operate, and service.

K. Control Authority: At least four conditions: Off, local manual control at chiller, local automatic control at chiller, and automatic control through a remote source.

L. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer.

M. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display chiller status and alarms.

Retain first subparagraph below if interface with the BAS is through hardwired points and minimal interface is required.

1. Hardwired Points:

   a. Monitoring: On-off status, common trouble alarm.
   b. Control: On-off operation.

2.13 FINISH

A. Paint chiller, using manufacturer's standard procedures.

2.14 ACCESSORIES

A. Sight Glasses: Equip unit with sight glasses for visual inspection of absorbent solution and refrigerant levels. Provide at least one sight glass in absorber and evaporator sections.

B. Flow Switches:

1. Chiller manufacturer shall furnish a switch for each evaporator and condenser and verify field-mounting location before installation.
2. Paddle Flow Switches:

   a. Vane operated to actuate a double-pole, double-throw switch with one pole field wired to the chiller control panel and the other pole field wired to the BAS.
   b. Contacts: Platinum alloy, silver alloy, or gold-plated switch contacts with a rating of 10 A at 120-V ac.
   c. Pressure rating equal to pressure rating of heat exchanger.
   d. Construct body and wetted parts of Type 316 stainless steel.
   e. House switch in a NEMA 250, enclosure constructed of die-cast aluminum.
   f. Vane length to suit installation.

C. Vibration Isolation:

1. Chiller manufacturer shall furnish neoprene-pad vibration isolation for each chiller.

D. Lithium Bromide Filter:

1. Factory install a filter, isolation valves, and associated piping.
2. Filter shall consist of a stainless-steel body, with removable and cleanable 150-micron, stainless-steel element.
3. Isolation valves shall provide isolation for filter servicing without disturbing operation of chiller.

2.15 SOURCE QUALITY CONTROL

A. Factory test and inspect absorber, generator, evaporator and condenser according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Pressure test tube-side of heat exchangers, including water boxes, to 1.5 times the rated pressure. Vacuum and pressure test shells for leaks.

B. Rate sound power level according to ARI 575.

C. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine chillers before installation. Reject chillers that are damaged.

B. Examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting chiller performance, maintenance, and operations before equipment installation.

1. Final chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CHILLER INSTALLATION

A. Install chillers on support structure indicated.

B. Equipment Mounting: Install chiller on concrete bases using elastomeric pads. Comply with requirements for concrete bases specified in Division 03 Section "Cast-in-Place Concrete." Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration Controls for HVAC Piping and Equipment."

C. Maintain manufacturer's recommended clearances for service and maintenance.

D. Charge chiller with absorbent and refrigerant if not factory charged.

E. Install separate devices furnished by manufacturer and not factory installed.

F. Insulate hot and cold chiller surfaces that are recommended by chiller manufacturer to be insulated, and are not factory insulated. Comply with requirements in Division 23 Section "HVAC Insulation."

3.3 CONNECTIONS

A. Comply with requirements in Division 23 Section "Hydronic Piping" for hydronic piping. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements in Division 23 Section "Steam and Condensate Heating Piping" for steam and condensate piping. Drawings indicate general arrangement of piping, fittings, and specialties.

C. Install piping adjacent to chiller to allow service and maintenance.

D. Generator Steam Piping Connections:

1. Connect steam piping with trapped drip leg, gate valve, strainer, control valve, and pressure gage. Install pressure reducing valve and safety relief valve upstream from steam-control valve to protect control valve from excessive steam pressure. Make connections to chiller with a flange.
2. Connect steam condensate piping with vacuum breaker, trapped drip leg, gate valve, strainer, float and thermostatic trap(s), condensate receiver and pump, and check valve. Make connections to chiller with a flange.

E. Evaporator-Fluid Connections: Connect to evaporator inlet with shutoff valve, thermometer, and plugged tee with shutoff valve and pressure gage. Connect to evaporator outlet with shutoff valve, balancing valve, flow switch, thermometer, plugged tee with shutoff valve and pressure gage, and drain connection with valve. Make connections to chiller with a mechanical coupling.

F. Absorber/Condenser-Fluid Connections: Connect to inlet with shutoff valve, thermometer, and plugged tee with shutoff valve and pressure gage. Connect to outlet with shutoff valve, balancing valve, flow switch, thermometer, plugged tee with shutoff valve and pressure gage, and drain connection with valve. Make connections to chiller with a mechanical coupling.

1. If not factory furnished or installed, provide pipe connecting fluid connection of absorber discharge and condenser inlet.

G. Refrigerant Pressure Relief Device Connections: Extend vent piping to the outdoors without valves or restrictions. Comply with ASHRAE 15. Connect to chiller pressure relief device with flexible connector and dirt leg with drain valve.

H. Extend purge vent piping to the outdoors. Comply with ASHRAE 15.

I. Connect each chiller drain connection with a union and drain pipe, and extend pipe, full size of connection, to floor drain. Provide a shutoff valve at each connection.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

2. Operate chiller for run-in period.
3. Verify that absorbent and refrigerant charge is sufficient and chiller has been leak tested.
4. Verify that pumps are installed and functional.
5. Verify that thermometers and gages are installed.
6. Operate chiller for run-in period.
7. Verify that refrigerant pressure relief device is vented outside.
8. Verify proper motor rotation.
9. Verify static deflection of vibration isolators including deflection during chiller startup and shutdown.
10. Verify and record performance of fluid flow and low-temperature interlocks for evaporator and condenser.
11. Verify and record performance of chiller protection devices.
12. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assembly, installation, and connection.

C. Prepare test and inspection startup reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain chillers.

END OF SECTION 236413