SECTION 236426.13 - AIR-COOLED, ROTARY-SCREW WATER CHILLERS

Revise this Section by deleting and inserting text to meet Project-specific requirements.

This Section uses the term "Architect." Change this term to match that used to identify the design professional as defined in the General and Supplementary Conditions.

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

1. GENERAL
	* + 1. RELATED DOCUMENTS

Retain or delete this article in all Sections of Project Manual.

* + - * 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
			1. SUMMARY
				1. Section Includes:

Packaged, air-cooled chillers.

Packaged, portable refrigerant recovery units.

Heat-exchanger, brush-cleaning system.

* + - 1. DEFINITIONS

Retain terms that remain after this Section has been edited for a project.

* + - * 1. 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.
				2. DDC: Direct digital control.
				3. 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.
				4. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by AHRI 550/590 and referenced to AHRI standard rating conditions.
				5. 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.
				6. NPLV: Nonstandard part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by AHRI 550/590 and intended for operating conditions other than AHRI standard rating conditions.
			1. ACTION SUBMITTALS
				1. Submittals for this section are subject to the re-evaluation fee identified in Article 4 of the General Conditions.
				2. Manufacturer's installation instructions shall be provided along with product data.
				3. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).
				4. Product Data: For each type of product.

Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.

Performance at AHRI standard conditions and at conditions indicated.

Performance at AHRI standard unloading conditions.

Minimum evaporator flow rate.

Refrigerant capacity of chiller.

Oil capacity of chiller.

Fluid capacity of evaporator.

Characteristics of safety relief valves.

Minimum entering condenser-air temperature.

Maximum entering condenser-air temperature.

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**] <**Insert temperature**> increments.

* + - * 1. Shop Drawings:

Include plans, elevations, sections, and attachment details.

Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

Include diagrams for power, signal, and control wiring.

* + - 1. INFORMATIONAL SUBMITTALS

Retain "Coordination Drawings" Paragraph below for situations where limited space necessitates maximum utilization for efficient installation of different components or if coordination is required for installation of products and materials by separate installers. Coordinate paragraph with other Sections specifying products listed below. Preparation of coordination drawings requires the participation of each trade involved in installations within the limited space.

* + - * 1. Coordination Drawings: Floor plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

Structural supports.

Piping roughing-in requirements.

Wiring roughing-in requirements, including spaces reserved for electrical equipment.

Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.

Retain "Product Certificates" Paragraph below if retaining certification in "Quality Assurance" Article.

* + - * 1. Product Certificates: For certification required in "Quality Assurance" Article.

Retain "Seismic Qualification Data" Paragraph below if required by seismic criteria applicable to Project. Coordinate below with Section 230548 "Vibration and Seismic Controls for HVAC." See ASCE/SEI 7 for certification requirements for equipment and components.

* + - * 1. Seismic Qualification Data: Certificate, for chillers, accessories, and components, from manufacturer.

Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

* + - * 1. Source quality-control reports.
				2. Field Test Reports: Include startup service reports.
				3. Sample Warranty: For AHRI special warranty.
			1. CLOSEOUT SUBMITTALS
				1. Operation and Maintenance Data: For each chiller to include in emergency, operation, and maintenance manuals.
			2. QUALITY ASSURANCE

Retain "AHRI Certification" Paragraph below if AHRI certification is required and Project requirements fall within limits of ARI 590 certification programs. Review the latest version to verify requirements.

* + - * 1. AHRI Certification: Certify chiller according to AHRI 590 certification program(s).
				2. AHRI Rating: Rate chiller performance according to requirements in AHRI 550/590.
				3. ASHRAE Compliance:

ASHRAE 15 for safety code for mechanical refrigeration.

ASHRAE 147 for refrigerant leaks, recovery, and handling and storage requirements.

Retain "ASHRAE/IES 90.1 Compliance" Paragraph below to require compliance with ASHRAE/IES 90.1.

* + - * 1. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.
				2. 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.
				3. Comply with NFPA 70.
				4. Comply with requirements of UL and UL Canada and include label by a qualified testing agency showing compliance.
			1. 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.

* + - * 1. Ship chillers from the factory fully charged with refrigerant.
				2. Ship each chiller with a full charge of refrigerant. Charge each chiller with nitrogen if refrigerant is shipped in containers separate from chiller.
				3. Ship each oil-lubricated chiller with a full charge of oil.

Retain subparagraph and one of two options below to restrict shipping requirements. Consult manufacturers.

Ship oil [**factory installed in chiller**] [**in containers separate from chiller**].

Retain paragraph below only for projects with special shipping requirements. Export shipping adds cost. Requirement is more applicable to chillers installed indoors.

* + - * 1. Package chiller for export shipping in totally enclosed [**crate**] [**and**] [**bagging**].
			1. WARRANTY

When warranties are required, verify with Director’s Representative's counsel that special warranties stated in this article are not less than remedies available to Director’s Representative under prevailing local laws.

* + - * 1. Special Warranty: Manufacturer agrees to repair or replace components of chillers that fail in materials or workmanship within specified warranty period.

Consult Director’s Representative about need for extended warranties.

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

Retain one of first three subparagraphs below.

Complete chiller including refrigerant and oil charge.

Complete compressor and drive assembly including refrigerant and oil charge.

Refrigerant [**and oil**]charge.

Parts [**only**] [**and labor**].

Loss of refrigerant charge for any reason.

Verify available warranties and warranty periods for units and components.

Warranty Period: [**Two**] [**Three**] [**Four**] [**Five**] <**Insert number**> years from date of Substantial Completion.

1. PRODUCTS

Manufacturers and products listed in SpecAgent and MasterWorks Paragraph Builder are neither recommended nor endorsed by the AIA or Deltek. Before inserting names, verify that manufacturers and products listed there comply with requirements retained or revised in descriptions and are both available and suitable for the intended applications. For definitions of terms and requirements for Contractor's product selection, see Section 016000 "Product Requirements."

* + - 1. PERFORMANCE REQUIREMENTS

Retain "Seismic Performance" Paragraph below with "Seismic Qualification Data" Paragraph in "Informational Submittals" Article for projects requiring seismic design. Delete paragraph if performance requirements are indicated on Drawings. Model building codes and ASCE/SEI 7 establish criteria for buildings subject to earthquake motions. Coordinate requirements with structural engineer.

* + - * 1. Seismic Performance: Chillers shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**] <**Insert requirement**>.

Retain subparagraph below to define the term "withstand" as it applies to this Project. Definition varies with type of building and occupancy and is critical to valid certification. Option is used for essential facilities where equipment must operate immediately after an earthquake.

The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."

* + - * 1. 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.

Retain "Performance Tolerance" Paragraph below if Project requires more stringent tolerances than allowed by AHRI 550/590.

* + - * 1. Performance Tolerance: Comply with the following in lieu of AHRI 550/590:

Allowable Capacity Tolerance: [**Zero**] <**Insert number**> percent.

Allowable IPLV/NPLV Performance Tolerance: [**Zero**] <**Insert number**> percent.

* + - 1. PACKAGED, AIR-COOLED CHILLERS

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=6209) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Carrier Global Corporation](http://www.specagent.com/Lookup?uid=123457139296).

[Daikin Applied](http://www.specagent.com/Lookup?uid=123457139297).

[Dunham-Bush](http://www.specagent.com/Lookup?uid=123457139298).

[Trane](http://www.specagent.com/Lookup?uid=123457139299).

[YORK; brand of Johnson Controls International plc, Building Solutions North America](http://www.specagent.com/Lookup?uid=123457139300).

* + - * 1. 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.

Retain first paragraph below for projects in seismic areas.

* + - * 1. Fabricate base, frame, and attachment to chiller components strong enough to resist chiller movement during a seismic event when chiller base is anchored to field support structure.
				2. Cabinet:

Base: Galvanized-steel base extending the perimeter of chiller. Secure frame, compressors, and evaporator to base to provide a single-piece unit.

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.

Casing: Galvanized steel.

Requirement in "Finish" Subparagraph below may not be offered by all listed manufacturers. Coordinate with "Corrosion-Resistant Coating" Paragraph and verify availability with manufacturer.

Finish: Coat base, frame, and casing with a corrosion-resistant coating.

Retain first subparagraph below for projects with stringent acoustical requirements. Sound-reduction packages are typically optional features.

Sound-reduction package designed to reduce sound level without affecting performance and consisting of the following:

Acoustic enclosure around compressors.

Reduced-speed fans with acoustic treatment.

Retain "Security Package" Subparagraph below for projects with security requirements and for projects where restricted access is not provided. Security packages are typically optional features and can conflict with other available optional packages such as sound-reduction packages. Consult manufacturer.

Security Package: Provide removable [**grilles**] [**louvered panels**] with fasteners for additional protection of compressors, evaporator, and condenser coils without inhibiting service access. Finish to match cabinet.

* + - * 1. Compressors:

Description: Positive displacement, hermetically sealed.

Casing: Cast iron, precision machined for minimum clearance about periphery of rotors.

Rotors: Manufacturer's standard one- or two-rotor design.

Each compressor provided with[**suction and**] discharge shutoff valves, crankcase oil heater, and suction strainer.

* + - * 1. Service: Easily accessible for inspection and service.
				2. 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.

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 "Operating Range" Subparagraph below without hot-gas bypass. Consult manufacturer for requirements.

Operating Range: From 100 to [**20**] [**15**] [**10**] [**5**] [**zero**] <**Insert number**> percent of design capacity.

Condenser-Air Unloading Requirements over Operating Range: [**Constant-design, entering condenser-air temperature**] [**Drop-in, entering condenser-air temperature of 5 deg F drop for each 10 percent in capacity reduction**] <**Insert conditions**>.

Retain subparagraph below for chiller equipped with a variable-frequency controller. As of June 2011, this feature is only offered by YORK.

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.

* + - * 1. Oil Lubrication System: Consisting of pump if required, filtration, heater, cooler, factory-wired power connection, and controls.

Provide lubrication to bearings, gears, and other rotating surfaces at all operating, startup, shutdown, and standby conditions including power failure.

Thermostatically controlled oil heater properly sized to remove refrigerant from oil.

Factory-installed and pressure-tested piping with isolation valves and accessories.

Oil compatible with refrigerant and chiller components.

Positive visual indication of oil level.

* + - * 1. Vibration Control:

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

Overspeed Test: 25 percent above design operating speed.

Retain subparagraph below for factory-installed vibration isolation.

Isolation: Mount individual compressors on vibration isolators.

* + - * 1. Compressor Motors:

Hermetically sealed and cooled by refrigerant suction gas.

High-torque, induction type with inherent thermal-overload protection on each phase.

* + - * 1. Compressor Motor Controllers:

Retain one of four subparagraphs below. Retain "Across the Line" or "Star-Delta, Reduced-Voltage Controller" Subparagraph below, or both. Indicate motor-controller type on Drawings if Project requirements for multiple chillers differ. McQuay uses a solid-state compressor motor controller as standard. None of the other manufacturers offer a solid-state compressor motor controller.

Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing.

Star-Delta, Reduced-Voltage Controller: NEMA ICS 2, closed transition.

Solid-state controller.

Retain subparagraph below for chiller equipped with a variable-frequency controller. This feature may limit competition.

Variable-Frequency Controller:

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.

Description: NEMA ICS 2; listed and labeled as a complete unit and arranged to provide variable speed by adjusting output voltage and frequency.

Enclosure: Unit mounted, NEMA 250, [**Type 3R**] <**Insert type**>, with hinged full-front access door with lock and key.

Integral Disconnecting Means: [**Door-interlocked,**]UL 489, 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**] [**65,000**] [**100,000**] <**Insert value**> A.

Technology: Pulse-width-modulated output suitable for constant or variable torque loads.

Motor current at start shall not exceed the rated load amperes, providing no electrical inrush.

* + - * 1. Refrigerant Circuits:

Retain "Refrigerant" or "Refrigerant Type" Subparagraph below. Retain first subparagraph and indicate refrigerant type on Drawings if Project requirements for multiple chillers differ.

Refrigerant: Type as indicated on Drawings.

Refrigerant types vary among chiller manufacturers and models. Retaining a specific refrigerant type may exclude some listed manufacturers. Verify availability of refrigerant type with manufacturer.

LEED 2009 NC and CS, and LEED 2009 for Schools Credit EA 4 require that new HVAC&R systems comply with requirements for enhanced refrigerant management. Retain "R-134a" or "any HFC" option in "Refrigerant Type" Subparagraph below for LEED 2009 NC, CS, and LEED 2009 for Schools. See "Sustainable Design Considerations" Article in the Evaluations for a discussion on this credit.

Refrigerant Type: [**R-134a**] [**R-407c**] [**or**] [**any HFC**] <**Insert type**>. Classified as Safety Group A1 according to ASHRAE 34.

Refrigerant Compatibility: Chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.

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.

Pressure Relief Device:

Comply with requirements in ASHRAE 15 and in applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

ASME-rated, spring-loaded pressure relief valve; single- or multiple-reseating type.

* + - * 1. Evaporator:

Description: Shell-and-tube design.

Retain one of first two subparagraphs below, or both. 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.

Direct-expansion type with fluid flowing through the shell, and refrigerant flowing through the tubes within the shell.

Flooded type with fluid flowing through tubes and refrigerant flowing around tubes within the shell.

Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

Shell Material: Carbon steel.

Shell Heads: Removable carbon-steel heads located at each end of the tube bundle.

Fluid Nozzles: Terminated with [**mechanical-coupling**] [**flanged**] end connections for connection to field piping.

Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.

Retain "Heater" Subparagraph below if chiller is exposed to ambient temperatures capable of freezing the fluid in the evaporator. See the Evaluations for discussion on evaporator freeze protection.

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

Retain "Remote Mounting" Subparagraph below if required to mount evaporator remote from chiller.

Remote Mounting: Designed for remote field mounting where indicated. Provide kit for field installation.

* + - * 1. Air-Cooled Condenser:

Plate-fin coil with integral subcooling on each circuit, rated at 450 psig.

Construct coil casing of [**galvanized**] [**or**] [**stainless**] steel.

Construct coils of copper tubes mechanically bonded to [**aluminum**] [**aluminum with precoated epoxy-phenolic**] [**copper**] fins.

Requirement subparagraph below may not be offered by all listed manufacturers. Coordinate with "Corrosion-Resistant Coating" Paragraph and verify availability with manufacturer. See the Evaluations.

Coat coils with a corrosion-resistant coating after fabrication.

Retain "Hail Protection" Subparagraph below if additional protection is required. Hail protection is typically an optional feature. Consult manufacturer.

Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.

Fans: Direct-drive propeller type with statically and dynamically balanced fan blades, arranged for vertical air discharge.

Fan Motors: Totally enclosed nonventilating or totally enclosed air over enclosure, with permanently lubricated bearings. Equip each motor with overload protection integral to either the motor or chiller controls.

Fan Guards: Steel safety guards with [**PVC**] [**corrosion-resistant coating**].

"Corrosion-Resistant Coating" Paragraph below may not be available from all manufacturers. Paragraph specifies a phenolic or epoxy coating that meets the requirements specified. If one coating is preferred, consult with manufacturer. ASTM B117 does not specify the duration of a salt test, only testing conditions.

* + - * 1. Corrosion-Resistant Coating: Apply a corrosion-resistant coating capable of withstanding a [**3,000**] <**Insert time**>-hour salt-spray test according to ASTM B117 to base, frame, and casing.

Standards:

ASTM B117 for salt spray.

ASTM D2794 for minimum impact resistance of 100 in-lb.

ASTM B3359 for cross-hatch adhesion of 5B.

Application: [**Immersion**] [**Spray**].

Thickness: [**1 mil**] <**Insert measurement**>.

Gloss: Minimum of 50 gloss units on a single-angle, 60-degree meter.

"UV Protection" Subparagraph below is optional.

UV Protection: Spray-applied topcoat.

* + - * 1. Electrical Power:

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

Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a [**multipoint**] [**single-point**], field-power connection to chiller.

House in a unit-mounted, NEMA 250, [**Type 3R**] <**Insert type**> enclosure with hinged access door[**with lock and key or padlock and key**].

Wiring shall be numbered[**and color-coded**] to match wiring diagram.

Install factory wiring outside of an enclosure in a raceway.

Field-power interface shall be to [**wire lugs**] [**NEMA KS 1, heavy-duty, nonfused disconnect switch**] [**UL 489, instantaneous-trip circuit breaker with lockable handle**].

Retain one of first two subparagraphs below, or both, if retaining second or third option in last subparagraph above.

Disconnect means shall be interlocked with door operation.

Minimum withstand rating shall be as required by electrical power distribution system, but not less than [**42,000**] [**65,000**] [**100,000**] <**Insert value**> A.

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

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.

UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit-trip set point.

Provide each motor with overcurrent protection.

Overload relay sized according to UL 1995 or an integral component of chiller control microprocessor.

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.

Provide power factor correction capacitors to correct power factor to [**0.90**] [**0.95**] <**Insert value**> at full load.

Retain "Control Transformer" Subparagraph below if required for controls or unit-mounted convenience power receptacle.

Control Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.

Power unit-mounted controls where indicated.

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

Power unit-mounted, ground fault interrupt duplex receptacle.

Control Relays: Auxiliary and adjustable time-delay relays.

For chiller electrical power supply, indicate the following:

Current and phase to phase for all three phases.

Voltage, phase to phase, and phase to neutral for all three phases.

Three-phase real power (kilowatts).

Three-phase reactive power (kilovolt amperes reactive).

Power factor.

Running log of total power versus time (kilowatt-hours).

Fault log, with time and date of each.

<**Insert features**>.

* + - * 1. Controls:

Standalone and microprocessor based.

Enclosure: Share enclosure with electrical power devices or provide a separate enclosure[**for remote mounting in the field**].

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.

Date and time.

Operating or alarm status.

Operating hours.

Outdoor-air temperature if required for chilled-water reset.

Temperature and pressure of operating set points.

Entering and leaving temperatures of chilled water.

Refrigerant pressures in evaporator and condenser.

Saturation temperature in evaporator and condenser.

No cooling load condition.

Elapsed time meter (compressor run status).

Pump status.

Antirecycling timer status.

Percent of maximum motor amperage.

Current-limit set point.

Number of compressor starts.

<**Insert items**>.

Control Functions:

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

Manual or automatic startup and shutdown time schedule.

Entering and leaving chilled-water temperatures, control set points, and motor load limits. Chilled-water leaving temperature shall be reset based on [**return-water**] [**outdoor-air**] [**space**] temperature.

Current limit and demand limit.

External chiller emergency stop.

Antirecycling timer.

Automatic lead-lag switching.

Variable evaporator flow.

Thermal storage.

<**Insert control functions**>.

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.

Low evaporator pressure or high condenser pressure.

Low chilled-water temperature.

Refrigerant high pressure.

High or low oil pressure.

High oil temperature.

Loss of chilled-water flow.

Control device failure.

<**Insert manually reset safety controls**>.

Trending: Capability to trend analog data of up to [**five**] <**Insert number**> parameters simultaneously over an adjustable period and frequency of polling.

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.

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 DDC system for HVAC. Coordinate with Section 230923 "Direct Digital Control (DDC) System for HVAC."

Interface with DDC System for HVAC: Factory-installed hardware and software to enable the DDC system for HVAC to monitor, control, and display chiller status and alarms.

Retain first subparagraph below if interface with the DDC system for HVAC is through hardwired points and minimal interface is required.

Hardwired Points:

Monitoring: On-off status, [**common trouble alarm**] [**electrical power demand (kilowatts)**] [**electrical power consumption (kilowatt-hours)**] <**Insert monitoring point**>.

Control: On-off operation, [**chilled-water, discharge temperature set-point adjustment**] [**electrical power demand limit**] <**Insert control point**>.

Delete "Hardwired Points" Subparagraph above and retain subparagraph below if extensive interface with the DDC system for HVAC is required and is beyond what hardwired points can provide. Requirement may exclude some manufacturers.

[**ASHRAE 135 (BACnet)**] [**LonTalk**] [**Modbus**] [**Industry-accepted, open-protocol**] <**Insert type of interface**> communication interface with the DDC system for HVAC shall enable the DDC system for HVAC operator to remotely control and monitor the chiller from an operator workstation. Control features and monitoring points displayed locally at chiller control panel shall be available through the DDC system for HVAC.

* + - * 1. Insulation:

Material: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C534, Type I for tubular materials and Type II for sheet materials.

Second option in "Thickness" Subparagraph below may not be offered by all listed manufacturers.

Thickness: [**3/4 inch**] [**1-1/2 inches**] <**Insert dimension**>.

Factory-applied insulation over cold surfaces of chiller components.

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

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

* + - * 1. Accessories:

Retain one or more of four subparagraphs below to add features furnished by chiller manufacturer.

Consult manufacturers for flow-switch requirements. Some chiller models of some manufacturers have other forms of protection built into chiller design and do not require flow switches. Some manufacturers offer factory-mounted flow switches as standard. Carrier, for example, factory mounts a thermal-dispersion-type flow switch on some models.

Factory-furnished, chilled-water flow switches for field installation.

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.

Factory-furnished [**neoprene**] [**or**] [**spring**] isolators for field installation.

Retain "Tool Kit" Subparagraph below only if requested by Director’s Representative. Servicing of chiller by unqualified personnel is not recommended by chiller manufacturers and may void chiller warranty.

Tool Kit: Chiller manufacturer shall assemble a tool kit specially designed for use in serving the chiller(s) furnished. Include special tools required to service chiller components not readily available to Director’s Representative service personnel in performing routine maintenance. Place tools in a lockable case with hinged cover. Provide a list of each tool furnished and attach the list to underside of case cover.

If Project has more than one type or configuration of chiller, delete "Capacities and Characteristics" Paragraph below and schedule chillers on Drawings.

* + - * 1. Capacities and Characteristics:

Capacity: <**Insert tons**>.

LEED 2009 Prerequisite EA 2 Minimum Energy Performance requires compliance with ASHRAE/IESNA 90.1-2007. LEED 2009 Credit EA 1 Optimize Energy Performance requires efficiency in excess of minimum efficiency required by ASHRAE/IESNA 90.1-2007. LEED v4 Energy and Atmosphere Prerequisite Minimum Energy Performance requires minimum efficiency in excess of minimum efficiency required by ASHRAE/IES 90.1-2010. Coordinate efficiency requirements with "Quality Assurance" Article.

Retain one of first three subparagraphs below. First subparagraph is used in ASHRAE/IES 90.1.

Full-Load Efficiency COP: <**Insert value**>.

Full-Load Efficiency (EER): <**Insert value**>.

Full-Load Efficiency (Power Input/Cooling Output): <**Insert kW/ton**>.

Retain one of first two subparagraphs below. Retain first subparagraph if operating conditions reference AHRI standard rating conditions; retain second subparagraph if operating conditions are other than AHRI standard rating conditions.

Part-Load Efficiency (IPLV): <**Insert value**>.

Part-Load Efficiency (NPLV): <**Insert value**>.

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

Low Ambient Operation: Chiller designed for operation to [**0 deg F**] <**Insert temperature**>.

Retain first subparagraph below if high ambient operation is required. Verify requirement with manufacturer.

High Ambient Operation: Chiller designed for operation to [**115 deg F**] <**Insert temperature**>.

Evaporator:

Configuration: [**Integral to chiller**] [**Shipped loose for field installation**].

Pressure Rating: [**150 psig**] [**300 psig**] <**Insert value**>.

Fluid Type: [**Water**] <**Insert fluid type**>.

Design Fluid Flow Rate: <**Insert gpm**>.

Minimum Fluid Flow Rate: <**Insert gpm**>.

Entering-Fluid Temperature: <**Insert deg F**>.

Leaving-Fluid Temperature: <**Insert deg F**>.

Fluid Pressure Drop: <**Insert feet of head**>.

Fluid Velocity: <**Insert fps**>.

Fouling factor units in first subparagraph below are consistent with AHRI 550/590; first option is based on AHRI 550/590 standard rating.

Fouling Factor: [**0.0001 sq. ft. x h x deg F/Btu**] [**0.00025 sq. ft. x h x deg F/Btu**] [**0.0005 sq. ft. x h x deg F/Btu**] <**Insert value**>.

Condenser Entering-Air Temperature: <**Insert deg F**>.

Condenser Fan External Static Pressure: <**Insert wg**>.

Site Altitude: <**Insert feet**>.

Number of Refrigerant Circuits: [**Two**] [**Each compressor on an independent circuit**] <**Insert requirement**>.

Compressor:

Number of Compressors: <**Insert number**>.

Copy first two subparagraphs below and insert values for each compressor of multiple compressor units.

Rated Load Amperes: <**Insert value**>.

Locked-Rotor Amperes: <**Insert value**>.

Control Electrical Requirements:

Power Connection: [**Fed through integral transformer**] [**Separate field-power connection**].

Retain first six subparagraphs below if retaining second option in "Power Connection" Subparagraph above.

Power Input: <**Insert kilowatts**>.

Minimum Circuit Ampacity: <**Insert value**>.

Maximum Overcurrent Protection Device: <**Insert amperage**>.

Volts: [**120**] <**Insert value**>-V ac.

Phase: Single.

Hertz: 60.

Chiller Electrical Requirements:

Power Input: <**Insert kilowatts**>.

Power Factor: <**Insert value**>.

Minimum Circuit Ampacity: <**Insert value**>.

Maximum Overcurrent Protection Device: <**Insert amperage**>.

Volts: [**208**] [**240**] [**480**] [**600**] <**Insert value**>.

Phase: Three.

Hertz: 60.

Noise Rating: <**Insert number**> dBA at <**Insert distance in feet**> when measured according to AHRI 370. Provide factory-installed sound treatment if necessary to achieve the performance indicated.

* + - 1. PACKAGED, PORTABLE REFRIGERANT RECOVERY UNITS
				1. Packaged, portable unit consisting of compressor, air-cooled condenser, recovery system, tank pressure gages, filter-dryer, and valving that allows for switching between liquid and vapor recovery mode. Refrigerant recovery unit shall be factory mounted on an ASME-constructed and -stamped refrigerant storage vessel that is sized to hold the full refrigerant charge of the largest chiller furnished.
			2. HEAT-EXCHANGER, BRUSH-CLEANING SYSTEM
				1. Furnish for field installation a brush-cleaning system on each chiller [**condenser**] <**Insert heat exchanger**> for tube cleaning and improved heat transfer.
				2. System shall maintain tube fouling at or below design conditions without interrupting normal equipment operation.
				3. System shall consist of a brush inserted in each tube and a catch basket attached to each end of the tube. A four-way valve shall operate to reverse the direction of water flow to push the brush through the tube while removing tube deposits. Four-way reversing valve's actuator shall be controlled by a preset time cycle that provides regular tube brushing during equipment operation. Frequency of the brushing cycle shall be set up to match Project requirements.
				4. Components:

Brush: Each brush shall have nylon bristles, titanium wires, and polypropylene tips. Brush interference fit with the ID of the tube shall not exceed 0.025 inch.

Basket: Single-piece polypropylene basket with neck OD to press fit ID of tube. Design shall provide for insertion of eddy current probe or removal of brushes without removing baskets from the valve.

Four-Way Valve:

Construct valve body of carbon steel with internal sealing parts of hard rubber and Type 304 stainless steel.

Configure valve with parallel flow connections to minimize field installation piping.

Construct to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, at a system working pressure equal to condenser.

Pipe connections shall be flanged.

Valve manufacturer to test and certify a maximum leakage rate of less than 0.05 percent of the design flow rate at operation conditions of maximum differential pressure.

Hydrostatically test to 1.5 times the design working pressure.

Design the valve to cause no more than 0.5-psig pressure drop at design flow conditions.

Provide valve with valve-mounted indicating/warning light, which shall light before valve begins rotation.

Retain one of two "Valve Actuator" subparagraphs below.

Valve Actuator: Mount electric actuator to operate valve.

Valve Actuator: Mount pneumatic piston-type actuator to operate valve. Actuator shall be suitable for operation using field-supplied air pressure.

Position Switches: Factory mount microswitches on valve to indicate the complete turn of valve in both normal and reverse flow.

Control Panel: Factory or field mount a control panel on chiller. Control panel shall include the following features:

NEMA 250, [**Type 1**] [**Type 4**] [**Type 4x**] [**Type 12**] enclosure.

Timer to automatically initiate the cleaning cycle over a 24-hour period.

Manual override of preset cleaning cycle.

Visual indication of "Power On," "Diverter Position," "Normal Flow," "Reverse Flow," and "Valve Malfunction" indicating a slow turn or incomplete valve turn.

For pneumatic actuators, mount four-way solenoid valve for actuator operation in the control panel.

Flow switch bypass.

Unloading signal to chiller.

* + - 1. SOURCE QUALITY CONTROL
				1. Perform functional tests of chillers before shipping.

Retain first paragraph below for air-cooled chillers.

* + - * 1. Factory run test each air-cooled chiller with water flowing through evaporator.

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.

* + - * 1. Factory performance test air-cooled chillers, before shipping, according to AHRI 550/590.

Test the following conditions:

Design conditions indicated.

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

Reduction in capacity from design to minimum load in steps of [**10**] [**25**] [**33**] <**Insert number**> with condenser air at design conditions.

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

Retain first subparagraph below to witness testing.

Allow [**Director’s Representative**] <**Insert entity**> access to place where chillers are being tested. Notify Architect [**14**] <**Insert number**> days in advance of testing.

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 sound testing. Factory sound tests are an added cost and may not be available from some manufacturers.

Factory sound testing of air-cooled chillers is uncommon. Consult manufacturer if required.

* + - * 1. Factory sound test air-cooled chillers, before shipping, according to AHRI 370.

Test the following conditions:

Design conditions indicated.

Chiller operating at calculated worst-case sound condition.

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

Retain first subparagraph below to witness testing.

Allow [**Director’s Representative**] <**Insert entity**> access to place where chillers are being tested. Notify Architect [**14**] <**Insert number**> days in advance of testing.

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

* + - * 1. 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.

* + - * 1. For chillers located indoors, rate sound power level according to AHRI 575.

Retain paragraph below for chillers located outdoors.

* + - * 1. For chillers located outdoors, rate sound power level according to AHRI 370.
1. EXECUTION
	* + 1. EXAMINATION
				1. Examine chillers before installation. Reject chillers that are damaged.
				2. 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.

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

* + - * 1. Proceed with installation only after unsatisfactory conditions have been corrected.
			1. CHILLER INSTALLATION

Retain first paragraph below for mounting chillers on concrete bases.

* + - * 1. 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.

* + - * 1. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.

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

* + - * 1. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

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

* + - * 1. Install chillers on support structure indicated.
				2. Equipment Mounting:

Retain first subparagraph below to require equipment to be installed on cast-in-place concrete equipment bases.

Install chillers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

Retain one of two subparagraphs below. Retain first for projects in seismic areas; retain second for projects not in seismic areas. Indicate vibration isolation and seismic control device type and minimum deflection in supported equipment schedule on Drawings.

Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

* + - * 1. Maintain manufacturer's recommended clearances for service and maintenance.
				2. Charge chiller with refrigerant and fill with oil if not factory installed.
				3. Install separate devices furnished by manufacturer and not factory installed.
			1. HEAT-EXCHANGER, BRUSH-CLEANING SYSTEM INSTALLATION

Retain this article for heat-exchanger, brush-cleaning system. Coordinate with "Heat-Exchanger, Brush-Cleaning System" Article.

* + - * 1. Install brush-cleaning system control panel adjacent to chiller control panel.
				2. Arrange piping to provide service access to four-way valve assembly without affecting access to chiller. Secure valve to prevent lateral movement and vibration during operation.
				3. Provide field electric power, as required, to each system control panel and electric actuated valve.
				4. Provide pneumatic piping with pressure regulator and isolation valve to each pneumatic supply connection. Coordinate field source of air with manufacturer to ensure that requirements are satisfied for proper valve operation.
				5. Interconnect brush-cleaning system controls with chiller controls. Coordinate requirements to ensure safe, trouble-free operation.
				6. Functionally test the entire brush-cleaning system, including the valve, actuator, position indicator, and control panel, with chiller in operation.
			1. CONNECTIONS

Coordinate piping installations and specialty arrangements with Drawings and with requirements specified in piping systems. If Drawings are explicit enough, these requirements may be reduced or omitted.

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

* + - * 1. Comply with requirements for piping specified in Section 232113 "Hydronic Piping," Section 232116 Hydronic Piping Specialties," [**and**] [**Section 232300 "Refrigerant Piping."**] Drawings indicate general arrangement of piping, fittings, and specialties.
				2. Install piping adjacent to chiller to allow service and maintenance.
				3. 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,[**flow meter,**] and drain connection with valve. Make connections to chiller with a [**flange**] [**or**] [**mechanical coupling**].

Retain "Condenser Fluid Connections" Paragraph below for chiller equipped with a water-cooled condenser.

* + - * 1. 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,[**flow meter,**] and drain connection with valve. Make connections to chiller with a [**flange**] [**or**] [**mechanical coupling**].

Retain first paragraph below for chiller equipped with a heat-reclaim condenser.

* + - * 1. Heat-Reclaim 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,[**flow meter,**] and drain connection with valve. Make connections to chiller with a [**flange**] [**or**] [**mechanical coupling**].
				2. Refrigerant Pressure Relief Device Connections: For chillers installed indoors, extend [**vent piping**] [**separate vent piping for each chiller**] 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.
				3. 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.
			1. STARTUP SERVICE
				1. Engage a Company Service Advisor to perform startup service.

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

Verify that refrigerant charge is sufficient and chiller has been leak tested.

Verify that pumps are installed and functional.

Verify that thermometers and gages are installed.

Operate chiller for run-in period.

Check bearing lubrication and oil levels.

For chillers installed indoors, verify that refrigerant pressure relief device is vented outdoors.

Verify proper motor rotation.

Verify static deflection of vibration isolators, including deflection during chiller startup and shutdown.

Retain one of two options in first subparagraph below for water-cooled chillers.

Verify and record performance of fluid flow and low-temperature interlocks for evaporator and condenser.

Verify and record performance of chiller protection devices.

Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

* + - * 1. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assembly, installation, and connection.
				2. Prepare test and inspection startup reports.
			1. DEMONSTRATION
				1. Engage a Company Field Advisor per OGS Spec Section 014216 to train Facility’s maintenance personnel to adjust, operate, and maintain chillers.[**Video record the training sessions.**]

END OF SECTION 236426.13