SECTION 236423 - AIR-COOLED PACKAGED SCROLL 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 packaged, air-cooled, electric-motor-driven, scroll water chillers.

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. DDC: Direct digital control.

D. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in Btu/h to the total power input given in watts at any given set of rating conditions.

E. GFI: Ground fault interrupt.

F. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit for a single chiller calculated per the method defined by AHRI 550/590 and referenced to AHRI standard rating conditions.

G. I/O: Input/output.

H. kW/Ton: The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons at any given set of rating conditions.

I. NPLV: Nonstandard part-load value. A single number part-load efficiency figure of merit for a single chiller calculated per the method defined by AHRI 550/590 and intended for operating conditions other than the AHRI standard rating conditions.

J. SCCR: Short-circuit current rating.

K. TEAO: Totally enclosed air over.

L. TENV: Totally enclosed nonventilating.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include refrigerant, rated capacities, operating characteristics, and furnished specialties and accessories.
2. Performance at AHRI standard conditions and at conditions indicated.
3. Performance at AHRI standard unloading conditions.
4. Minimum evaporator flow rate.
5. Refrigerant capacity of water chiller.
6. Oil capacity of water chiller.
7. Fluid capacity of evaporator.
8. Characteristics of safety relief valves.
9. Force and moment capacity of each piping connection.

B. Shop Drawings: Complete set of manufacturer's prints of water chiller assemblies, control panels, sections and elevations, and unit isolation. Include the following:

1. Assembled unit dimensions.
2. Weight and load distribution.
3. Required clearances for maintenance and operation.
4. Size and location of piping and wiring connections.
5. Diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

1. Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

a. Structural supports.
b. Piping roughing-in requirements.
c. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
d. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.

2. Coordination drawings showing plan, section and elevation views, drawn to <**Insert scale**>.
3. Each view to show screened background with the following:

a. Column grids, beams, columns, and concrete housekeeping pads.
b. Layout with walls, floors, and roofs, including each room name and number.
c. Equipment and products of other trades that are located in vicinity of chillers and part of final installation, such as plumbing systems.

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

C. Seismic Qualification Data: Certificates, for water chillers, accessories, and components, from manufacturers.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Installation instructions.

E. Source quality-control reports.

F. Startup service reports.

G. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

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

B. Spare Parts List: Recommended spare parts list with quantity for each.

C. Touchup Paint Description: Detailed description of paint used in application of finish coat to allow for procurement of a matching paint.

D. Instructional Videos: Including those that are prerecorded and those that are recorded during training.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Tool kit to include the following:

1. A tool kit specially designed by chiller manufacturer for use in servicing chiller(s) furnished.
2. Special tools required to service chiller components not readily available to Owner service personnel in performing routine maintenance.
3. Lockable case with hinged cover, marked with large and permanent text to indicate the special purpose of tool kit, such as "Chiller Tool Kit." Text size shall be at least 1 inch (25 mm) high.
4. A list of each tool furnished. Permanently attach the list to underside of case cover. Text size shall be at least 1/2 inch (13 mm) high.

B. Touchup Paint: [**32 oz. (1 L)**] <**Insert volume**> container of paint used for finish coat. Label outside of container with detailed description of paint to allow for procurement of a matching paint in the future.

1.8 QUALITY ASSURANCE

A. Retain "AHRI Certification" Paragraph below if AHRI certification is required and Project requirements fall within limits of AHRI 590 certification program. AHRI 550/590 is broken into

two certification programs; AHRI 590 certification program is applicable to scroll water chillers. Review the latest version to confirm requirements.

B. Unit shall be rated in accordance with AHRI (Air-Conditioning, Heating and Refrigeration Institute) Standard 550/590, latest edition (U.S.A.) and all units shall be ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) 90.1-2013 compliant.

C. Unit construction shall comply with ASHRAE 15 Safety Code, UL (Underwriters Laboratories) latest edition, and ASME (American Society of Mechanical Engineers) applicable codes (U.S.A. codes).

D. The management system governing the manufacture of this product is ISO (International Organization for Standardization) 9001:2008 certified.

E. Unit shall be full load run tested at the factory.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Ship water chillers from the factory fully charged with refrigerant and filled with oil.

B. Package water chiller for export shipping.

C. Unit controls shall be capable of withstanding 150°F (66°C) storage temperatures in the control compartment.

D. Unit shall be stored and handled per unit manufacturer's recommendations.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of water 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 including refrigerant and oil charge.
b. Complete compressor and drive assembly including refrigerant and oil charge.
c. Refrigerant and oil charge.

1) Loss of refrigerant charge for any reason due to manufacturer's product defect and product installation.

d. Parts and labor.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Site Altitude: Chiller shall be suitable for altitude at which installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.

B. Performance Tolerance: Comply with the following in lieu of AHRI 550/590:

1. Allowable Capacity Tolerance: Zero percent.
2. Allowable Full-Load Energy Efficiency Tolerance: Zero percent.
3. Allowable Part-Load Energy Efficiency Tolerance: Zero percent.

C. AHRI Rating: Rate water chiller performance according to requirements in AHRI 550/590.

D. ASHRAE Compliance: ASHRAE 15 for safety code for mechanical refrigeration.

E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

F. ASME Compliance: Fabricate and stamp water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code.

G. Comply with NFPA 70.

H. Comply with requirements of UL 1995, "Heating and Cooling Equipment," and include label by a qualified testing agency showing compliance.

I. Operation Following Loss of Normal Power:

1. Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply connected to backup power system shall automatically return equipment and associated controls to the operating state occurring immediately before loss of normal power without need for manual intervention by an operator when power is restored either through a backup power source, or through normal power if restored before backup power is brought on-line.
2. See drawings for equipment served by backup power systems.
3. Provide means and methods required to satisfy requirement even if not explicitly indicated.

J. Outdoor Installations:

1. Chiller shall be suitable for outdoor installation indicated. Provide adequate weather protection to ensure reliable service life over a 25-year period with minimal degradation due to exposure to outdoor ambient conditions.
2. Chillers equipped to provide safe and stable operation while achieving performance indicated when operating at extreme outdoor temperatures encountered by the installation. Review historical weather database and provide equipment that can operate at extreme outdoor temperatures recorded over past 30-year period.

2.2 MANUFACTURERS

A. Carrier (Basis of Design)

B. Trane

C. York

D. Or equal

2.3 SYSTEM DESCRIPTION

A. Microprocessor controlled, air-cooled liquid chiller for outdoor installation, utilizing scroll compressors, low sound fans, electronic expansion valve, optional hydronic pump system (60 Hz only), and fluid storage tank (storage tank on models 011-060 only).

B. For units that incorporate Greenspeed intelligence, all fans are controlled with variable speed fan drive motors. Chiller software shall be specifically developed to coordinate optimal fan speed for application conditions and provide refriger-ant circuit optimization, resulting in higher part load efficiency and reduced acoustic levels.

2.4 EQUIPMENT

A. General:

Factory assembled, single-piece chassis, air-cooled liquid chiller. Contained within the unit cabinet shall be all factory wiring, piping, controls, refrigerant charge (R-410A), and special features required prior to field start-up.

B. Materials of Construction:

1. Frame shall be of heavy-gage, galvanized steel.
2. Exterior panels shall be galvanized steel with a baked enamel powder or pre-painted finish.
3. Cabinet shall be capable of withstanding 500-hour salt spray test in accordance with the ASTM (American Society for Testing and Materials, U.S.A.) B-117 standard.
4. All units 60 tons and below shall conform to Florida Building Code 5th Edition requirements for installation including High Velocity Hurricane Zone (HVHZ) Risk Category IV (V [Velocity] = 186 mph), exposure category “C” and installation height up to and including 100 feet above grade.

C. Fans:

1. Standard condenser fans shall be direct-driven (VFD [variable frequency drive] controlled on units with Greenspeed intelligence), 9-blade airfoil cross-section, reinforced polymer construction, shrouded-axial type, and shall be statically and dynamically balanced with inherent corrosion resistance.
2. The variable speed drives for the condenser fans on 30RAP units with Greenspeed intelligence shall include a DC link reactor.
3. Fan operation shall allow reduced sound levels during scheduled unoccupied operating periods. Manufacturers without unoccupied reduced sound capability shall submit $^1/_3$ oc-

tave band data and sound power data as measured according to AHRI 370 as confirmation of unit sound characteristics.
4. Air shall be discharged vertically upward.
5. Fans shall be protected by coated steel wire safety guards.

D. Compressor/Compressor Assembly:

1. Fully hermetic, direct-drive, scroll-type compressors.
2. Compressor motors shall be cooled by refrigerant gas passing through motor windings and shall have either internal line break thermal and current overload protection or external current overload modules with compressor temperature sensors.
3. Compressors shall be mounted on rubber in shear vibration isolators.
4. Staging of compressors shall provide unloading capability. Digital compressor unloading control shall be available as an option (sizes 011-090 only).
5. Each compressor (sizes 070-150 only) shall be equipped with crankcase heaters to minimize oil dilution. Crankcase heaters are not required on sizes 011-060 due to very low refrigerant charge.

E. Cooler:

1. Cooler shall be rated for a refrigerant working-side pressure of 505 psig (3482 kPa) on sizes 011-025, 565 psig (3896 kPa) on sizes 030-060, and 450 psig (3103 kPa) on sizes 070-150 and shall be tested for a maximum water-side pressure of 300 psig (2068 kPa) or 150 psig (1034 kPa) when optional hydronic package is installed.
2. Shall be single-pass, ANSI (American National Standards Institute) type 316 stainless steel, brazed plate construction.
3. Shell shall be insulated with $^{3}/_{4}$-in. (19 mm) closed-cell, polyvinyl-chloride foam with a maximum K factor of 0.28.
4. Shall incorporate 2 independent refrigerant circuits on sizes 035 to 150; sizes 011 to 030 shall have one independent refrigerant circuit.
5. Cooler shall have optional factory-installed heater, to protect cooler from ambient temperature freeze down to –20°F (–29°C) for 60 Hz applications and –15°F (–26°C) for 50 Hz applications.
6. Unit shall be provided with a factory-installed flow switch.
7. All connections shall use standard Victaulic-type fittings.
8. Cooler fluid inlet line shall have a 40 mesh strainer just ahead of the cooler.

F. Condenser:

1. Coil shall be air-cooled Novation® heat exchanger technology with microchannel (MCHX) coils and shall have a series of flat tubes containing a series of multiple, parallel flow microchannels layered between the refrigerant manifolds.
2. Coils shall consist of a two-pass arrangement. Coil construction shall consist of aluminum alloys for fins, tubes, and manifolds in combination with a corrosion-resistant coating.
3. Tubes shall be cleaned, dehydrated, and sealed.
4. Assembled condenser coils shall be leak tested and pressure tested at 656 psig (4522 kPa).
5. To plan the chiller installation and for ease of maintenance/coil removal on unit sizes 30RAP070-150, all refrigerant piping entering and leaving the condenser coils shall be located on only one side of the chiller so the coils can be removed (when needed) from the side free of piping. This is important to consider because removing the coils from the header side, although possible, involves extra labor due to extra bending and brazing of the coil headers.

G. Refrigeration Components:

Refrigerant circuit components shall include filter drier, moisture indicating sight glass, electronic expansion device, discharge and liquid service valves (sizes 070-150 only) and complete operating charge of both refrigerant R-410A and compressor oil.

H. Controls, Safeties, and Diagnostics:

1. Unit controls shall include the following minimum components:

   a. Microprocessor with non-volatile memory. Battery backup system shall not be accepted.
   b. Separate terminal block for power and controls.
   c. Control transformer to serve all controllers, relays, and control components.
   d. ON/OFF control switch.
   e. Replaceable solid-state controllers.
   f. Pressure sensors shall be installed to measure suction and discharge pressure for each circuit. Thermistors shall be installed to measure cooler entering and leaving fluid temperatures, outdoor ambient temperature, and suction temperature. Provision for field installation of accessory sensor to measure compressor return gas temperature.

2. Unit controls shall include the following functions:

   a. Automatic circuit lead/lag for dual circuit chillers.
   b. Hermetic scroll compressors are maintenance free and protected by an auto-adaptive control that minimizes compressor wear.
   c. Capacity control based on leaving chilled fluid temperature and compensated by rate of change of return-fluid temperature with temperature set point accuracy to 0.1°F (0.06°C).
   d. Limiting the chilled fluid temperature pull-down rate at start-up to an adjustable range of 0.2°F to 2°F (0.11°C to 1.1°C) per minute to prevent excessive demand spikes at start-up.
   e. Seven-day time schedule.
   f. Leaving chilled fluid temperature reset from return fluid and outside air temperature.
   g. Chilled water pump start/stop control and primary/standby sequencing to ensure equal pump run time.
   h. Dual chiller control for parallel chiller applications without addition of hardware modules and control panels (additional thermistors and wells are required).
   i. Timed maintenance scheduling to signal maintenance activities for pumps, condenser coil cleanings, strainer maintenance and user-defined maintenance activities.
   j. Boiler enable signal to initiate system heating mode.
   k. Low ambient protection to energize cooler and hydronic system heaters.
   l. Periodic pump start to ensure pump seals are properly maintained during off-season periods.
   m. Single step demand limit control activated by remote contact closure.
   n. Nighttime sound mode to reduce the sound of the machine by a user-defined schedule.

3. Diagnostics:

   a. The control panel shall include, as standard, a scrolling marquee display capable of indicating the safety lockout condition by displaying a code for which an explanation may be scrolled at the display.

b. Information included for display shall be:

1) Compressor lockout.
2) Loss of charge.
3) Low fluid flow.
4) Cooler freeze protection.
5) Cooler set point.
6) Chilled water reset parameters.
7) Thermistor and transducer malfunction.
8) Entering and leaving-fluid temperature.
9) Compressor suction temperature.
10) Cooler and condenser pressure.
11) System refrigerant temperatures.
12) Chiller run hours.
13) Compressor run hours.
14) Compressor number of starts.
15) Low superheat.
16) Time of day:

a) Display module, in conjunction with the microprocessor, must also be capable of displaying the output (results) of a service test. Service test shall verify operation of every switch, thermistor, fan, and compressor before chiller is started.
b) Diagnostics shall include the ability to review a list of the 20 most recent alarms with clear language descriptions of the alarm event. Display of alarm codes without the ability for clear language descriptions shall be prohibited.
c) An alarm history buffer shall allow the user to store no less than 20 alarm events with clear language descriptions, time and date stamp event entry.
d) The chiller controller shall include multiple connection ports for communicating with the local equipment network, the Carrier Comfort Network® (CCN) system and access to chiller control functions from any point on the chiller.
e) The control system shall allow software upgrade without the need for new hardware modules.

4. Safeties:

a. Unit shall be equipped with thermistors and all necessary components in conjunction with the control system to provide the unit with the following protections:

1) Loss of refrigerant charge.
2) Reverse rotation.
3) Low chilled fluid temperature.
4) Thermal overload.
5) High pressure.
6) Electrical overload.

b. Factory pump motors (available in 60 Hz only) shall have external overcurrent protection.

I. Operating Characteristics:

1. Unit shall be capable of starting and operating down to –20°F (–29°C) on size 011 and 016 units, 45°F (7°C) on size 018-030 units, and 32°F (0°C) on size 035-150 units as standard.
2. Unit shall be capable of starting and running at outdoor ambient temperatures up to 120°F (50°C) for all sizes. Unit shall additionally be able to stay online when running with a 125°F (52°C) ambient temperature.
3. Unit shall be capable of starting up with 95°F (35°C) entering fluid temperature to the cooler.

J. Fan Motors:

1. Condenser fans shall be direct-drive AeroAcoustic™ type, discharging air vertically upward.
2. All condenser fan motors shall be totally enclosed 3-phase type with permanently lubricated ball bearings, Class F insulation and internal, automatic reset thermal overload protection or manual reset calibrated circuit breakers.
3. Shafts shall have inherent corrosion resistance.
4. Fan blades shall be statically and dynamically balanced.
5. Condenser fan openings shall be equipped with PVC coated steel wire safety guards.

K. Electrical Requirements:

1. Unit/module primary electrical power supply shall enter the unit at a single electrical box (includes option for dual point connection on sizes 070-150).
2. Unit shall operate on 3-phase power at the voltage shown in the equipment schedule.
3. Control points shall be accessed through terminal block.
4. Unit shall be shipped with factory control and power wiring installed.

L. Chilled Water Circuit:

1. Chilled water circuit shall be rated for 300 psig (2068 kPa). Units with optional pump package (60 Hz only) are rated for 150 psig (1034 kPa) working pressure.
2. Solid-state flow monitor with integral relay shall be factory installed and wired.
3. Brass body strainer with 40 mesh screen and ball type blow down.
4. Optional hydronic package (60 Hz only, applies to all unit sizes except as noted, with or without the use of a VFD [variable frequency drive]):

    a. Field pipe connections shall be carbon steel Victaulic type.
    b. Optional single or primary/stand-by operation pump systems. Dual pump systems shall have a pump discharge check valve.
    c. For dual-pump packages, the equipment shall have one pump operating, and a simple transition to the back-up pump shall be accomplished by means of a valve which shall be supplied with this configuration.
    d. For dual-pump packages, when servicing is required, the pump removal/installation process shall require neither the chiller to be drained nor the installation of a blank flange to replace the pump being removed/installed.
    e. Pumps shall be single stage design, capable of being serviced without disturbing piping connections.

        1) Pump casing shall be of class 30 cast iron.
        2) The impeller shall be of cast bronze, closed type, dynamically balanced, keyed to the shaft and secured by locking cap screw.
        3) The hydronic kit will be provided with a flush line connection to ensure lubrication at the seal face and allow for positive venting of the seal chamber.
        4) Pump shall be rated for 150 psig (1034 kPa) working pressure.
        5) The pump case shall have gage tappings at the suction and discharge nozzles and include drain ports.

6) Motors shall totally enclosed 3-phase type with grease lubricated ball bearings.
7) Each pump shall be factory tested per Hydraulic Institute Standards.
8) Pump motors shall be VFD compatible.

a. Fluid expansion tank (sizes 011-060) shall be factory installed within the chiller cabinet insulates, pre-charged and rated for a maximum working pressure of 150 psig (1034 kPa).
b. Water pressure taps (2) shall be factory installed across the cooler and rated for 150 psig (1034 kPa).
c. Balancing valve shall be factory installed to set flow gage ports shall be factory-installed and rated for 300 psig (2068 kPa).
d. Hydronic assembly shall have factory- supplied electric freeze protection to –20°F (–29°C) when optional heaters are used.
e. Piping shall be type-L seamless copper tubing.

5. With VFD (60 Hz only) (these comments are applicable in addition to the comments in section L.4 when the VFD hydronic package is employed [30RAP070-150 only]):

a. The drive shall be of the VVC-PWM (voltage vector control - pulse with modulation) type, providing near unity displacement power factor without the need for external power factor correction capacitors at all loads and speeds.
b. The drive and motor protection shall include; motor phase to ground fault, loss of supply phase, over voltage, under voltage, motor overtemperature, inverter overload, and overcurrent. Overcurrent is not allowed, ensuring hydronic units will not overload the motor at any point in the operating range of the unit.
c. Sensorless control software shall be available in the hydronic unit to provide automatic speed control without the need for pump mounted (internal/external) or remotely mounted differential pressure system feedback sensors. Control mode setting and minimum/maximum head set points shall be set at the factory and be user adjustable via the programming interface.
d. The integrated control shall incorporate an integrated graphical user interface that shall provide running and diagnostic information and identify faults and status in clear English language. Faults shall be logged and/or recorded for review at a later date. It shall be possible to upload parameters from one drive into the non-volatile memory of a computer and download the parameters into other drives requiring the same settings. The keypad shall incorporate Hand-Off-Auto pushbuttons to enable switching between BMS (Building Management System) and manual control. The drive shall incorporate a USB port for direct connection to a PC and an RS485 connection with Modbus[1] RTU protocol. Optional protocols available should include BACnet[2] and LonWorks[3].
e. The control shall have the following additional features: Sensorless override for BMS, manual pump control or closed loop PID (proportional/integral/derivative) control; programmable skip frequencies and adjustable switching frequency for noise/vibration control; auto alarm reset; motor pre-heat function; six programmable digital inputs; two analog inputs; one programmable analog/digital output; two volt-free contacts.

[1]Modbus is a registered trademark of Schneider Electric.

[2]BACnet is a registered trademark of ASHRAE (American Society of Heating, Refrigerating, and Air-Conditioning Engineers).

[3]LonWorks is a registered trademark of Echelon Corporation.

f. The hydronic unit shall be capable of operating in any of the following control modes:

1) Duty pump and standby pumps with sensorless control.
2) Duty pump and standby pumps with remote sensor or building automation system (BAS) control.

M. Special Features:

Certain standard features are not applicable when the features designated by * are specified. For assistance in amending the specifications, contact your Carrier representative.

1. High-efficiency variable condenser fans:

All fans on the unit shall have variable speed fan motors to provide higher part load efficiency and reduced acoustic levels. Each fan circuit shall have a factory-installed, independent variable speed drive with display. Variable speed drives are rated IP-55 enclosures and UL Listed. The use of this option, with the addition of antifreeze in the cooler circuit and wind baffles, shall allow running with outdoor ambient temperatures down to –20°F (–28.9°C). This option is a standard feature on sizes 011 and 016, is not available on sizes 070-150, and is not available in combination with low ambient head pressure control.

2. Low-Ambient Operation:

Unit shall be capable of starting and operating down to –20°F (–29°C) with the addition of either the field or factory-installed solid-state low ambient head pressure control or high-efficiency vari-able con-denser fans. In addition, adequate field-supplied antifreeze with suitable corrosion inhibitor protection shall be field-installed in the cooler circuit. Field-installed wind baffles shall also be required. If significant low-load operation is anticipated, then hot gas bypass is recommended. High-efficiency variable condenser fans are standard on sizes 011 and 016.

NOTE: The motors associated with low ambient head pressure control will be open type and shall have class B insulation.

3. Unit-Mounted Non-Fused Disconnect:

Unit shall be supplied with factory-installed, non-fused electrical disconnect for main power supply. For unit sizes 070 and larger, this option is available only with single-point power. Additionally, on sizes 100-150, this option is not available with 208/230 volts. This option is included with the high SCCR option.

4. Optional Condenser Coil Materials:

a. E-coated microchannel coils:

E-coated aluminum microchannel coil shall have a flexible epoxy polymer coating uniformly applied to all coil external surface areas without material bridging between fins or louvers. Coating process shall ensure complete coil encapsulation, including all exposed fin edges. E-coat shall have a thickness of 0.8 to 1.2 mil with top coat having a uniform dry film thickness from 1.0 to 2.0 mil on all external coil surface areas including fin edges. E-coated coils shall have superior hardness characteristics of 2H per ASTM D3363-00 and cross hatch adhesion of 4B-5B per ASTM D3359-02. Impact resistance shall be up to 160 in./lb

(ASTM D2794-93). E-coated coil shall have superior impact resistance with no cracking, chipping, or peeling per NSF/ANSI 51-2002 Method 10.2. E-coated aluminum microchannel coils shall be capable of withstanding 8,000-hour salt spray test in accordance with the ASTM (American Society for Testing and Materials) B-117 Standard.

b. Aluminum fin/copper tube coils:

Coil shall be constructed of seamless copper tubes mechanically bonded to aluminum fins. Fins shall have wavy enhancements. These condenser coils are recommended with remote cooler applications. These coils are not recommended for corrosive environments.

c. Pre-coated aluminum-fin coils:

Coil shall have a durable epoxy-phenolic coating to provide protection in mildly corrosive coastal environments. Coating shall be applied to the aluminum fin stock prior to the fin stamping process to create an inert barrier between the aluminum fin and copper tube. Epoxy-phenolic barrier shall minimize galvanic action between dissimilar metals.

d. Copper-fin coils:

Coil shall be constructed of copper fins mechanically bonded to copper tubes and copper tube sheets. Galvanized steel tube sheets shall not be acceptable. A polymer strip shall prevent coil assembly from contacting sheet metal coil pan to minimize potential for galvanic corrosion between the coil and pan. All-copper construction shall provide protection in moderate coastal applications.

e. E-coated aluminum-fin coils:

Coil shall have a flexible epoxy polymer coating uniformly applied to all coil surface areas without material bridging between fins. Coating process shall ensure complete coil encapsulation. Color shall be high gloss black with gloss; 60° of 65 to 90% per ASTM ID523-89. Uniform dry film thickness from 0.8 to 1.2 mil on all surface areas including fin edges. Superior hardness characteristics of 2H per ASTM D3363-92A and cross hatch adhesion of 4B-5B per ASTM D3359-93. Impact resistance shall be up to 160 in./lb (ASTM D2794-93). Humidity and water immersion resistance shall be up to minimum 1000 and 250 hours respectively (ASTM D2247-92 and ASTM D870-92). Corrosion durability shall be confirmed through testing to no less than 3000 hours salt spray per ASTM B117-90. Coil construction shall be aluminum fins mechanically bonded to copper tubes.

f. E-coated copper-fin coils:

Coil shall have a flexible epoxy polymer coating uniformly applied to all coil surface areas without material bridging between fins. Coating process shall ensure complete coil encapsulation. Color shall be high gloss black with gloss; 60° of 65 to 90% per ASTM D523-89. Uniform dry film thickness from 0.8 to 1.2 mil on all surface areas including fin edges. Superior hardness characteristics of 2H per ASTM D3363-92A and cross hatch adhesion of 4B-5B per ASTM D3359-93. Impact resistance shall be up to 160 in./lb (ASTM D2794-93). Humidity and water immersion resistance shall be up to minimum 1000 and 250 hours respectively (ASTM D2247-92 and ASTM D870-92). Corrosion durability shall be confirmed

through testing to no less than 3000 hours salt spray per ASTM B117-90. Coil construction shall be copper-fins mechanically bonded to copper tube sheets. Galvanized steel tube sheets shall not be acceptable. A polymer strip shall prevent coil assembly from contacting sheet metal coil pan to maintain coating integrity and minimize corrosion potential between the coil and pan.

1. Remote Enhanced Display:
   Unit shall be supplied with indoor-mounted, remote, 40-character per line, 16-line display panel for field installation.
2. Chillervisor System Manager III Multi-Unit Control:
   Field-installed control shall sequence between 2 and 8 chillers in parallel in a single system.
3. Hot Gas Bypass:
   Unit shall be equipped with factory or field-installed, microprocessor-controlled, hot gas bypass that shall permit unit operation down below the minimum standard step of capacity. The factory option is not available on sizes 011 and 016 or on any application with a leaving fluid temperature below 35°F (2°C). Option and accessory not available on units with the digital compressor option.
4. Energy Management Module:
   A factory or field-installed module shall provide the following energy management capabilities: 4 to 20 mA signals for leaving fluid temperature reset, cooling set point or demand limit control; 2-point demand limit control (from 15% to 100%) activated by a remote contact closure; and discrete input for “Ice Done” indication for ice storage system interface.
5. Security Grilles/Hail Guards:
   Unit shall be supplied with factory or field-installed, louvered, sheet metal panels which securely fasten to the chiller and provide condenser coil protection against hail and other physical damage. This option or accessory directly covers the coil(s) on sizes 011 to 060. On sizes 070 and larger, the louvered panels are only on the ends of the chiller, with a wire guard entirely covering the sides of the chiller.
6. Vibration Isolation:
   Vibration isolation pads shall be supplied for field installation at unit mounting points. Pads shall help to reduce vibration transmission into the occupied space.
7. Chilled Water Storage Tank (Sizes 011-060 only):

   a. Fluid storage tank shall be rated for a maximum of 150 psig (1034 kPa).
   b. Shall provide a minimum 4 gallon per ton (3.7 L per kW) fluid storage capacity.
   c. Shall fit under the chiller to minimize system footprint requirements. Tanks fitted outside of chiller footprint shall not be acceptable.
   d. Tank shall be constructed a cold rolled carbon steel shell.
   e. Tank shall be insulated with $^{3}/_{4}$-in. (19 mm) closed-cell, polyvinyl-chloride foam with a maximum K factor of 0.28.
   f. Tank shall be baffled to prevent temperature stratification.
   g. Tank shall have Victaulic connections.
   h. Tank shall have vent and drain plugs accessible from outside tank enclosure.
   i. Internal heaters shall provide freeze protection to –20°F (–29°C). The included heater thermostat prevents overheating of the fluid.

1. BACnet Communication Option:
2. Shall provide pre-programmed factory-installed communication capability with a BACnet MS/TP network. Allows integration with i-Vu® Open control system or a third-party BACnet building automation system. No field programming shall be required.
3. BACnet/Modbus Translator Control:
4. Unit shall be supplied with field-installed interface between the chiller and a BACnet Local Area Network (LAN, i.e., MS/TP EIA-485). Field programming shall be required.

5. LON Translator control:
6. Unit shall be supplied with field-installed interface between the chiller and a Local Operating Network (LON, i.e., LonWorks FT-10A ANSI/EIA-709.1). Field programming shall be required.
7. Navigator™ Hand-Held Display:

    a. Portable hand held display module with a minimum of 4 lines and 20 characters per line, of clear English, Spanish, Portuguese or French language.
    b. Display menus shall provide clear language descriptions of all menu items, operating modes, configuration points and alarm diagnostics. Reference to factory codes shall not be accepted.
    c. RJ-14 connection plug shall allow display module to be connected to factory-installed receptacle.
    d. Industrial grade coiled extension cord shall allow the display module to be moved around the chiller.
    e. Magnets shall hold the display module to any sheet metal panel to allow hands-free operation.
    f. Display module shall have NEMA 4x housing suitable for use in outdoor environments.
    g. Display shall have back light and contrast adjustment for easy viewing in bright sunlight or night conditions.
    h. Raised surface buttons with positive tactile response.

8. Touch Pilot™ Display:
9. Unit shall be supplied with a remote mount touch screen display for network attachment to the chiller.
10. GFI Convenience Outlet (60 Hz Only):
11. Shall be factory or field installed to provide the chiller with a 4 amp GFI receptacle. The receptacle shall have independent fuse protection. The convenience outlet is a 115-v female receptacle.
12. Freeze Protection Cooler Heaters:
13. Cooler heaters shall provide protection from cooler freeze-up to –20°F (–29°C) 60 Hz and –15°F (–26°C) 50 Hz.
14. Value Sound Fans:
15. Shall provide propeller-type fans for applications that are not highly sound-sensitive. These fans shall have Class F insulation and internal, automatic-reset thermal overload protection or manual reset calibrated circuit breakers.
16. Ultra-Low Sound:
17. Shall provide sound blankets around each compressor in conjunction with low-sound AeroAcoustic™ fans to provide significant chiller sound reduction.
18. High SCCR (Short Circuit Current Rating):
19. The optional high SCCR (short circuit current rating) device shall allow the chiller to tolerate a 65 kA (208/230, 380, 380/415, and 460-v units) or 25 kA (575-v units) short circuit current for a brief period of time while protecting the downstream components. The high SCCR option shall provide a higher level of protection than the standard unit. This is not available with dual point power at any size, or with 208/230-v units in the size range of 100-150. The selection of this option includes a non-fused disconnect.
20. Compressor Suction Service Valves (Sizes 070-150 only):
21. Shall provide a suction service valve per circuit, which is in addition to the standard discharge service valve.
22. Digital Compressor Option (Sizes 011-090 only):
23. Shall provide a factory-installed digital compressor to provide incremental steps for tighter temperature control (not available on any application with a leaving fluid temperature below 35°F [2°C]).
24. Remote Cooler Kit:

25. Field-installed remote cooler kit shall provide the additional hardware required to remotely mount the cooler from the unit. There are limits to total separation of the unit to the cooler as well as vertical separation limits, and these shall be delineated in the accessory installation instructions. Never bury refrigerant piping on these or any other applications.
26. Wind Baffles:
27. Wind baffles facilitate operation down to –20°F (–29°C) when used in conjunction with either low ambient temperature head pressure control or high-efficiency variable condenser fans.
28. Low Sound Compressor Blankets:
29. Accessory low sound compressor blankets shall reduce unit the sound levels by providing an acoustic blanket on each compressor.
30. Seismic Certification:
31. A seismic kit is available. Its use will result in a unit SDS (seismic design acceleration parameter) level of 2.5 for 30RAP011-060 units, or a unit SDS level of 2.1 for 30RAP070-150 units.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before water chiller installation, examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, controls, and electrical connections to verify actual locations, sizes, and other conditions affecting water chiller performance, maintenance, and operations.

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

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

3.2 WATER CHILLER INSTALLATION

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

B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures with actual equipment provided.

C. Install water chillers on support structure indicated.

D. Equipment Mounting:

1. Install water chillers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in [**Section 033000 "Cast-in-Place Concrete."**] [**Section 033053 "Miscellaneous Cast-in-Place Concrete."**]
2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

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

F. Maintain clearances required by governing code.

G. Chiller manufacturer's factory-trained service personnel shall charge water chiller with refrigerant if not factory charged and fill with oil if not factory installed.

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

1. Chillers shipped in multiple major assemblies shall be field assembled by chiller manufacturer's factory-trained service personnel.

3.3 PIPING CONNECTIONS

A. Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements in Section 232300 "Refrigerant Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

C. Where installing piping adjacent to chillers, allow space for service and maintenance.

D. Evaporator Fluid Connections:

1. Connect to evaporator inlet with shutoff valve,[**strainer,**] [**flexible connector,**] thermometer, and plugged tee with pressure gage.
2. Connect to evaporator outlet with shutoff valve, balancing valve,[**flexible connector,**] flow switch, thermometer, plugged tee with pressure gage,[**flow meter,**] and drain connection with valve.
3. Make connections to water chiller with a [**union**] [**flange**] [**or**] [**mechanical coupling**].

E. Heat Recovery Condenser Fluid Connections:

1. Connect to condenser inlet with shutoff valve,[**strainer,**] [**flexible connector,**] thermometer, and plugged tee with pressure gage.
2. Connect to condenser outlet with shutoff valve, balancing valve,[**flexible connector,**] flow switch, thermometer, plugged tee with pressure gage,[**flow meter,**] and drain connection with valve.
3. Make connections to water chiller with a [**union**] [**flange**] [**or**] [**mechanical coupling**].

F. Connect each drain connection with a drain valve, full size of drain connection.[**Connect drain pipe to drain valve with union and extend drain pipe to terminate over floor drain.**]

G. Connect each chiller vent connection with [**an automatic**] [**or**] [**a manual**] vent, full size of vent connection.

3.4 ELECTRICAL POWER CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Provide nameplate for each electrical connection indicating electrical equipment designation and circuit number feeding connection. Nameplate shall be laminated phenolic layers of black

with engraved white letters at least 1/2 inch (13 mm) high. Locate nameplate where easily visible.

3.5 CONTROLS CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between chillers and other equipment to interlock operation as required to provide a complete and functioning system.

C. Connect control wiring between chiller control interface and [**DDC system**] <**Insert system description**> for remote monitoring and control of chillers. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."

D. Provide nameplate on face of chiller control panel indicating control equipment designation serving chiller and the I/O point designation for each control connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least 1/2 inch (13 mm) high.

3.6 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**] [**Perform**] startup service.

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

C. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

1. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
2. Verify that pumps are installed and functional.
3. Verify that thermometers and gages are installed.
4. Operate water chiller for run-in period.
5. Check bearing lubrication and oil levels.
6. Verify that refrigerant pressure relief device for chillers installed indoors is vented outside.
7. Verify proper motor rotation.
8. Verify static deflection of vibration isolators, including deflection during water chiller startup and shutdown.
9. Verify and record performance of chilled-[**and heat recovery condenser-**]water flow and low-temperature interlocks.
10. Verify and record performance of water chiller protection devices.
11. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

D. Visually inspect chiller for damage before starting. Repair or replace damaged components, including insulation. Do not start chiller until damage that is detrimental to operation has been corrected.

E. Prepare a written startup report that records results of tests and inspections.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water chillers.[**Video record the training sessions and provide electronic copy to Owner.**]

1. Instructor shall be factory trained and certified.
2. Provide not less than [**eight**] <**Insert time**> hours of training.
3. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
4. Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
5. Obtain Owner sign-off that training is complete.
6. Owner training shall be held at Project site.

END OF SECTION 236423.13