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Modified by MSU Physical Plant / Engineering and Architectural Services

SECTION 236423 - SCROLL WATER CHILLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Packaged, water-cooled, electric-motor-driven, scroll water chillers.
- 2. Packaged, air-cooled, electric-motor-driven, scroll water chillers.

- B. Related Sections:

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

1.3 DEFINITIONS

- A. 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.
- B. 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.
- C. 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.
- D. 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.
- E. 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 the ARI standard rating conditions.

1.4 ACTION SUBMITTALS

- A. Product Data: 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 water chiller.
5. Oil capacity of water chiller.
6. Fluid capacity of evaporator.

Retain first subparagraph below for water-cooled water chillers.

7. Fluid capacity of condenser.
8. Characteristics of safety relief valves.

Retain first two subparagraphs below for water-cooled water chillers.

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

Retain two subparagraphs below for air-cooled water chillers.

11. Minimum entering condenser-air temperature
12. Performance at varying capacity with constant design entering condenser-air temperature. Repeat performance at varying capacity 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; coordinate with requirements selected in Part 2 for refrigerants.

1. Product Data for Credit EA 4: Documentation indicating that equipment and refrigerants comply.

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

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

1.5 INFORMATIONAL SUBMITTALS

- A. Certificates: For certification required in "Quality Assurance" Article.
- B. Source quality-control test reports.
- C. Startup service reports.

1.6 CLOSEOUT SUBMITTALS

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

1.7 QUALITY ASSURANCE

Retain first paragraph below if ARI certification is required and Project requirements fall within limits of ARI 590 certification program. ARI 550/590 standard is broken into two certification programs; ARI 590 certification program is applicable to scroll water chillers. Review the latest version to confirm requirements.

- A. ARI Certification: Certify chiller according to ARI 590 certification program.
- B. ARI Rating: Rate water chiller performance according to requirements in ARI 550/590, "Water Chilling Packages Using the Vapor Compression Cycle."
- C. ASHRAE Compliance: ASHRAE 15 for safety code for mechanical refrigeration.

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. Coordinate efficiency requirements with Part 2 "Capacities and Characteristics" paragraphs.

- D. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- E. ASME Compliance: Fabricate and stamp water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code.
- F. Comply with NFPA 70.

1.8 DELIVERY, STORAGE, AND HANDLING

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

1.9 COORDINATION

Retain first paragraph below for mounting water chillers on concrete bases.

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

Retain first paragraph below for mounting water 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 water chillers.

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

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of water chillers that fail in materials or workmanship within specified period.
1. Compressor Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PACKAGED WATER-COOLED WATER CHILLERS

For applications up to 60 tons.

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
1. Carrier Corporation; a United Technologies company.
 2. McQuay International.
 3. Trane.
- B. Description: Factory-assembled and run-tested water chiller complete with compressor(s), compressor motors and motor controllers, evaporator, condenser where indicated, electrical power, controls, and indicated accessories.
- C. Compressors:
1. Description: Positive-displacement direct drive with hermetically sealed casing.
 2. Each compressor provided with suction and discharge service valves, crankcase oil heater, and suction strainer.
 3. Operating Speed: Nominal 3600 rpm for 60-Hz applications.
 4. Capacity Control: On-off compressor cycling, plus hot-gas bypass.
 5. Oil Lubrication System: Automatic pump with strainer, sight glass, filling connection, filter with magnetic plug, and initial oil charge.
 6. Vibration Isolation: Mount individual compressors on vibration isolators.
 7. Sound-reduction package shall consist of acoustic enclosures around the compressors that are designed to reduce sound level without affecting performance.
- D. Compressor Motors:
1. Hermetically sealed and cooled by refrigerant suction gas.
 2. High-torque, two-pole induction type with inherent thermal-overload protection on each phase.
- E. Compressor Motor Controllers:
1. Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing.
- F. Refrigeration:

1. Refrigerant: **R-134a or R-410a**. Classified as Safety Group A1 according to ASHRAE 34.
2. Refrigerant Compatibility: Parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
3. Refrigerant Circuit: Each circuit shall include a thermal-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. Refrigerant Isolation: Factory install positive shutoff isolation valves in the compressor discharge line and the refrigerant liquid-line to allow the isolation and storage of the refrigerant charge in the chiller condenser.

G. Evaporator:

1. Shell and Tube:
 - a. Description: Direct-expansion, shell-and-tube design with fluid flowing through the shell and refrigerant flowing through the tubes within the shell.
 - b. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.
 - c. Shell Material: Carbon steel.
 - d. Shell Heads: Removable carbon-steel heads with multipass baffles designed to ensure positive oil return and located at each end of the tube bundle.
 - e. Shell Nozzles: Fluid nozzles located along the side of the shell and 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.

H. Condenser:

1. Shell and Tube:
 - a. Description: Shell-and-tube design with refrigerant flowing through the shell and fluid flowing through the tubes within the shell.
 - b. Provides positive subcooling of liquid refrigerant.
 - c. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.
 - 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.

I. Electrical Power:

1. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to water chiller.
2. Wiring shall be numbered and color-coded to match wiring diagram.
3. Install factory wiring outside of an enclosure in a raceway.
4. Provide each motor with overcurrent protection.
5. Overload relay sized according to UL 1995, or an integral component of water chiller control microprocessor.
6. Phase-Failure and Undervoltage: Solid-state sensing with adjustable settings.
7. Controls Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
8. Control Relays: Auxiliary and adjustable time-delay relays.
9. Indicate the following for water chiller electrical power supply:
 - a. Current, 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.
10. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

J. Controls:

1. Stand-alone, microprocessor based.
2. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure of matching construction.
3. Operator Interface: Keypad or pressure-sensitive touch screen. Multiple-character, backlit, liquid-crystal display or light-emitting diodes. Display the following:

Verify availability of items in list below; status displays may vary depending on unit size.

- a. Date and time.
- b. Operating or alarm status.
- c. Operating hours.
- d. Outside-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. Entering and leaving temperatures of condenser water.
- h. Refrigerant pressures in evaporator and condenser.
- i. Saturation temperature in evaporator and condenser.
- j. No cooling load condition.
- k. Elapsed time meter (compressor run status).
- l. Pump status.
- m. Antirecycling timer status.
- n. Percent of maximum motor amperage.
- o. Current-limit set point.

- p. Number of compressor starts.
- 4. Control Functions:
 - a. Manual or automatic startup and shutdown time schedule.
 - b. Entering and leaving chilled-water temperatures, control set points, and motor load limit. Chilled-water leaving temperature shall be reset based on return-water temperature.
 - c. Current limit and demand limit.
 - d. Condenser-water temperature.
 - e. External water chiller emergency stop.
 - f. Antirecycling timer.
 - g. Automatic lead-lag switching.
- 5. Manual-Reset Safety Controls: The following conditions shall shut down water chiller and require manual reset:
 - 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-water flow.
 - h. Control device failure.
- 6. Building Automation System Interface: Factory-installed hardware and software to enable building automation system to monitor, control, and display water chiller status and alarms.

Retain first subparagraph below if interface with building automation system 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.
- K. 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 water 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.
- L. 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 refrigeration circuit.
3. Factory-furnished neoprene or spring isolators for field installation.

M. Characteristics:

1. Evaporator Type: Brazed plate or shell and tube.

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

2. Evaporator Fouling Factor: 0.0001 sq. ft. x h x deg F/Btu (0.000018 sq. m x deg C/W).
3. Condenser Type: Shell and tube.

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

4. Condenser Fouling Factor: 0.00025 sq. ft. x h x deg F/Btu (0.000044 sq. m x deg C/W).

Select dual refrigerant circuits for 40 tons and larger chillers.

5. Number of Refrigeration Circuits: Two.

2.2 PACKAGED AIR-COOLED WATER CHILLERS

For applications up to 120 tons.

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product 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 water 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 water 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 from 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 consisting of the following:
 - a. Acoustic enclosure around compressors.
 - b. Reduced-speed fans with acoustic treatment.
 - c. Designed to reduce sound level without affecting performance.

D. Compressors:

1. Description: Positive-displacement direct drive with hermetically sealed casing.
2. Each compressor provided with suction and discharge service valves, crankcase oil heater, and suction strainer.
3. Operating Speed: Nominal 3600 rpm for 60-Hz applications.
4. Capacity Control: On-off compressor cycling, plus hot-gas bypass.
5. Oil Lubrication System: Automatic pump with strainer, sight glass, filling connection, filter with magnetic plug, and initial oil charge.
6. Vibration Isolation: Mount individual compressors on vibration isolators.

E. Compressor Motors:

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

F. Compressor Motor Controllers:

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

G. Refrigeration:

LEED-NC Credit EA 4 awards a single point if all HVAC&R equipment meets requirements for enhanced refrigerant management. Retain second, third, or sixth option in first subparagraph below to comply with Credit EA 4.

1. Refrigerant: **R-134a** or R-410a. Classified as Safety Group A1 according to ASHRAE 34.
2. Refrigerant Compatibility: Parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
3. Refrigerant Circuit: Each circuit shall include a thermal-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. Refrigerant Isolation: Factory install positive shutoff isolation valves in the compressor discharge line and the refrigerant liquid-line to allow the isolation and storage of the refrigerant charge in the chiller condenser.

H. Evaporator:

1. Shell and Tube:
 - a. Description: Direct-expansion, shell-and-tube design with fluid flowing through the shell and refrigerant flowing through the tubes within the shell.
 - b. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.
 - c. Shell Material: Carbon steel.
 - d. Shell Heads: Removable carbon-steel heads with multipass baffles designed to ensure positive oil return and located at each end of the tube bundle.

- e. Shell Nozzles: Fluid nozzles located along the side of the shell and 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.
2. Heater: Factory-installed and -wired electric heater with integral controls designed to protect the evaporator to minus 20 deg F (minus 29 deg C).
 3. Remote Mounting: Designed for remote field mounting where indicated. Provide kit for field installation.
- I. Air-Cooled Condenser:
1. Plate-fin coil with integral subcooling on each circuit, rated at 450 psig (3103 kPa).
 - a. 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, and having built-in overcurrent- and thermal-overload protection.
 4. Fan Guards: Steel safety guards with corrosion-resistant coating.
- J. Electrical Power:
1. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to water chiller.
 2. Wiring shall be numbered and color-coded to match wiring diagram.
 3. Install factory wiring outside of an enclosure in a raceway.
 4. Provide each motor with overcurrent protection.
 5. Overload relay sized according to UL 1995, or an integral component of water chiller control microprocessor.
 6. Phase-Failure and Undervoltage: Solid-state sensing with adjustable settings.
 7. 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.
 8. Control Relays: Auxiliary and adjustable time-delay relays.
 9. Indicate the following for water chiller electrical power supply:
 - a. Current, 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.

K. Controls:

1. Stand-alone, microprocessor based.
2. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure of matching construction.
3. Operator Interface: Keypad or pressure-sensitive touch screen. Multiple-character, backlit, liquid-crystal display or light-emitting diodes. Display the following:
 - a. Date and time.
 - b. Operating or alarm status.
 - c. Operating hours.
 - d. Outside-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:
 - a. Manual or automatic startup and shutdown time schedule.
 - b. Entering and leaving chilled-water temperatures, control set points, and motor load limit. Chilled-water leaving temperature shall be reset based on return-water temperature.
 - c. Current limit and demand limit.
 - d. External water chiller emergency stop.
 - e. Antirecycling timer.
 - f. Automatic lead-lag switching.
5. Manual-Reset Safety Controls: The following conditions shall shut down water chiller and require manual reset:
 - 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. Building Automation System Interface: Factory-installed hardware and software to enable building automation system to monitor, control, and display water chiller status and alarms.

Retain first subparagraph below if interface with building automation system 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.

L. 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 water 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.

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

N. Characteristics:

1. Low Ambient Operation: Chiller designed for operation to 0 deg F (minus 18 deg C).
2. Evaporator Configuration: Integral to chiller.
3. Evaporator Pressure Rating: 150 psig (1034 kPa).
4. Evaporator Fluid Type: Water.
5. Evaporator Fouling Factor: 0.0001 sq. ft. x h x deg F/Btu (0.000018 sq. m x deg C/W).

Select dual refrigerant circuits for 40 tons and larger chillers.

6. Number of Refrigeration Circuits: Two.

2.3 SOURCE QUALITY CONTROL

- A. Perform functional test of water chillers before shipping.
- B. Factory performance test water chillers, before shipping, according to ARI 550/590, "Water Chilling Packages Using the Vapor Compression Cycle."

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

- C. Factory test and inspect evaporator and water-cooled condenser according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Stamp with ASME label.

Retain first paragraph below for water chillers located indoors.

- D. For water chillers located indoors, rate sound power level according to ARI 575 procedure.

Retain paragraph below for water chillers located outdoors.

- E. For water chillers located outdoors, rate sound power level according to ARI 370 procedure.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Before water chiller installation, examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting water chiller performance, maintenance, and operations.
1. Water chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 WATER CHILLER INSTALLATION

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

- A. Install water chillers on support structure indicated.

Retain first paragraph for equipment supported on concrete base and vibration isolation devices.

- B. Equipment Mounting: Install water chiller on concrete bases using elastomeric pads, elastomeric mounts or restrained spring isolators. Comply with requirements in Division 03 Section "Cast-in-Place Concrete." Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration Controls for HVAC Piping and Equipment."
- C. Maintain manufacturer's recommended clearances for service and maintenance.
- D. Charge water chiller with refrigerant if not factory charged and fill with oil if not factory installed.
- E. Install separate devices furnished by manufacturer and not factory installed.

3.3 CONNECTIONS

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

Retain first paragraph below for chillers with remote evaporator or condenser.

- B. Comply with requirements in Division 23 Section "Refrigerant Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- C. Install piping adjacent to chiller to allow service and maintenance.
- D. 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 pressure gage, and drain connection with valve. Make connections to water chiller with a flange or mechanical coupling.

Retain first paragraph below for water-cooled water chillers.

- E. 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 pressure gage, and drain connection with valve. Make connections to water chiller with a flange or mechanical coupling.

Retain first paragraph below for chillers installed indoors.

- F. Refrigerant Pressure Relief Valve Connections: For water chillers installed indoors, extend vent piping to the outside without valves or restrictions. Comply with ASHRAE 15.
- G. Connect each 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 if required.

3.4 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.
- C. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
 - 1. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
 - 2. Verify that pumps are installed and functional.
 - 3. Verify that thermometers and gages are installed.
 - 4. Operate water chiller for run-in period.
 - 5. Check bearing lubrication and oil levels.
 - 6. Verify that refrigerant pressure relief device for chillers installed indoors is vented outside.
 - 7. Verify proper motor rotation.
 - 8. Verify static deflection of vibration isolators, including deflection during water chiller startup and shutdown.

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

9. Verify and record performance of chilled- and condenser-water flow and low-temperature interlocks.
 10. Verify and record performance of water chiller protection devices.
 11. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
- D. Prepare a written startup report that records results of tests and inspections.

3.5 DEMONSTRATION

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

END OF SECTION 236423