SECTION 236426 - ROTARY-SCREW 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, multiple-compressor chillers.
2. Packaged, air-cooled chillers.

B. Related Section:

1. Division 28 Section "Refrigerant Detection and Alarm" for refrigerant monitors, alarms, supplemental breathing apparatus, and ventilation equipment interlocks.

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

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

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

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

1.4 PERFORMANCE REQUIREMENTS

Retain first paragraph below for water-cooled chillers. Verify requirements with manufacturer.

A. Condenser-Fluid Temperature Performance:

1. Startup Condenser-Fluid Temperature: Chiller shall be capable of starting with an entering condenser-fluid temperature of 60 deg F (16 deg C) 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 (18 deg C).
3. Make factory modifications to standard chiller design if necessary to comply with performance indicated.

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

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include refrigerant, 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. Refrigerant capacity of chiller.
5. Oil capacity of chiller.
6. Fluid capacity of evaporator.
7. Characteristics of safety relief valves.

Retain first three subparagraphs below for water-cooled chillers.

8. Fluid capacity of condenser.
9. Minimum entering condenser-fluid temperature.
10. Performance at varying capacities with constant-design entering condenser-fluid temperature. Repeat performance at varying capacities for different condenser-fluid temperatures from design to minimum in 5 deg F (3 deg C) increments.

Retain three subparagraphs below for air-cooled chillers.

11. Minimum entering condenser-air temperature.
12. Maximum entering condenser-air temperature.
13. Performance at varying capacities with constant-design entering condenser-air temperature. Repeat performance at varying capacities for different entering condenser-air temperatures from design to minimum in 10 deg F (6 deg C) increments.

B. LEED Submittal:

Retain subparagraph below for LEED-NC Credit EA 4.

1. Product Data for 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.

1.6 INFORMATIONAL SUBMITTALS

Retain first paragraph below if Drawings do not include detailed plans or if Project involves unusual coordination requirements.

A. 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 item involed:

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.

Retain first paragraph below if retaining certification in "Quality Assurance" Article.

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

C. Source quality-control reports.

D. Startup service reports.

E. Warranty: Sample of special warranty.

1.7 CLOSEOUT SUBMITTALS

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

1.8 QUALITY ASSURANCE

Retain first paragraph below if ARI certification is required and Project requirements fall within limits of ARI 550 and ARI 590 certification programs. ARI 550/590 is broken into two certification programs; ARI 550 certification program is applicable to water-cooled, rotary-screw chillers and ARI 590 certification program is applicable to air-cooled, rotary-screw chillers. Review the latest version to verify requirements.

A. ARI Certification: Certify chiller according to [ARI 550] [and] [ARI 590] certification program(s).

B. ARI Rating: Rate chiller performance according to requirements in ARI 550/590.

C. ASHRAE Compliance:

1. ASHRAE 15 for safety code for mechanical refrigeration.
2. ASHRAE 147 for refrigerant leaks, recovery, and handling and storage requirements.

LEED-NC Prerequisite EA 2 requires minimum efficiency equal to requirements in ASHRAE/IESNA 90.1. LEED-NC Credit EA 1 requires efficiency in excess of minimum efficiency required by ASHRAE/IESNA 90.1. See "LEED Rating System" Article in the Evaluations for discussion on LEED prerequisites and credits.

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

E. ASME Compliance: Fabricate and label chiller to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, and include an ASME U-stamp and nameplate certifying compliance.

F. Comply with NFPA 70.

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

1.9 DELIVERY, STORAGE, AND HANDLING

Retain one of first two paragraphs below. Retain first paragraph to restrict shipping requirements. Retain second paragraph to allow manufacturer alternatives. Consult manufacturers.

A. Ship chillers from the factory fully charged with refrigerant.

B. Ship each chiller with a full charge of refrigerant. Charge each chiller with nitrogen if refrigerant is shipped in containers separate from chiller.

C. Ship each oil-lubricated chiller with a full charge of oil.

1.10 COORDINATION

Retain first paragraph below for mounting chillers on concrete bases.

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

Retain first paragraph below for mounting chillers on a structural-steel support structure.

B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.

Retain paragraph below for roof-mounted, air-cooled chillers.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.11 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 compressor and drive assembly including refrigerant and oil charge.
b. Parts only.
c. Loss of refrigerant charge for any reason.

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

PART 2 - PRODUCTS

2.1 PACKAGED, WATER-COOLED, MULTIPLE-COMPRESSOR CHILLERS

For applications up to 500 tons.

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

1. Carrier Corporation; a United Technologies company.
2. McQuay International.
3. Trane.
4. YORK International Corporation.

B. Description: Factory-assembled and [run]-tested chiller with compressor(s), compressor motors and motor controllers, evaporator, condenser where indicated, electrical power, controls, and indicated accessories.

Retain subparagraph below where 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.

C. Compressors:

1. Description: Positive displacement, hermetically sealed.
2. Casing: Cast iron, precision machined for minimum clearance about periphery of rotors.
3. Rotors: Manufacturer's standard one- or two-rotor design.

D. Service: Easily accessible for inspection and service.

Verify availability of requirements in two subparagraphs below with manufacturer.

1. Compressor's internal components shall be accessible without having to remove compressor-drive assembly from chiller.
2. Provide lifting lugs or eyebolts attached to casing.

E. Capacity Control: On-off compressor cycling and modulating slide-valve assembly or port unloaders combined with hot-gas bypass, if necessary, to achieve performance indicated.

1. Maintain stable operation throughout range of operation. Configure to achieve most energy-efficient operation possible.

Standard operating range varies among manufacturers. Not all listed manufacturers comply with options in first subparagraph below without hot-gas bypass. Consult manufacturer for requirements.

2. Operating Range: From 100 to [20] [15] [10] percent of design capacity.
3. Condenser-Fluid Unloading Requirements over Operating Range: Constant-design entering condenser-fluid temperature.

F. Oil Lubrication System: Consisting of pump if required, filtration, heater, cooler, factory-wired power connection, and controls.

1. Provide lubrication to bearings, gears, and other rotating surfaces at all operating, startup, shutdown, and standby conditions including power failure.
2. Thermostatically controlled oil heater properly sized to remove refrigerant from oil.
3. Factory-installed and pressure-tested piping with isolation valves and accessories.
4. Oil compatible with refrigerant and chiller components.
5. Positive visual indication of oil level.

G. Vibration Control:

1. Vibration Balance: Balance chiller compressor and drive assembly to provide a precision balance that is free of noticeable vibration over the entire operating range.

a. Overspeed Test: 25 percent above design operating speed.

Retain subparagraph below for factory-installed vibration isolation.

2. Isolation: Mount individual compressors on vibration isolators.

H. Sound Control: Sound-reduction package shall consist of removable acoustic enclosures around the compressors and drive assemblies that are designed to reduce sound levels without affecting performance.

I. Compressor Motors:

1. Hermetically sealed and cooled by refrigerant suction gas.
2. High-torque, induction type with inherent thermal-overload protection on each phase.

J. Refrigerant Circuits:

LEED-NC Credit EA 4 requires that new HVAC&R systems use refrigerants that reduce ozone depletion potential and support early compliance with the Montreal Protocol while minimizing direct contributions to global warming. The credit requires that calculations be submitted to justify that refrigerant selected meets requirements. See "LEED Rating System" Article in the Evaluations for discussion on this credit.

1. Refrigerant Type: R-134a. Classified as Safety Group A1 according to ASHRAE 34.
2. Refrigerant Compatibility: Chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
3. Refrigerant Circuit: Each shall include a thermal- or electronic-expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.
4. Pressure Relief Device:

    a. Comply with requirements in ASHRAE 15 and in applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
    b. ASME-rated, spring-loaded pressure relief valve; single- or multiple-reseating type.

Subparagraph below is not applicable to all chiller types and sizes. Consult manufacturers.

5. Refrigerant Isolation: Factory install positive shutoff isolation valves in the compressor discharge line to the condenser and the refrigerant liquid-line leaving the condenser to allow for isolation and storage of full refrigerant charge in the chiller condenser shell.

K. Evaporator:

1. Description: Shell-and-tube design.

Retain one or both of first two subparagraphs below. Indicate evaporator type on Drawings if Project requirements for multiple chillers differ. Evaporator types vary among chiller manufacturers and models. Retaining a specific type may exclude some listed manufacturers. Verify availability of type with manufacturer.

    a. Direct-expansion (DX) type with fluid flowing through the shell, and refrigerant flowing through the tubes within the shell.
    b. Flooded type with fluid flowing through tubes and refrigerant flowing around tubes within the shell.

2. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Shell Material: Carbon steel.
4. Shell Heads: Removable carbon-steel heads with multipass baffles, and located at each end of the tube bundle.
5. Fluid Nozzles: Terminated with mechanical-coupling or flanged end connections for connection to field piping.
6. Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.

L. Condenser:

1. Shell and Tube:

    a. Description: Shell-and-tube design with refrigerant flowing through shell, and fluid flowing through tubes within shell.
    b. Provides positive subcooling of liquid refrigerant.

c. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
d. Shell Material: Carbon steel.
e. Water Boxes: Removable, of carbon-steel construction, located at each end of the tube bundle with fluid nozzles terminated with mechanical-coupling end connections for connection to field piping.
f. Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.
g. Provide each condenser with a pressure relief device, purge cock, and liquid-line shutoff valve.

Retain subparagraph below for chillers with remote field-installed condensers. Air-cooled condensers are specified in Division 23 Section "Air-Cooled Refrigerant Condensers."

2. Provide chiller without an integral condenser and design chiller for field connection to remote condenser. Coordinate requirements with Division 23 Section "Air-Cooled Refrigerant Condensers."

M. Electrical Power:

Not all manufacturers provide all features indicated in subparagraphs below. Verify availability with manufacturers.

1. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point, field-power connection to chiller.
2. House in a unit-mounted, NEMA 250, Type 1 enclosure with hinged access door.
3. Wiring shall be numbered and color-coded to match wiring diagram.
4. Field-power interface shall be to NEMA KS 1, heavy-duty, nonfused disconnect switch.

    a. Disconnect means shall be interlocked with door operation.

5. Provide branch power circuit to each motor and to controls with one of the following disconnecting means:

    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.

6. Provide each motor with overcurrent protection.
7. Overload relay sized according to UL 1995 or an integral component of chiller control microprocessor.
8. Phase-Failure and Undervoltage Relays: Solid-state sensing with adjustable settings.
9. Control Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
10. Control Relays: Auxiliary and adjustable time-delay relays.
11. For chiller electrical power supply, indicate the following:

    a. Current and phase to phase for all three phases.

b. Voltage, phase to phase, and phase to neutral for all three phases.
c. Three-phase real power (kilowatts).
d. Three-phase reactive power (kilovolt amperes reactive).
e. Power factor.
f. Running log of total power versus time (kilowatt-hours).
g. Fault log, with time and date of each.

N. Compressor Motor Controllers:

Retain one or both subparagraphs below. Indicate motor-controller type on Drawings if Project requirements for multiple chillers differ. McQuay uses a solid-state compressor motor controller as standard. Retain options if including McQuay as a listed manufacturer. None of the other manufacturers offer a solid-state compressor motor controller.

1. Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing, or solid state.

In subparagraph below, all manufacturers except Carrier use "closed-transition" controllers; Carrier uses "open-transition" controllers.

2. Star-Delta, Reduced-Voltage Controller: NEMA ICS 2, closed or open transition, or solid state.

O. Controls:

1. Standalone and microprocessor based.
2. Enclosure: Share enclosure with electrical-power devices or provide a separate enclosure of matching construction.
3. 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, display the following information:

Revise list below to suit Project. Verify availability of displayed information with chiller manufacturers. Some information may be optional; other information may not be available from all listed manufacturers.

a. Date and time.
b. Operating or alarm status.
c. Fault history with not less than last 10 faults displayed.
d. Set points of controllable parameters.
e. Trend data.
f. Operating hours.
g. Number of chiller starts.
h. Outdoor-air temperature or space temperature if required for chilled-water reset.
i. Temperature and pressure of operating set points.
j. Entering- and leaving-fluid temperatures of evaporator and condenser.
k. Difference in fluid temperatures of evaporator and condenser.
l. Refrigerant pressures in evaporator and condenser.
m. Refrigerant saturation temperature in evaporator and condenser.
n. No cooling load condition.
o. Elapsed time meter (compressor run status).
p. Pump status.
q. Antirecycling timer status.
r. Percent of maximum motor amperage.
s. Current-limit set point.

t. Number of compressor starts.
u. Compressor refrigerant suction and discharge temperature.
v. Oil temperature.
w. Oil discharge pressure.
x. Phase current.
y. Percent of motor rated load amperes.
z. Phase voltage.

4. Control Functions:

Revise list below to suit Project. Verify availability; functions may vary among manufacturers and models.

a. Manual or automatic startup and shutdown time schedule.
b. Entering and leaving chilled-water temperatures, control set points, and motor load limits. Chilled-water leaving temperature shall be reset based on return-water temperature.
c. Current limit and demand limit.
d. Condenser-fluid temperature.
e. External chiller emergency stop.
f. Antirecycling timer.
g. Automatic lead-lag switching.
h. Variable evaporator flow.
i. Thermal storage.

5. Manually Reset Safety Controls: The following conditions shall shut down chiller and require manual reset:

Revise list below to suit Project. Verify availability; conditions may vary among manufacturers and models.

a. Low evaporator pressure, or high condenser pressure.
b. Low chilled-water temperature.
c. Refrigerant high pressure.
d. High or low oil pressure.
e. High oil temperature.
f. Loss of chilled-water flow.
g. Loss of condenser-fluid flow.
h. Control device failure.

6. Trending: Capability to trend analog data of up to five parameters simultaneously over an adjustable period and frequency of polling.
7. 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.
8. Control Authority: At least four conditions: Off, local manual control at chiller, local automatic control at chiller, and automatic control through a remote source.

Retain subparagraph below if chiller controls interface with the BAS. Coordinate with Division 23 Section "Instrumentation and Control for HVAC."

9. 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.

a. Hardwired Points:

1) Monitoring: On-off status, common trouble alarm.
2) Control: On-off operation,.

P. Insulation:

1. Material: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
2. Thickness: 3/4 inch (19 mm).
3. Adhesive: As recommended by insulation manufacturer and applied to 100 percent of insulation contact surface. Seal seams and joints.
4. Factory-applied insulation over 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 suction pipe from evaporator to compressor, cold surfaces of compressor, refrigerant-cooled motor, and auxiliary piping.

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

Q. Finish:

1. Paint chiller, using manufacturer's standard procedures, except comply with the following minimum requirements:

a. Provide at least one coat of primer.
b. Provide finish coat of alkyd-modified, vinyl enamel.
c. Paint surfaces that are to be insulated before applying the insulation.
d. Paint installed insulation to match adjacent uninsulated surfaces.

R. Accessories:

1. Factory-furnished, chilled- and condenser-water flow switches for field installation.
2. Individual compressor suction and discharge pressure gages with shutoff valves for each refrigerant circuit.
3. Factory-furnished neoprene or spring isolators for field installation.

S. Characteristics:

1. Evaporator Fouling Factor: 0.0001 sq. ft. x h x deg F/Btu (0.000018 sq. m x deg C/W).
2. Condenser Fouling Factor: 0.00025 sq. ft. x h x deg F/Btu (0.000044 sq. m x deg C/W)
3. Number of Refrigerant Circuits: Two.

2.2 PACKAGED, AIR-COOLED CHILLERS

For applications up to 500 tons.

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

1. Carrier Corporation; a United Technologies company.
2. Dunham-Bush.
3. McQuay International.
4. Trane.
5. YORK International Corporation.

B. Description: Factory-assembled and run-tested chiller complete with base and frame, condenser casing, compressors, compressor motors and motor controllers, evaporator, condenser coils, condenser fans and motors, electrical power, controls, and accessories.

C. Cabinet:

1. Base: Galvanized-steel base extending the perimeter of chiller. Secure frame, compressors, and evaporator to base to provide a single-piece unit.
2. Frame: Rigid galvanized-steel frame secured to base and designed to support cabinet, condenser, control panel, and other chiller components not directly supported by base.
3. Casing: Galvanized steel.
4. Finish: Coat base, frame, and casing with a corrosion-resistant coating capable of withstanding a 500-hour salt-spray test according to ASTM B 117.
5. Sound-reduction package designed to reduce sound level without affecting performance and consisting of the following:

    a. Acoustic enclosure around compressors.
    b. Reduced-speed fans with acoustic treatment.

D. Compressors:

1. Description: Positive displacement, hermetically sealed.
2. Casing: Cast iron, precision machined for minimum clearance about periphery of rotors.
3. Rotors: Manufacturer's standard one- or two-rotor design.
4. Each compressor provided with suction and discharge shutoff valves, crankcase oil heater, and suction strainer.

E. Service: Easily accessible for inspection and service.

F. Capacity Control: On-off compressor cycling and modulating slide-valve assembly or port unloaders combined with hot-gas bypass, if necessary, to achieve performance indicated.

1. Maintain stable operation throughout range of operation. Configure to achieve most energy-efficient operation possible.
2. Operating Range: From 100 to [20] [15] [10] percent of design capacity.
3. Condenser-Air Unloading Requirements over Operating Range: Constant-design entering condenser-air temperature.

Retain subparagraph below for chiller equipped with a variable frequency controller. As of March 2006, this feature is only offered by YORK.

4. For units equipped with a variable frequency controller, capacity control shall be both "valveless" and "stepless," requiring no slide valve or capacity-control valve(s) to operate at reduced capacity.

G. Oil Lubrication System: Consisting of pump if required, filtration, heater, cooler, factory-wired power connection, and controls.

1. Provide lubrication to bearings, gears, and other rotating surfaces at all operating, startup, shutdown, and standby conditions including power failure.
2. Thermostatically controlled oil heater properly sized to remove refrigerant from oil.
3. Factory-installed and pressure-tested piping with isolation valves and accessories.
4. Oil compatible with refrigerant and chiller components.
5. Positive visual indication of oil level.

H. Vibration Control:

1. Vibration Balance: Balance chiller compressors and drive assemblies to provide a precision balance that is free of noticeable vibration over the entire operating range.

a. Overspeed Test: 25 percent above design operating speed.

2. Isolation: Mount individual compressors on vibration isolators.

I. Compressor Motors:

1. Hermetically sealed and cooled by refrigerant suction gas.
2. High-torque, induction type with inherent thermal-overload protection on each phase.

J. Compressor Motor Controllers:

Retain one or both of first two subparagraphs below. Indicate motor-controller type on Drawings if Project requirements for multiple chillers differ. McQuay uses a solid-state compressor motor controller as standard. Retain options if including McQuay as a listed manufacturer. None of the other manufacturers offer a solid-state compressor motor controller.

1. Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing, or solid state.
2. Star-Delta, Reduced-Voltage Controller: NEMA ICS 2, closed transition, or solid state.

Retain subparagraph below for chiller equipped with a variable frequency controller. As of March 2006, this feature is only offered by YORK.

3. Variable Frequency Controller:

a. Motor controller shall be factory mounted and wired on the chiller to provide a single-point, field-power termination to the chiller and its auxiliaries.
b. Description: NEMA ICS 2; listed and labeled as a complete unit and arranged to provide variable speed by adjusting output voltage and frequency.
c. Enclosure: Unit mounted, NEMA 250, Type 3R, with hinged full-front access door with lock and key.

d. Integral Disconnecting Means: Door-interlocked, NEMA AB 1, instantaneous-trip circuit breaker with lockable handle. Minimum withstand rating shall be as required by electrical power distribution system, but not less than 42,000 A.
e. Technology: Pulse width modulated (PWM) output suitable for constant or variable torque loads.
f. Motor current at start shall not exceed the rated load amperes, providing no electrical inrush.

K. Refrigerant Circuits:

LEED-NC Credit EA 4 requires that new HVAC&R systems use refrigerants that reduce ozone depletion potential and support early compliance with the Montreal Protocol while minimizing direct contributions to global warming. The credit requires that calculations be submitted to justify that refrigerant selected meets requirements. See "LEED Rating System" Article in the Evaluations for a discussion on this credit.

1. Refrigerant Type: R-134a or R-407c. Classified as Safety Group A1 according to ASHRAE 34.
2. Refrigerant Compatibility: Chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
3. Refrigerant Circuit: Each shall include a thermal- or electronic-expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-corefilter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.
4. Pressure Relief Device:

a. Comply with requirements in ASHRAE 15 and in applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
b. ASME-rated, spring-loaded pressure relief valve; single- or multiple-reseating type.

L. Evaporator:

1. Description: Shell-and-tube design.

Retain one or both of first two subparagraphs below. Indicate evaporator type on Drawings if Project requirements for multiple chillers differ. Evaporator types vary among chiller manufacturers and models. Retaining a specific type may exclude some listed manufacturers. Verify availability of type with manufacturer.

a. Direct-expansion (DX) type with fluid flowing through the shell, and refrigerant flowing through the tubes within the shell.
b. Flooded type with fluid flowing through tubes and refrigerant flowing around tubes within the shell.

2. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Shell Material: Carbon steel.
4. Shell Heads: Removable carbon-steel heads located at each end of the tube bundle.
5. Fluid Nozzles: Terminated with mechanical-coupling end connections for connection to field piping.
6. Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.

7. Heater: Factory-installed and -wired electric heater with integral controls designed to protect the evaporator to minus 20 deg F (minus 29 deg C).

M. Air-Cooled Condenser:

1. Plate-fin coil with integral subcooling on each circuit, rated at 450 psig (3103 kPa).

   a. Construct coil casing of galvanized steel.
   b. Construct coils of copper tubes mechanically bonded to aluminum fins.

2. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades, arranged for vertical air discharge.
3. Fan Motors: Totally enclosed nonventilating (TENV) or totally enclosed air over (TEAO) enclosure, with permanently lubricated bearings. Equip each motor with overload protection integral to either the motor or chiller controls.
4. Fan Guards: Steel safety guards with corrosion-resistant coating.

N. Electrical Power:

Not all manufacturers provide all features indicated in subparagraphs below. Verify availability with manufacturers.

1. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point, field-power connection to chiller.
2. House in a unit-mounted, NEMA 250, Type 3R enclosure.
3. Wiring shall be numbered and color-coded to match wiring diagram.
4. Install factory wiring outside of an enclosure in a raceway.
5. Field-power interface shall be to NEMA KS 1, heavy-duty, nonfused disconnect switch.

   a. Disconnect means shall be interlocked with door operation.

6. Provide branch power circuit to each motor and to controls with one of the following disconnecting means:

   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.

7. Provide each motor with overcurrent protection.
8. Overload relay sized according to UL 1995 or an integral component of chiller control microprocessor.
9. Phase-Failure and Undervoltage Relays: Solid-state sensing with adjustable settings.

Retain first subparagraph below for power factor correction. Consult manufacturers for availability. Power factor correction is inherent with chillers equipped with variable frequency controllers.

10. Provide power factor correction capacitors to correct power factor to 0.90 at full load.
11. Control Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.

a. Power unit-mounted controls where indicated.

Retain first subparagraph below if unit-mounted convenience power receptacle is required. Consult manufacturers for availability.

b. Power unit-mounted, ground fault interrupt (GFI) duplex receptacle.

12. Control Relays: Auxiliary and adjustable time-delay relays.
13. For chiller electrical power supply, indicate the following:

a. Current and phase to phase for all three phases.
b. Voltage, phase to phase, and phase to neutral for all three phases.
c. Three-phase real power (kilowatts).
d. Three-phase reactive power (kilovolt amperes reactive).
e. Power factor.
f. Running log of total power versus time (kilowatt-hours).
g. Fault log, with time and date of each.

O. Controls:

1. Standalone and microprocessor based.
2. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure.
3. 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, display the following information:

Revise list below to suit Project. Verify availability of displayed information with chiller manufacturers. Some information may be optional; other information may not be available from all listed manufacturers.

a. Date and time.
b. Operating or alarm status.
c. Operating hours.
d. Outdoor-air temperature if required for chilled-water reset.
e. Temperature and pressure of operating set points.
f. Entering and leaving temperatures of chilled water.
g. Refrigerant pressures in evaporator and condenser.
h. Saturation temperature in evaporator and condenser.
i. No cooling load condition.
j. Elapsed time meter (compressor run status).
k. Pump status.
l. Antirecycling timer status.
m. Percent of maximum motor amperage.
n. Current-limit set point.
o. Number of compressor starts.

4. Control Functions:

Revise list below to suit Project. Verify availability; functions may vary among manufacturers and models.

a. Manual or automatic startup and shutdown time schedule.

b. Entering and leaving chilled-water temperatures, control set points, and motor load limits. Chilled-water leaving temperature shall be reset based on return-water temperature.
c. Current limit and demand limit.
d. External chiller emergency stop.
e. Antirecycling timer.
f. Automatic lead-lag switching.
g. Variable evaporator flow.
h. Thermal storage.

5. Manually Reset Safety Controls: The following conditions shall shut down chiller and require manual reset:

Revise list below to suit Project. Verify availability; conditions may vary among manufacturers and models.

a. Low evaporator pressure or high condenser pressure.
b. Low chilled-water temperature.
c. Refrigerant high pressure.
d. High or low oil pressure.
e. High oil temperature.
f. Loss of chilled-water flow.
g. Control device failure.

6. Trending: Capability to trend analog data of up to five parameters simultaneously over an adjustable period and frequency of polling.
7. 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.
8. Control Authority: At least four conditions: Off, local manual control at chiller, local automatic control at chiller, and automatic control through a remote source.

Retain subparagraph below if chiller controls interface with the BAS. Coordinate with Division 23 Section "Instrumentation and Control for HVAC."

9. 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.

a. Hardwired Points:

1) Monitoring: On-off status, common trouble alarm.
2) Control: On-off operation.

P. Insulation:

1. Material: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
2. Thickness: 3/4 inch (19 mm).
3. Factory-applied insulation over cold surfaces of chiller components.

a. Adhesive: As recommended by insulation manufacturer and applied to 100 percent of insulation contact surface. Seal seams and joints.

4. Apply protective coating to exposed surfaces of insulation to protect insulation from weather.

Q. Accessories:

1. Factory-furnished, chilled-water flow switches for field installation.
2. Individual compressor suction and discharge pressure gages with shutoff valves for each refrigerant circuit.

Before retaining spring isolators for use on rotary-screw chillers, consult a vibration consultant to verify suitability.

3. Factory-furnished neoprene or spring isolators for field installation.

R. Characteristics:

Retain first subparagraph below if low ambient operation is required. Dunham-Bush, McQuay, Trane, and YORK can operate to 0 deg F (minus 18 deg C) with optional accessories. Carrier can operate to minus 20 deg F (minus 29 deg C).

1. Low Ambient Operation: Chiller designed for operation to 0 deg F (minus 18 deg C).
2. Evaporator:

a. Configuration: Integral to chiller.
b. Pressure Rating: 150 psig (1034 kPa).
c. Fluid Type: Water.
d. Fouling Factor: 0.0001 sq. ft. x h x deg F/Btu (0.000018 sq. m x deg C/W).

3. Number of Refrigerant Circuits: Two.

2.3 SOURCE QUALITY CONTROL

A. Perform functional tests of chillers before shipping.

Retain first paragraph below for air-cooled chillers.

B. Factory run test each air-cooled chiller with water flowing through evaporator.

Retain first paragraph below for factory performance testing of water-cooled chillers. Factory performance tests are an added cost.

C. Factory performance test water-cooled chillers, before shipping, according to ARI 550/590.

1. Test the following conditions:

a. Design conditions indicated.
b. Reduction in capacity from design to minimum load in steps of [**10**] [**25**] [**33**] <**Insert number**> with condenser fluid at design conditions.
c. Reduction in capacity from design to minimum load in steps of [**10**] [**25**] [**33**] <**Insert number**> with varying entering condenser-fluid temperature from design to minimum conditions in [**5 deg F (3 deg C)**] <**Insert temperature**> increments.

d. At [**one**] [**two**] [**three**] [**four**] [**five**] [**10**] <**Insert number**> point(s) of varying part-load performance to be selected by Owner at time of test.

Retain first subparagraph below to witness testing.

2. Allow [**Owner**] <**Insert entity**> access to place where chillers are being tested. Notify Architect [**14**] <**Insert number**> days in advance of testing.
3. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

Retain first paragraph below for factory performance testing of air-cooled chillers. Factory performance tests are an added cost and are not available from most of the listed manufacturers.

D. Factory performance test air-cooled chillers, before shipping, according to ARI 550/590.

1. Test the following conditions:

a. Design conditions indicated.

Retain one of first two subparagraphs below for part-load performance testing of air-cooled chillers.

b. Reduction in capacity from design to minimum load in steps of [**10**] [**25**] [**33**] <**Insert number**> with condenser air at design conditions.
c. At [**one**] [**two**] [**three**] [**four**] [**five**] <**Insert number**> point(s) of varying part-load performance to be selected by Owner at time of test.

Retain first subparagraph below to witness testing.

2. Allow [**Owner**] <**Insert entity**> access to place where chillers are being tested. Notify Architect [**14**] <**Insert number**> days in advance of testing.
3. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

E. Factory test and inspect evaporator and condenser according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

Retain first paragraph below for chillers located indoors.

F. For chillers located indoors, rate sound power level according to ARI 575.

Retain paragraph below for chillers located outdoors.

G. For chillers located outdoors, rate sound power level according to ARI 370.

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

Retain first paragraph below if chillers are to be installed on a support structure other than a concrete base. Indicate design of support structure on Drawings.

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 and Seismic Controls for HVAC Piping and Equipment."

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

D. Charge chiller with refrigerant and fill with oil if not factory installed.

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

3.3 CONNECTIONS

Retain option in first paragraph below for chillers with remote condenser.

A. Comply with requirements for piping specified in Division 23 Section "Hydronic Piping" [and Division 23 Section “Refrigerant Piping”]. Drawings indicate general arrangement of piping, fittings, and specialties.

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

C. Evaporator Fluid Connections: Connect to evaporator inlet with shutoff valve, strainer, flexible connector, thermometer, and plugged tee with pressure gage. Connect to evaporator outlet with shutoff valve, balancing valve, flexible connector, flow switch, thermometer, plugged tee with shutoff valve and pressure gage, and drain connection with valve. Make connections to chiller with a flange or mechanical coupling.

Retain first paragraph below for chiller equipped with a water-cooled condenser.

D. Condenser Fluid Connections: Connect to condenser inlet with shutoff valve, strainer, flexible connector, thermometer, and plugged tee with pressure gage. Connect to condenser outlet with shutoff valve, balancing valve, flexible connector, flow switch, thermometer, plugged tee with shutoff valve and pressure gage, and drain connection with valve. Make connections to chiller with a flange or mechanical coupling.

E. Refrigerant Pressure Relief Device Connections: For chillers installed indoors, extend vent piping to the outdoors without valves or restrictions. Comply with ASHRAE 15. Connect vent to chiller pressure relief device with flexible connector and dirt leg with drain valve.

F. 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. Verify that refrigerant charge is sufficient and chiller has been leak tested.
3. Verify that pumps are installed and functional.
4. Verify that thermometers and gages are installed.
5. Operate chiller for run-in period.
6. Check bearing lubrication and oil levels.
7. For chillers installed indoors, verify that refrigerant pressure relief device is vented outdoors.
8. Verify proper motor rotation.
9. Verify static deflection of vibration isolators, including deflection during chiller startup and shutdown.

Retain option in first subparagraph below for water-cooled chillers.

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 236426