SECTION 236416

CENTRIFUGAL WATER CHILLERS

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**NOTE TO SPECIFIER**

*Use this Specification Section for Mail Processing Facilities.*

***This is a Type 1 Specification with completely editable text; therefore, any portion of the text can be modified by the A/E preparing the Solicitation Package to suit the project.***

*For Design/Build projects, do not delete the Notes to Specifier in this Section so that they may be available to Design/Build entity when preparing the Construction Documents.*

*For the Design/Build entity, this specification is intended as a guide for the Architect/Engineer preparing the Construction Documents.*

*The MPF specifications may also be used for Design/Bid/Build projects. In either case, it is the responsibility of the design professional to edit the Specifications Sections as appropriate for the project.*

*Text shown in brackets must be modified as needed for project specific requirements.* *See the “Using the USPS Guide Specifications” document in Folder C for more information.*

*The last date that USPS revised this standard specification section occurs in two places, at the end of this section and in the Table of Contents. If the date in this section matches the date in the Table of Contents, then you are using the latest version. Do not delete or revise the “last revised” date at the end of the section during the development of the Project Manual.*

*The footer in this section should be edited to replace the text, “USPS MPF SPECIFICATION” with the project name, and the blank date in the center should be replaced with the submission date, for interim design reviews, or the issue date of the completed Project Manual.*

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1. GENERAL
	1. SUMMARY
		1. Section Includes: Packaged, water-cooled, electric-motor-driven centrifugal chillers.
	2. PERFORMANCE REQUIREMENTS
		1. Condenser-Fluid Temperature Performance:
			1. Startup Condenser-Fluid Temperature: Chiller shall be capable of starting with an entering condenser-fluid temperature of 55 deg F and providing stable operation until the system temperature is elevated to the minimum operating entering condenser-fluid temperature.
			2. Make factory modifications to standard chiller design if necessary to comply with performance indicated.
		2. Site Altitude: Chiller shall be suitable for altitude at which installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.
	3. SUBMITTALS
		1. Product Data: For each type of product indicated. Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.
		2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
		3. Certificates: For certification required in "Quality Assurance" Article.
		4. Startup service reports.
		5. Operation and maintenance data.
		6. Warranty.
	4. QUALITY ASSURANCE
		1. AHRI Rating: Rate chiller performance according to requirements in AHRI Standard 550/590.
		2. ASHRAE Compliance:
			1. ASHRAE Standard 15-2016 for safety codes for mechanical refrigeration.
			2. ASHRAE Standard 34-2016 for safety classifications of refrigerants based on toxicity and flammability data.
			3. ASHRAE Standard 147-2013 for refrigerant leaks, recovery, and handling and storage requirements.
		3. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/ISESNA 90.1-2004.
		4. ASME Compliance: Fabricate and label chillers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1**,**as applicable to chiller design. For chillers charged with R-134a refrigerant, include an ASME U-stamp and nameplate certifying compliance.
		5. Comply with NFPA 70.
		6. Comply with requirements of UL and UL Canada, and include label by a qualified testing agency showing compliance.
		7. Comply with U.S. EPA Final Rule 21 (40 CFR Part 82 – 81 FR 86778) for acceptability status of substitute refrigerants.
		8. Comply with any state, fire marshal, building code or other local authority prohibitions or regulations related to flammable refrigerants.
	5. WARRANTY
		1. 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:
				1. Complete compressor and drive assembly including refrigerant and oil charge.
				2. Parts only.
			2. Warranty Period: Five years from date of Substantial Completion.
2. PRODUCTS

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**NOTE TO SPECIFIER**

Verify manufacturer information, Product numbers, and availability at time of Project Manual preparation for Project.

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* 1. MANUFACTURERS
		1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
			1. Carrier Global Corporation.
			2. Daikin Applied Americas.
			3. Trane Technologies.
			4. Johnson Controls International.
	2. MANUFACTURED UNIT
		1. Description: Factory-assembled chiller complete with compressor, compressor motor, compressor motor controller, evaporator, condenser, [controls, interconnecting unit piping and wiring, and indicated accessories.
			1. For chillers with dual compressors, provide each compressor with a dedicated motor and motor controller, and provide for continued operation when either compressor-drive assembly fails or is being serviced.

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**NOTE TO SPECIFIER**

Retain paragraph below for projects in seismic areas.

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* + 1. Fabricate chiller mounting base with reinforcement strong enough to resist chiller movement during a seismic event when chiller is anchored to field support structure.
	1. COMPRESSOR-DRIVE ASSEMBLY
		1. Description: Single-stage or multistage, variable-displacement, centrifugal-type compressor driven by an electric motor.
		2. Compressor:
			1. Casing: Cast iron, precision ground.
			2. Impeller: High-strength cast aluminum or cast-aluminum alloy on carbon- or alloy-steel shaft.
		3. Compressor Motor:
			1. Continuous-duty, squirrel-cage, induction-type, two-pole motor with energy efficiency required to suit chiller energy efficiency indicated.
			2. Factory mounted, aligned, and balanced as part of compressor assembly before shipping.
			3. Motor shall be of sufficient capacity to drive compressor throughout entire operating range without overload and with sufficient capacity to start and accelerate compressor without damage.
			4. For chillers with open drives, provide motor with open-dripproof enclosure.
			5. Provide motor with thermistor or RTD to monitor bearing temperature and report information to chiller control panel.
			6. Provide open-drive motor with internal electric heater, internally powered from chiller power supply.
		4. Service: Easily accessible for inspection and service.
			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.
		5. Capacity Control: Modulating, variable-inlet, guide-vane assembly combined with hot-gas bypass, if necessary, to achieve performance indicated.
			1. Maintain stable operation that is free of surge, cavitation, and vibration throughout range of operation. Configure to achieve most energy-efficient operation possible.
			2. Operating Range: From 100 to 10 percent of design capacity.
			3. Chillers with variable frequency controllers shall modulate compressor speed with variable-inlet, guide-vane control to achieve optimum energy efficiency.
		6. Oil Lubrication System: Consisting of pump, filtration, heater, cooler, factory-wired power connection, and controls.
	2. REFRIGERATION
		1. Refrigerant:
			1. Type: R-134A ASHRAE 34, Class A1.
1. NOTE: Effective January 1, 2024, the manufacture and sale of new centrifugal chillers utilizing R-134a will not be allowed. See Item 2., below.
	* + 1. Comply with U.S. EPA’s Significant New Alternatives Policy (SNAP) program for acceptable substitute refrigerants. As the deadline for phase out approaches, new generation chiller equipment utilizing lower Global Warming Potential (GWP) hydrofluoroolefin (HFO) refrigerants (e.g., R-1234ze) and blends (e.g., R-513a and R-450a) should be considered.
				1. Comply with current ASHRAE 15 guidance on the use of “mildly flammable” refrigerants such as R-1234ze that has an ASHRAE 34 rating of A2L.
			2. Compatibility: Chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
		1. Refrigerant Flow Control: Manufacturer's standard refrigerant flow-control device satisfying performance requirements indicated.
		2. Pressure Relief Device:
			1. Comply with requirements in ASHRAE 15 and in applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
		3. Positive-Pressure System:
			1. During nonoperational periods, positive-pressure system shall automatically maintain a positive pressure for atmosphere in the refrigerant pressure vessel of not less than 0.5 psig (adjustable) up to a pressure that remains within the vessel design pressure limits.
			2. System shall be factory wired and include controller, electric heat, pressure transmitter, or switch.
		4. Refrigerant Isolation for Chillers Using R-134a:
			1. Factory install positive shutoff, manual 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. In addition, provide isolation valve on suction side of compressor from evaporator to allow for isolation and storage of full refrigerant charge in the chiller evaporator shell.
	1. EVAPORATOR
		1. Description: Shell-and-tube design with water in tubes and refrigerant surrounding tubes within shell. Shell is separate from condenser.
		2. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.
		3. Designed to prevent liquid refrigerant carryover from entering compressor.
		4. Provide evaporator with sight glass or other form of positive visual verification of liquid-refrigerant level.
		5. Tubes:
			1. Individually replaceable from either end and without damage to tube sheets and other tubes.
			2. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
			3. Tube materials vary among manufacturers and chiller models; verify availability with manufacturer. First option in first subparagraph below is current standard of listed manufacturers.
			4. Material: Copper.
			5. Minimum Wall Thickness: 0.028 inch.
			6. External Finish: Manufacturer's standard.
			7. Internal Finish: Enhanced.
		6. End Tube Sheets: Continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.
		7. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.
		8. Water Box:
			1. Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
			2. Standard or Marine type for water box with piping connections. Standard type for water box without piping connections.
			3. Provide water boxes [and marine water-box covers ]with lifting lugs or eyebolts.
			4. Retain one of first two subparagraphs below for special applications.
			5. Thermistor or RTD temperature sensor factory installed in each nozzle.
			6. Fit each water box with 3/4- or 1-inch drain connection at low point and vent connection at high point, each with threaded plug.
	2. CONDENSER
		1. Description: Shell-and-tube design with water in tubes and refrigerant surrounding tubes within shell. Shell is separate from evaporator.
		2. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.
		3. Designed to prevent direct impingement of high-velocity hot gas from compressor discharge on tubes.
		4. Provide condenser with sight glass or other form of positive visual verification of refrigerant charge and condition.
		5. Tubes:
			1. Individually replaceable from either end and without damage to tube sheets and other tubes.
			2. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
			3. Material: Copper.
			4. Minimum Wall Thickness: 0.028 inch.
			5. External Finish: Manufacturer's standard.
			6. Internal Finish: Enhanced.
		6. End Tube Sheets: Continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.
		7. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.
		8. Water Box:
			1. Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
			2. Standard or Marine type for water box with piping connections. Standard type for water box without piping connections.
			3. Thermistor or RTD temperature sensor factory installed in each nozzle.
			4. Fit each water box with 3/4- or 1-inch drain connection at low point and vent connection at high point, each with threaded plug.
		9. Additional Corrosion Protection:
			1. Electrolytic corrosion-inhibitor anode.
			2. Retain one of two subparagraphs below.
			3. Coat wetted surfaces with a corrosion-resistant finish.
			4. Using same material as tubes, clad surfaces of end tube sheets in contact with fluid. Coat other wetted surfaces, including water boxes, with a corrosion-resistant finish.
	3. INSULATION
		1. Closed-cell, flexible elastomeric thermal insulation complying with ASTM C 534, Type I for tube and Type II for sheet materials.
			1. Thickness: 3/4 inch.
		2. Adhesive: As recommended by insulation manufacturer.
		3. Factory apply insulation over all cold surfaces of chiller capable of forming condensation. Components shall include, but not be limited to, evaporator shell and end tube sheets, evaporator water boxes including nozzles, refrigerant suction pipe from evaporator to compressor, cold surfaces of compressor, refrigerant-cooled motor, and auxiliary piping.
			1. Apply adhesive to 100 percent of insulation contact surface.
			2. Before insulating steel surfaces, prepare surfaces for paint, and prime and paint as indicated for other painted components. Do not insulate unpainted steel surfaces.
			3. Seal seams and joints to provide a vapor barrier.
			4. After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.
	4. ELECTRICAL
		1. Factory installed and wired, and functionally tested at factory before shipment.
		2. Single-point, field-power connection to fused disconnect switch. Minimum withstand rating shall be as required by electrical power distribution system.
		3. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.
	5. MOTOR CONTROLLER

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**NOTE TO SPECIFIER**

Not all chiller manufacturers provide all features specified in this specification section; verify availability, and edit subparagraphs below to match project. Coordinate electrical requirements with Drawings and Division 26 Sections. Delete this section if chiller is to be provided with a variable frequency drive controller.

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* + 1. Enclosure: Factory installed, unit mounted, with hinged full-front access door.
		2. Overload Relay: Shall be sized according to UL 1995 or shall be an integral component of chiller control microprocessor.
		3. Star-Delta, Reduced-Voltage Controller: NEMA ICS 2, closed transition.
		4. Autotransformer Reduced-Voltage Controller: NEMA ICS 2, closed transition; include isolation switch and current-limiting fuses.
		5. Solid-State, Reduced-Voltage Controller: NEMA ICS 2.
			1. Surge suppressor in solid-state power circuits providing three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
			2. Visual indication of motor and control status, including the following conditions:
				1. Controller on.
				2. Overload trip.
				3. Loss of phase.
				4. Starter fault.
		6. Accessories: Devices shall be factory installed in controller enclosure unless otherwise indicated.

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**NOTE TO SPECIFIER**

Edit subparagraphs below to suit project.

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* + - 1. Externally Operated, Door-Interlocked Disconnect:
			2. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
			3. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
			4. Control Relays: Time-delay relays.
			5. Elapsed-Time Meters: Numerical readout in hours on face of enclosure.
			6. Number-of-Starts Counter: Numerical readout on face of enclosure.
			7. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
				1. Selectable, digital display of the following:

Phase Currents, Each Phase: Plus or minus 1 percent.

Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.

Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.

Three-Phase Real Power: Plus or minus 2 percent.

Three-Phase Reactive Power: Plus or minus 2 percent.

Power Factor: Plus or minus 2 percent.

Frequency: Plus or minus 0.5 percent.

Integrated Demand with Demand Interval Selectable from Five to 60 Minutes: Plus or minus 2 percent.

Accumulated energy, in megawatt hours (joules), plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.

* + - * 1. Mounting: Display and control unit flush or semirecessed in instrument compartment door.
			1. Phase-Failure, Phase-Reversal, Undervoltage Relays: Solid-state sensing circuit with adjustable undervoltage setting and isolated output contacts for hardwired connection.
			2. Power Protection: Chiller shall shut down within six cycles of power interruption.

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**NOTE TO SPECIFIER**

Delete this section if chillers are to be provided with starters in lieu of variable frequency drive controllers. Edit subparagraphs to match proposed chiller(s).

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* 1. VARIABLE SPEED DRIVE
		1. Provide where scheduled on Drawings.
		2. A variable speed drive shall be factory installed on the chiller. The variable speed drive shall vary the compressor motor speed by controlling the frequency and voltage of the electrical power to the motor. The adaptive capacity control logic shall automatically adjust motor speed and compressor pre-rotation van position independently for maximum part-load efficiency by analyzing information fed to it by sensors located throughout the chiller.
		3. Drive shall be pulse width modulation type utilizing insulated gate bipolar transistors with a power factor of 0.95 or better at all loads and speeds.
		4. The variable speed drive shall be unit-mounted in a NEMA-1 enclosure with all power and control wiring between the drive and chiller factory installed, including power to the chiller oil pump. Field power wiring shall be a single point connection and electrical lugs for incoming power wiring shall be provided. The entire chiller package shall be UL listed.
		5. The following features shall be provided:
			1. A door interlocked circuit breaker, capable of being padlocked.
			2. UL listed ground fault protection.
			3. Overvoltage and undervoltage protection.
			4. 3-phase sensing motor.
			5. Overcurrent protection.
			6. Single phase protection
			7. Insensitive to phase rotation.
			8. Over temperature protection.
			9. Digital readout at the chiller unit control panel of:
				1. Output Frequency.
				2. Output Voltage.
				3. Input Kilowatts (kW) and Kilowatt-hours (kWh).
				4. Self-diagnostic service parameters.
		6. Separate meters for this information shall not be acceptable. A harmonic filter that limits electrical power supply distortion for the variable speed drive to comply with the guidelines of IEEE Std. 519-1992 shall be provided. The filter shall be unit mounted within the same NEMA -1 enclosure and shall be UL listed. The following digital readouts shall be provided at the chiller unit control panel as part of the filter package:
			1. Input kVA.
			2. Total power factor.
			3. 3-Phase input voltage.
			4. 3-Phase input current.
			5. 3-Phase input voltage total harmonic distortion (THD).
			6. 3-Phase input current total demand distortion (TDD).
			7. Self-diagnostic service parameters.
	2. CONTROLS

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**NOTE TO SPECIFIER**

Coordinate this section with Division 25 Section " Building Automation System (BAS) General

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* + 1. Control: Standalone and microprocessor based, with all memory stored in nonvolatile memory so that reprogramming is not required on loss of electrical power.
		2. Enclosure: Unit mounted, NEMA 250, Type 1, hinged or lockable; factory wired with a single-point, field-power connection and a separate control circuit.
		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 selectable through the interface, display the following information:

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**NOTE TO SPECIFIER**

Revise list below to suit Project.

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* + 1. Trending: Capability to trend analog data of up to five parameters simultaneously over an adjustable period and frequency of polling.
		2. 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.
		3. Control Authority: At least four conditions: Off, local manual control at chiller, local automatic control at chiller, and automatic control through a remote source.
		4. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer and a notebook computer.

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**NOTE TO SPECIFIER**

Coordinate with Division 25 Section " Building Automation System (BAS) General

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* + 1. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display chiller status and alarms.
			1. ASHRAE 135 (BACnet) or Modbus communication interface with the BAS shall enable the BAS 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 BAS.
	1. FINISH
		1. Paint chiller, using manufacturer's standard procedures.
	2. ACCESSORIES
		1. Flow Switches:
			1. Chiller manufacturer shall furnish a switch for evaporator and confirm field-mounting location before installation.
			2. Flow Switches:
		2. Vibration Isolation:
			1. Chiller manufacturer shall furnish vibration isolation for each chiller.
			2. Neoprene Pad:
				1. Two layers of 0.375-inch-thick, ribbed- or waffle-pattern neoprene pads separated by a 16-gage, stainless-steel plate.
				2. Fabricate pads from 40- to 50-durometer neoprene.
				3. Provide stainless-steel square bearing plate to load the pad uniformly between 20 and 40 psig with a 0.12- to 0.16-inch deflection.
	3. CAPACITIES AND CHARACTERISTICS

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**NOTE TO SPECIFIER**

List maximum efficiencies from 4.2.10.1 of Repair and Alterations Criteria. Lower is better.

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* + 1. Minimum Full-Load Efficiency:
			1. Maximum FL value: [Insert value]kw/Ton.
		2. Minimum Part-Load Efficiency:
			1. Maximum IPLV value: [Insert value] kw/Ton.
	1. SOURCE QUALITY CONTROL
		1. For chillers using R-134a refrigerant, factory test and inspect evaporator and condenser according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
		2. For chillers located indoors, rate sound power level according to ARI 575.
1. EXECUTION
	1. CHILLER INSTALLATION
		1. Install chillers on support structure indicated.
		2. Equipment Mounting: Install chiller on concrete bases using elastomeric pads. Comply with requirements for concrete bases specified in Division 3 Sections.
		3. Maintain manufacturer's recommended clearances for service and maintenance.
		4. Charge chiller with refrigerant and fill with oil if not factory installed.
		5. Install separate devices furnished by manufacturer and not factory installed.
	2. CONNECTIONS
		1. 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.
		2. Install piping adjacent to chiller to allow service and maintenance.
		3. Evaporator Fluid Connections: Connect to evaporator inlet with shutoff valve, 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
		4. Condenser-Fluid Connections: Connect to condenser inlet with shutoff valve, 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. Refrigerant Pressure Relief Device Connections: For chillers installed indoors, extend vent piping to the outdoors without valves or restrictions. Comply with ASHRAE 15. Connect to chiller pressure relief device with flexible connector and dirt leg with drain valve.
		5. 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. STARTUP SERVICE
		1. 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. Retain first subparagraph below for oil-lubricated chillers.
			7. Check bearing lubrication and oil levels.
			8. Verify that refrigerant pressure relief device is vented outside.
			9. Verify proper motor rotation.
			10. Verify static deflection of vibration isolators, including deflection during chiller startup and shutdown.
			11. Verify and record performance of fluid flow and low-temperature interlocks for evaporator and condenser.
			12. Verify and record performance of chiller protection devices.
			13. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
		2. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assembly, installation, and connection.
		3. Prepare test and inspection startup reports.

END OF SECTION

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