SECTION 232300 - REFRIGERANT PIPING

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

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.

Verify with equipment specifications refrigeration components that are supplied and edit this Section as needed.

* + - 1. SUMMARY
         1. Section Includes:

Copper tube and fittings.

Steel pipe and fittings.

Valves and specialties.

Refrigerants.

* + - 1. 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 valve, refrigerant piping, and piping specialty.

Include pressure drop, based on manufacturer's test data, for the following:

Thermostatic expansion valves.

Solenoid valves.

Hot-gas bypass valves.

Filter dryers.

Strainers.

Pressure-regulating valves.

* + - * 1. Shop Drawings:

Retain one of first two subparagraphs below. Retain first if Drawings indicate pipe size and layout; retain second to have Contractor size and design refrigeration piping.

Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes; flow capacities; valve arrangements and locations; slopes of horizontal runs; oil traps; double risers; wall and floor penetrations; and equipment connection details.

Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

Show interface and spatial relationships between piping and equipment.

Shop Drawing Scale: [**1/4 inch equals 1 foot**] <**Insert value**>.

Retain "Welding certificates" paragraph below if retaining "Welding Qualifications" paragraph in "Quality Assurance" Article.

* + - * 1. Welding certificates.

Retain "Field quality-control reports" paragraph below if Contractor is responsible for field quality-control testing and inspecting.

* + - * 1. Field quality-control reports.
      1. CLOSEOUT SUBMITTALS
         1. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.
      2. QUALITY ASSURANCE
         1. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
         2. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."
      3. PRODUCT STORAGE AND HANDLING
         1. Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.

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.

* + - 1. PERFORMANCE REQUIREMENTS

If more than one type of refrigerant is required for Project, retain applicable paragraphs below and indicate on Drawings which piping circuit requires which refrigerant.

* + - * 1. Line Test Pressure for Refrigerant R-134a:

Suction Lines for Air-Conditioning Applications: 115 psig.

Suction Lines for Heat-Pump Applications: 225 psig.

Hot-Gas and Liquid Lines: 225 psig.

* + - * 1. Line Test Pressure for Refrigerant R-407C:

Suction Lines for Air-Conditioning Applications: 230 psig.

Suction Lines for Heat-Pump Applications: 380 psig.

Hot-Gas and Liquid Lines: 380 psig.

* + - * 1. Line Test Pressure for Refrigerant R-410A:

Suction Lines for Air-Conditioning Applications: 300 psig.

Suction Lines for Heat-Pump Applications: 535 psig.

Hot-Gas and Liquid Lines: 535 psig.

Coordinate first two articles below with piping application articles in Part 3. See "Writing Guide" Article in the Evaluations. Materials included in this Section are examples listed in the 2008 ASHRAE HANDBOOK - "HVAC Systems and Equipment" (Ch. 45, "Pipes, Tubes, and Fittings").

* + - 1. COPPER TUBE AND FITTINGS
         1. Copper Tube: [**ASTM B 280, Type ACR**].
         2. Wrought-Copper Fittings, Brazed-Joint: ASME B16.50.

Manufacturers cite wrought copper unions complying with ASME B16.22, although that standard applies to wrought copper and copper alloy solder-joint pressure fittings. No alternative standards specific to wrought copper unions was found.

* + - * 1. Wrought-Copper Unions: ASME B16.22.

See the Evaluations for discussions of brazing materials.

* + - * 1. Brazing Filler Metals: AWS A5.8.
        2. Flexible Connectors:

Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.

End Connections: Socket ends.

Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch- long assembly.

Working Pressure Rating: Factory test at minimum 500 psig.

Maximum Operating Temperature: 250 deg F.

* + - * 1. Flared Tube Fittings:

Refrigerant Tube Type: SAE J513.

* + - * 1. Copper-Tube, Pressure-Seal-Joint Fittings for Refrigerant Piping:

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:

Conex Banninger - USA.

Parker Hannifin, Sporlan Division.

Approved equivalent.

Standard: UL 207; certified by UL for field installation. Certification as a UL-recognized component alone is unacceptable.

Housing: Copper.

O-Rings: HNBR or compatible with specific refrigerant.

Tools: Manufacturer's approved special tools.

Minimum Rated Pressure: 700 psig.

* + - 1. VALVES AND SPECIALTIES
         1. Diaphragm Packless Valves:

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:

Danfoss Inc.

Heldon Products; Henry Technologies.

Paul Mueller Company.

Approved equivalent.

Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.

Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.

Operator: Rising stem and hand wheel.

Seat: Nylon.

End Connections: Socket, union, or flanged.

Working Pressure Rating: 500 psig.

Maximum Operating Temperature: 275 deg F.

* + - * 1. Packed-Angle Valves:

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:

Danfoss Inc.

Heldon Products; Henry Technologies.

Paul Mueller Company.

Approved equivalent.

Body and Bonnet: Forged brass or cast bronze.

Packing: Molded stem, back seating, and replaceable under pressure.

Operator: Rising stem.

Seat: Nonrotating, self-aligning polytetrafluoroethylene.

Seal Cap: Forged-brass or valox hex cap.

End Connections: Socket, union, threaded, or flanged.

Working Pressure Rating: 500 psig.

Maximum Operating Temperature: 275 deg F.

* + - * 1. Check Valves:

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:

Heldon Products; Henry Technologies.

Paul Mueller Company.

Approved equivalent.

Body: Ductile iron, forged brass, or cast bronze; globe pattern.

Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.

Piston: Removable polytetrafluoroethylene seat.

Closing Spring: Stainless steel.

Retain "Manual Opening Stem" subparagraph below for optional manual opening feature.

Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.

End Connections: Socket, union, threaded, or flanged.

Maximum Opening Pressure: 0.50 psig.

Working Pressure Rating: 500 psig.

Maximum Operating Temperature: 275 deg F.

* + - * 1. Service Valves:

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:

Danfoss Inc.

Heldon Products; Henry Technologies.

Paul Mueller Company.

Approved equivalent.

Body: Forged brass with brass cap including key end to remove core.

Core: Removable ball-type check valve with stainless-steel spring.

Seat: Polytetrafluoroethylene.

End Connections: Copper spring.

Working Pressure Rating: 500 psig.

* + - * 1. Refrigerant Locking Caps:

International Mechanical Code and International Residential Code require locking-type, tamper-resistant caps on refrigerant charging ports that are located outdoors unless otherwise protected from unauthorized access by a means acceptable to the authority having jurisdiction.

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:

C & D Valve, LLC.

JB Industries.

RectorSeal HVAC; a CSW Industrials Company.

Approved equivalent.

Description: Locking-type, tamper-resistant, threaded caps to protect refrigerant charging ports from unauthorized refrigerant access and leakage.

Material: Brass, with protective shroud or sleeve.

Color-coded identification is currently only available for R-22 (which is not listed in this Section due to its phase-out date) and for R-410A. For other refrigerants, choose the third option in the subparagraph below or verify current availability of color-coded, refrigerant-specific types with manufacturers.

Refrigerant Identification: [**Color-coded, refrigerant specific**] [**or**] [**Universal**] design.

Special Tool: For installing and unlocking.

Solenoid valves in "Solenoid Valves" paragraph below are made normally closed or normally open. Normally closed are direct acting and pilot operated. Holding coils are available in several voltages.

* + - * 1. Solenoid Valves: Comply with AHRI 760 and UL 429; listed and labeled by a National Recognized Testing Laboratory (NRTL).

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:

Danfoss Inc.

Heldon Products; Henry Technologies.

Paul Mueller Company.

Approved equivalent.

Body and Bonnet: Plated steel.

Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.

Seat: Polytetrafluoroethylene.

End Connections: Threaded.

Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and [**24**] [**115**] [**208**]-V ac coil.

Working Pressure Rating: 400 psig.

Maximum Operating Temperature: 240 deg F.

Retain "Safety Relief Valves" paragraph below for optional manual opening feature.

* + - * 1. Safety Relief Valves: Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

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:

Danfoss Inc.

Heldon Products; Henry Technologies.

Paul Mueller Company.

Approved equivalent.

Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.

Piston, Closing Spring, and Seat Insert: Stainless steel.

Seat: Polytetrafluoroethylene.

End Connections: Threaded.

Working Pressure Rating: 400 psig.

Maximum Operating Temperature: 240 deg F.

* + - * 1. Thermostatic Expansion Valves: Comply with AHRI 750.

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:

Danfoss Inc.

Emerson Climate Technologies.

Paul Mueller Company.

Approved equivalent.

Body, Bonnet, and Seal Cap: Forged brass or steel.

Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.

Packing and Gaskets: Non-asbestos.

Capillary and Bulb: Copper tubing filled with refrigerant charge.

Suction Temperature: [**40 deg F**] <**Insert temperature**>.

Superheat: [**Adjustable**] [**Nonadjustable**].

Reverse-flow option (for heat-pump applications).

End Connections: Socket, flare, or threaded union.

Working Pressure Rating: [**700 psig**] [**450 psig**] <**Insert value**>.

* + - * 1. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.

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:

Danfoss Inc.

Heldon Products; Henry Technologies.

Parker Hannifin Corp.

Approved equivalent.

Body, Bonnet, and Seal Cap: Ductile iron or steel.

Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.

Packing and Gaskets: Non-asbestos.

Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.

Seat: Polytetrafluoroethylene.

Equalizer: [**Internal**] [**External**].

Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter and [**24**] [**115**] [**208**]-V ac coil.

End Connections: Socket.

Set Pressure: <**Insert psig**>.

Throttling Range: Maximum 5 psig.

Working Pressure Rating: 500 psig.

Maximum Operating Temperature: 240 deg F.

* + - * 1. Straight-Type Strainers:

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:

Danfoss Inc.

Heldon Products; Henry Technologies.

Parker Hannifin Corp.

Approved equivalent.

Body: Welded steel with corrosion-resistant coating.

Screen: 100-mesh stainless steel.

End Connections: Socket or flare.

Working Pressure Rating: 500 psig.

Maximum Operating Temperature: 275 deg F.

* + - * 1. Angle-Type Strainers:

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:

Danfoss Inc.

Heldon Products; Henry Technologies.

Parker Hannifin Corp.

Approved equivalent.

Body: Forged brass or cast bronze.

Drain Plug: Brass hex plug.

Screen: 100-mesh monel.

End Connections: Socket or flare.

Working Pressure Rating: 500 psig.

Maximum Operating Temperature: 275 deg F.

* + - * 1. Moisture/Liquid Indicators:

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:

Danfoss Inc.

Heldon Products; Henry Technologies.

Parker Hannifin Corp.

Approved equivalent.

Body: Forged brass.

Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.

Indicator: Color coded to show moisture content in parts per million (ppm).

Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.

End Connections: Socket or flare.

Working Pressure Rating: 500 psig.

Maximum Operating Temperature: 240 deg F.

* + - * 1. Replaceable-Core Filter Dryers: Comply with AHRI 730.

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:

Danfoss Inc.

Heldon Products; Henry Technologies.

Parker Hannifin Corp.

Approved equivalent.

Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.

Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.

Desiccant Media: Activated [**alumina**] [**charcoal**].

Retain first subparagraph below for heat pumps.

Designed for reverse flow (for heat-pump applications).

End Connections: Socket.

Retain "Access Ports" subparagraph below for suction-line filter dryers.

Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.

Maximum Pressure Loss: [**2 psig**] <**Insert value**>.

Rated Flow: <**Insert tons**>.

Working Pressure Rating: 500 psig.

Maximum Operating Temperature: 240 deg F.

* + - * 1. Permanent Filter Dryers: Comply with AHRI 730.

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:

Danfoss Inc.

Heldon Products; Henry Technologies.

Parker Hannifin Corp.

Approved equivalent.

Body and Cover: Painted-steel shell.

Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.

Desiccant Media: Activated [**alumina**] [**charcoal**].

Retain first subparagraph below for heat pumps.

Designed for reverse flow (for heat-pump applications).

End Connections: Socket.

Retain first subparagraph below for suction-line filter dryers.

Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.

Maximum Pressure Loss: [**2 psig**] <**Insert value**>.

Rated Flow: <**Insert tons**>.

Working Pressure Rating: 500 psig.

Maximum Operating Temperature: 240 deg F.

* + - * 1. Mufflers:

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:

Danfoss Inc.

Emerson Climate Technologies.

Heldon Products; Henry Technologies.

Approved equivalent.

Body: Welded steel with corrosion-resistant coating.

End Connections: Socket or flare.

Working Pressure Rating: 500 psig.

Maximum Operating Temperature: 275 deg F.

* + - * 1. Receivers: Comply with AHRI 495.

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:

Heldon Products; Henry Technologies.

Approved equivalent.

Retain first subparagraph below for receivers larger than 6 inches.

Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

Comply with UL 207; listed and labeled by an NRTL.

Body: Welded steel with corrosion-resistant coating.

Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.

End Connections: Socket or threaded.

Working Pressure Rating: 500 psig.

Maximum Operating Temperature: 275 deg F.

* + - * 1. Liquid Accumulators: Comply with AHRI 495.

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:

Emerson Climate Technologies.

Heldon Products; Henry Technologies.

Parker Hannifin Corp.

Approved equivalent.

Body: Welded steel with corrosion-resistant coating.

End Connections: Socket or threaded.

Working Pressure Rating: 500 psig.

Maximum Operating Temperature: 275 deg F.

* + - 1. REFRIGERANTS
         1. ASHRAE 34, R-134a: Tetrafluoroethane.

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:

Arkema Inc.

DuPont Fluorochemicals Div.

Mexichem Fluor Inc.

Approved equivalent.

* + - * 1. ASHRAE 34, R-407C: Difluoromethane/Pentafluoroethane/1,1,1,2-Tetrafluoroethane.

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:

Arkema Inc.

DuPont Fluorochemicals Div.

Mexichem Fluor Inc.

Approved equivalent.

* + - * 1. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

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:

Arkema Inc.

DuPont Fluorochemicals Div.

Mexichem Fluor Inc.

Approved equivalent.

1. EXECUTION

If more than one refrigerant is required for Project, retain appropriate refrigerant piping articles below and indicate refrigerant type for each piping line on Drawings.

* + - 1. PIPING APPLICATIONS FOR REFRIGERANT R-134a

Retain one or both suction line paragraphs below. Retain first paragraph to require all piping to be Type ACR, annealed temper. Type ACR, annealed-temper tubing is available only in sizes NPS 1-1/2 (DN 40) and smaller. Retain second paragraph if pipe sizes exceed NPS 1-1/2 (DN 40) and it is desirable to have all piping be of same tube type and joining method. Retain both paragraphs to require piping larger than NPS 1-1/2 (DN 40) to be different from Type ACR, annealed temper. Delete both paragraphs below if suction lines are part of a heat-pump installation.

* + - * 1. Suction Lines [**NPS 1-1/2 and Smaller**] <**Insert pipe size range**> for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with [**brazed**] joints.
        2. Suction Lines [**NPS 4 and Smaller**] [**NPS 2 to NPS 4**] <**Insert pipe size range**> for Conventional Air-Conditioning Applications: Copper, [**Type ACR**], drawn-temper tubing and wrought-copper fittings with [**brazed**] joints.

Retain one of first two hot-gas and liquid line paragraphs below.

* + - * 1. Hot-Gas and Liquid Lines[**, and Suction Lines for Heat-Pump Applications**]:

Retain first subparagraph below to require all piping to be Type ACR, annealed temper. Type ACR annealed-temper tubing is available only in sizes NPS 1-1/2 (DN 40) and smaller.

Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with [**brazed**] joints.

Retain first subparagraph below if pipe sizes exceed NPS 1-1/2 (DN 40) and it is desirable to have all piping be of same tube type and joining method.

Copper, [**Type ACR**], drawn-temper tubing and wrought-copper fittings with brazed joints.

Retain first paragraph below to require different tube types and joining methods for various pipe sizes.

* + - * 1. Hot-Gas and Liquid Lines[**, and Suction Lines for Heat-Pump Applications**], Multiple Tube Types and Joining Methods:

Retain one of first two subparagraphs below.

[**NPS 1-1/2 and Smaller**] <**Insert pipe size range**>, Type ACR, Annealed Temper: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with [**brazed**] joints.

[**NPS 1-1/2 and Smaller**] <**Insert pipe size range**>: Copper, [**Type ACR**, drawn-temper tubing and wrought-copper fittings with [**brazed**] [**or**] [**soldered**] joints.

[**NPS 4**] <**Insert pipe size**>: Copper, [**Type ACR**], drawn-temper tubing and wrought-copper fittings with [**brazed**] joints.

Retain one of first three paragraphs below. Retain first paragraph to require all safety-relief-valve discharge piping to be steel. Retain second paragraph to require all pipe sizes to be copper of same tube type and joining method. Retain third paragraph to require different tube types and joining methods for various pipe sizes.

* + - * 1. Safety-Relief-Valve Discharge Piping, Steel: Schedule 40, black-steel and wrought-steel fittings with welded joints.
        2. Safety-Relief-Valve Discharge Piping, Copper: Copper, [**Type ACR**], drawn-temper tubing and wrought-copper fittings with brazed joints.
        3. Safety-Relief-Valve Discharge Piping, Multiple Tube Types and Joining Methods:

Retain one of first two subparagraphs below.

[**NPS 1-1/2 and Smaller**] <**Insert pipe size range**>, Type ACR, Annealed Temper: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with [**brazed**] joints.

[**NPS 1-1/2 and Smaller**] <**Insert pipe size range**>: Copper, [**Type ACR**], drawn-temper tubing and wrought-copper fittings with [**brazed**] joints.

[**NPS 4**] <**Insert pipe size**>: Copper, [**Type ACR**], drawn-temper tubing and wrought-copper fittings with [**brazed**] joints.

* + - 1. PIPING APPLICATIONS FOR REFRIGERANT R-407C

Retain one or both suction line paragraphs below. Retain first paragraph to require all piping to be Type ACR, annealed temper. Type ACR, annealed-temper tubing is available only in sizes NPS 1-1/2 (DN 40) and smaller. Retain second paragraph if pipe sizes exceed NPS 1-1/2 (DN 40) and it is desirable to have all piping be of same tube type and joining method. Retain both paragraphs to require piping larger than NPS 1-1/2 (DN 40) to be different from Type ACR, annealed temper. Delete both paragraphs if suction lines are part of a heat-pump installation.

* + - * 1. Suction Lines [**NPS 1-1/2 and Smaller**] <**Insert pipe size range**> for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with [**brazed**] joints.
        2. Suction Lines [**NPS 4 and Smaller**] [**NPS 2 to NPS 4**] <**Insert pipe size range**> for Conventional Air-Conditioning Applications: Copper, drawn-temper tubing and wrought-copper fittings with [**brazed**] joints.

Retain one of two hot-gas and liquid line paragraphs below.

* + - * 1. Hot-Gas and Liquid Lines[**, and Suction Lines for Heat-Pump Applications**]:

Retain first subparagraph below to require all piping to be Type ACR, annealed temper. Type ACR annealed-temper tubing is available only in sizes NPS 1-1/2 (DN 40) and smaller; however, brazed ACR can withstand pressure of this service only up to NPS 1 (DN 25).

Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with [**brazed**] joints.

Retain first subparagraph below if pipe sizes exceed NPS 1-1/2 (DN40) and it is desirable to have all piping be of same tube type and joining method.

Copper, [**Type ACR**], drawn-temper tubing and wrought-copper fittings with brazed joints.

Retain first paragraph below to require different tube types and joining methods for various pipe sizes.

* + - * 1. Hot-Gas and Liquid Lines[**, and Suction Lines for Heat-Pump Applications**], Multiple Tube Types and Joining Methods:

Retain one of first two subparagraphs below.

[**NPS 1 and Smaller**] <**Insert pipe size range**>, Type ACR, Annealed Temper: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with [**brazed**] joints.

[**NPS 1 and Smaller**] <**Insert pipe size range**>: Copper, [**Type ACR**], drawn-temper tubing and wrought-copper fittings with [**brazed**] joints.

[**NPS 1-1/4 to NPS 2**] <**Insert pipe size range**>: Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with [**brazed**]] joints.

[**NPS 4**] <**Insert pipe size**>: Copper, [**Type ACR**] , drawn-temper tubing and wrought-copper fittings with soldered joints.

Retain one of first three paragraphs below. Retain first paragraph to require all safety-relief-valve discharge piping to be steel. Retain second paragraph to require all pipe sizes to be copper of same tube type and joining method. Retain third paragraph to require different tubes type and joining methods for various pipe sizes.

* + - * 1. Safety-Relief-Valve Discharge Piping, Steel: Schedule 40, black-steel and wrought-steel fittings with welded joints.
        2. Safety-Relief-Valve Discharge Piping, Copper: Copper, [**Type ACR**], drawn-temper tubing and wrought-copper fittings with brazed joints.
        3. Safety-Relief-Valve Discharge Piping, Multiple Tube Types and Joining Materials:

Retain one of first two subparagraphs below.

[**NPS 1 and Smaller**] <**Insert pipe size range**>, Type ACR, Annealed Temper: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with [**brazed**] joints.

[**NPS 1 and Smaller**] <**Insert pipe size range**>: Copper, [**Type ACR**], drawn-temper tubing and wrought-copper fittings with [**brazed**] joints.

[**NPS 1-1/4 to NPS 2**] <**Insert pipe size range**>: Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with [**brazed**] joints.

[**NPS 4**] <**Insert pipe size**>: Copper, [**Type ACR**], drawn-temper tubing and wrought-copper fittings with brazed joints.

* + - 1. PIPING APPLICATIONS FOR REFRIGERANT R-410A

Retain one of three suction line paragraphs below. Retain first paragraph to require all piping to be Type ACR, annealed temper. Type ACR, annealed temper tubing is only available in sizes NPS 1-1/2 (DN 40) and smaller. Retain second or third paragraph if pipe sizes exceed NPS 1-1/2 (DN 40) and it is desirable to have all piping be of same tube type and joining method. Retain second and third paragraphs to require piping larger than NPS 1-1/2 (DN 40) to be different from Type ACR, annealed temper. Delete all three paragraphs if suction lines are part of a heat-pump installation.

* + - * 1. Suction Lines [**NPS 1-1/2 and Smaller**] <**Insert pipe size range**> for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with [**brazed**] joints.
        2. Suction Lines [**NPS 3-1/2 and Smaller**] [**NPS 2 to NPS 3-1/2**] <**Insert pipe size range**> for Conventional Air-Conditioning Applications: Copper, [**Type ACR**], drawn-temper tubing and wrought-copper fittings with [**brazed**] joints.
        3. Suction Lines [**NPS 4 and Smaller**] <**Insert pipe size range**> for Conventional Air-Conditioning Applications: Copper, [**Type ACR**] , drawn-temper tubing and wrought-copper fittings with brazed joints.

Retain one or more of first two hot-gas and liquid line paragraphs below. Each material and each joining method is limited by the pressure rating on the resulting material and joining methods. See Test Pressures for Various Refrigerants - psig (kPa) Table in the Evaluations for pressure-rating limitations.

* + - * 1. Hot-Gas and Liquid Lines [**, and Suction Lines for Heat-Pump Applications**]:

Retain first subparagraph if tubing is not larger than NPS 5/8 (DN 18) and it is desirable to have all piping be of same tube type and joining method.

Copper, [**Type ACR**], annealed- or drawn-temper tubing and wrought-copper fittings with [**brazed**] joints.

Retain first subparagraph below if tubing is not larger than NPS 1 (DN 25) and it is desirable to have all piping be of same tube type and joining method.

Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with [**brazed**] joints.

Retain first subparagraph below if tubing is not larger than NPS 1-1/4 (DN 32) and it is desirable to have all piping be of same tube type and joining method.

Copper, [**Type ACR**], drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony brazed joints.

Retain first subparagraph below if tubing is not larger than NPS 2 (DN 50) and it is desirable to have all piping be of same tube type and joining method.

Copper, [**Type ACR**], drawn-temper tubing and wrought-copper fittings with Alloy HB brazed joints.

Retain paragraph below to require different tube type and joining methods for various pipe sizes.

* + - * 1. Hot-Gas and Liquid Lines[**, and Suction Lines for Heat-Pump Applications**], Multiple Tube Types and Joining Methods:

[**NPS 5/8 and Smaller**] <**Insert pipe size range**>: Copper, [**Type ACR**], annealed- or drawn-temper tubing and wrought-copper fittings with [**brazed**] joints.

[**NPS 3/4 to NPS 1 and Smaller**] <**Insert pipe size range**>: Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with [**brazed**] joints.

[**NPS 1-1/4 and Smaller**] <**Insert pipe size range**>: Copper, [**Type ACR**], drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony brazed joints.

[**NPS 1-1/2 to NPS 2**] <**Insert pipe size range**>: Copper, [**Type ACR**], drawn-temper tubing and wrought-copper fittings with Alloy HB brazed joints.

[**NPS 2 to NPS 4**] <**Insert pipe size range**>: Schedule 40, black-steel and wrought-steel fittings with welded joints.

Retain one of first two paragraphs below. Each material and each joining method is limited by the pressure rating on the resulting material and joining methods. See Tests Pressures for Various Refrigerants - psig (kPa) Table in the Evaluations for pressure-rating limitations.

* + - * 1. Safety-Relief-Valve Discharge Piping:

Retain first subparagraph if tubing is not larger than NPS 5/8 (DN 18) and it is desirable to have all piping be of same tube type and joining method.

Copper, [**Type ACR**], annealed- or drawn-temper tubing and wrought-copper fittings with [**brazed**] joints.

Retain first subparagraph below if tubing is not larger than NPS 1 (DN 25) and it is desirable to have all piping be of same tube type and joining method.

Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with [**brazed**] joints.

Retain first subparagraph below if tubing is not larger than NPS 1-1/4 (DN 32) and it is desirable to have all piping be of same tube type and joining method.

Copper, [**Type ACR**], drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony brazed joints.

Retain first subparagraph below if tubing is not larger than NPS 2 (DN 50) and it is desirable to have all piping be of same tube type and joining method.

Copper, [**Type ACR**], drawn-temper tubing and wrought-copper fittings with Alloy HB brazed joints.

Retain first paragraph below to require different tube types and joining methods for various pipe sizes.

* + - * 1. Safety-Relief-Valve Discharge Piping, Multiple Tube Sizes and Joining Materials:

[**NPS 5/8 and Smaller**] <**Insert pipe size range**>: Copper, [**Type ACR**], annealed- or drawn-temper tubing and wrought-copper fittings with [**brazed**] joints.

[**NPS 3/4 to NPS 1 and Smaller**] <**Insert pipe size range**>: Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with [**brazed**] joints.

[**NPS 1-1/4 and Smaller**] <**Insert pipe size range**>: Copper, [**Type ACR**], drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony brazed joints.

[**NPS 1-1/2 to NPS 2**] <**Insert pipe size range**>: Copper, [**Type ACR**], drawn-temper tubing and wrought-copper fittings with Alloy HB brazed joints.

[**NPS 2 to NPS 4**] <**Insert pipe size range**>: Schedule 40, black-steel and wrought-steel fittings with welded joints.

* + - 1. VALVE AND SPECIALTY APPLICATIONS

Delete first paragraph below if valves are specified in Section 236200 "Packaged Compressor and Condenser Units."

* + - * 1. Install [**diaphragm packless**] [**packed-angle**] valves in suction and discharge lines of compressor.
        2. Install service valves for gauge taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

Retain first paragraph below if suction line will be exposed to air temperatures less than 75 deg F (24 deg C) during compressor operation.

* + - * 1. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
        2. Except as otherwise indicated, install [**diaphragm packless**] [**packed-angle**] valves on inlet and outlet side of filter dryers.

Retain first paragraph below only for systems that cannot be shut down for a short time to replace the filter dryer.

* + - * 1. Install a full-size, three-valve bypass around filter dryers.

Retain first paragraph below for solenoid valves on systems with multiple thermostatic expansion valves. Retain for hot-gas bypass valve if not integral to the valve.

* + - * 1. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.
        2. Install thermostatic expansion valves as close as possible to distributors on evaporators.

Install valve so diaphragm case is warmer than bulb.

In first subparagraph below, verify proper location for bulb with valve manufacturer.

Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.

If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

* + - * 1. Install safety relief valves where required by 2010 ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.
        2. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
        3. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for the device being protected:

Edit list below for equipment required for Project.

Solenoid valves.

Thermostatic expansion valves.

Hot-gas bypass valves.

Compressor.

* + - * 1. Install filter dryers in liquid line between compressor and thermostatic expansion valve [**, and in the suction line at the compressor**].

Consult refrigeration equipment manufacturer to determine the need for a receiver.

* + - * 1. Install receivers sized to accommodate pump-down charge.

See the Evaluations for discussion of flexible connectors.

* + - * 1. Install flexible connectors at compressors.
        2. Provide refrigerant locking caps on refrigerant charging ports that are located outdoors unless otherwise protected from unauthorized access by a means acceptable to the authority having jurisdiction.
      1. INSTALLATION OF PIPING, GENERAL
         1. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
         2. Install refrigerant piping according to ASHRAE 15.
         3. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
         4. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
         5. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
         6. Install piping adjacent to machines to allow service and maintenance.
         7. Install piping free of sags and bends.
         8. Install fittings for changes in direction and branch connections.
         9. Select system components with pressure rating equal to or greater than system operating pressure.
         10. Refer to Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC" for solenoid valve controllers, control wiring, and sequence of operation.
         11. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
         12. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083113 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.
         13. Install refrigerant piping in protective conduit where installed belowground.
         14. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
         15. Slope refrigerant piping as follows:

See the Evaluations for discussion of oil entrainment. Refer to the 2010 ASHRAE HANDBOOK - "Refrigeration" for discussion of methods for managing oil entrainment in refrigerant gas and liquid.

Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.

Install horizontal suction lines with a uniform slope downward to compressor.

Use double-suction riser for maximum compressor efficiencies if load variation is expected.

Install traps and double risers to entrain oil in vertical runs.

Liquid lines may be installed level.

* + - * 1. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

Retain first paragraph below for steel pipe. Review the cost of steel pipe using these procedures versus the cost of copper piping. Also consider limiting the size of the refrigerant system and its piping to avoid the use of steel pipe.

* + - * 1. Before installation of steel refrigerant piping, clean pipe and fittings using the following procedures:

Shot blast the interior of piping.

Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through tubing by means of a wire or electrician's tape.

Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.

Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.

Finally, draw a clean, dry, lintless cloth through the tube or pipe.

Safety-relief-valve discharge piping is not required to be cleaned but is required to be open to allow unrestricted flow.

* + - * 1. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
        2. Identify refrigerant piping and valves according to Section 230553 "Identification for HVAC Piping and Equipment."
        3. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

Retain first paragraph below for piping that penetrates an exterior concrete wall or concrete slab.

* + - * 1. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
        2. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."
      1. PIPE JOINT CONSTRUCTION
         1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
         2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
         3. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.
         4. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.

Use Type BAg (cadmium-free silver) alloy for joining copper with bronze.

* + - * 1. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
      1. INSTALLATION OF HANGERS AND SUPPORTS

Retain first paragraph below for projects in areas that require seismic restraints.

* + - * 1. Comply with requirements for seismic restraints in Section 230548 "Vibration and Seismic Controls for HVAC."
        2. Comply with Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.
        3. Install the following pipe attachments:

Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.

Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.

Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.

Spring hangers to support vertical runs.

Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

* + - * 1. Install hangers for [**copper tubing**], with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
        2. Support horizontal piping within [**12 inches**] <**Insert dimension**> of each fitting.
        3. Support vertical runs of [**copper tubing**] to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
      1. FIELD QUALITY CONTROL

Retain "Perform the following tests and inspections" paragraph below to require Contractor to perform tests and inspections.

* + - * 1. Perform the following tests and inspections:

Comply with ASME B31.5, Chapter VI.

Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.

Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.

Fill system with nitrogen to the required test pressure.

System shall maintain test pressure at the manifold gage throughout duration of test.

Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.

Remake leaking joints using new materials, and retest until satisfactory results are achieved.

* + - * 1. Prepare test and inspection reports.
      1. SYSTEM CHARGING
         1. Charge system using the following procedures:

Install core in filter dryers after leak test but before evacuation.

Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.

Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.

Charge system with a new filter-dryer core in charging line.

* + - 1. ADJUSTING

Retain first paragraph below for adjustable thermostatic expansion valves.

* + - * 1. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
        2. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
        3. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
        4. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

Open shutoff valves in condenser water circuit.

Verify that compressor oil level is correct.

Open compressor suction and discharge valves.

Open refrigerant valves except bypass valves that are used for other purposes.

Check open compressor-motor alignment and verify lubrication for motors and bearings.

* + - * 1. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 232300