SECTION 221513 - GENERAL-SERVICE COMPRESSED-AIR PIPING

1. GENERAL
	* + 1. RELATED DOCUMENTS
				1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

Pipes, tubes, and fittings.

Joining materials.

Valves.

Dielectric fittings.

Flexible pipe connectors.

Specialties.

Quick couplings.

Hose assemblies.

* + - * 1. Related Sections include the following:

Section 221519 "General-Service Packaged Air Compressors and Receivers" for general- service air compressors and accessories.

List below only products that the reader might expect to find in this Section but are specified elsewhere.

* + - 1. DEFINITIONS

Retain abbreviations and definitions that remain after this Section has been edited.

* + - * 1. ABS: Acrylonitrile-butadiene-styrene plastic.
				2. CR: Chlorosulfonated polyethylene synthetic rubber.
				3. EPDM: Ethylene-propylene-diene terpolymer rubber.
				4. HDPE: High-density polyethylene plastic.
				5. NBR: Acrylonitrile-butadiene rubber.
				6. PE: Polyethylene plastic.
				7. PVC: Polyvinyl chloride plastic.
				8. High-Pressure Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures between 150 and 200 psig.
				9. Low-Pressure Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures of 150 psig or less.
			1. PERFORMANCE REQUIREMENTS

Revise this Article to indicate specific loads determined by Project's Structural Engineer or refer to loads indicated on Drawings. Model building codes and SEI/ASCE 7 establish criteria for buildings subject to earthquake motions. Verify requirements of authorities having jurisdiction.

* + - * 1. Seismic Performance: Compressed-air piping and support and installation shall withstand effects of seismic events determined according to [**SEI/ASCE 7, "Minimum Design Loads for Buildings and Other Structures."**] <**Insert applicable code requirement.**>
			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 the following:

Plastic pipes, fittings, and valves.

Dielectric fittings.

Flexible pipe connectors.

Safety valves.

Pressure regulators. Include rated capacities and operating characteristics.

Automatic drain valves.

Filters. Include rated capacities and operating characteristics.

Lubricators. Include rated capacities and operating characteristics.

Quick couplings.

Hose assemblies.

USE PARAGRAPH BELOW WITH EPD REQUIREMENT WHEN PROJECT ESTIMATE IS $1M OR MORE.

* + - * 1. Submit an Environmental Product Declaration (EPD) from the manufacturer for steel pipe within this specification section, if available. A statement of the contractor’s good faith effort to obtain the EPD shall be provided if not available.

Manufacturer-provided EPDs must be Product Specific Type III (Third-Party Reviewed), in adherence with ISO 14025 *Environmental labels and declarations*, ISO 14044 *Environmental management – Life cycle assessment*, and ISO 21930 *Core rules for environmental product declarations of construction products and services*.

* + - * 1. **[Brazing] [Brazing and welding] [Welding**] certificates.
				2. Field quality-control test reports.
			1. CLOSEOUT SUBMITTALS
				1. Operation and Maintenance Data: For general-service compressed-air piping specialties to include in emergency, operation, and maintenance manuals.
			2. QUALITY ASSURANCE
				1. Installer Qualifications:

Pressure-Seal Joining Procedure for Copper Tubing: Qualify operators according to training provided by Viega; Plumbing and Heating Systems.

Pressure-Seal Joining Procedure for Steel Piping. Qualify operators according to training provided by Victaulic Company.

Joining Procedures for Aluminum Piping Systems: Qualify installers according to training provided by manufacturers.

Retain "Brazing certificates" paragraph in "Informational Submittals" Article if retaining paragraph below.

Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or to AWS B2.2, "Standard for Brazing Procedure and Performance Qualification.”

Retain "Welding certificates" paragraph in "Informational Submittals" Article if retaining first paragraph below.

Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

ASME Compliance:

Comply with ASME B31.1, "Power Piping," for high-pressure compressed-air piping.

Comply with ASME B31.3, "Process Piping," for high- and low-pressure compressed-air piping.

Comply with ASME B31.9, "Building Services Piping," for low-pressure compressed-air piping.

* + - 1. PROJECT CONDITIONS

Retain this Article if interruption of existing compressed-air service is required.

* + - * 1. Interruption of Existing Compressed-Air Service: Do not interrupt compressed-air service to occupied facilities unless permitted under the following conditions and then only after arranging to provide temporary compressed-air service according to requirements indicated:

Notify [**Architect**] [**Construction Manager**] [**Director’s Representative**] no fewer than [**two**] <**Insert number**> days in advance of proposed interruption of compressed-air service.

Do not proceed with interruption of compressed-air service without [**Architect's**] [**Construction Manager's**] [**Director’s Representative's**] written permission.

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. PIPES, TUBES, AND FITTINGS

Retain piping materials in this Article to match those retained in Part 3 "Piping Applications" Article.

* + - * 1. Schedule 40, Steel Pipe: ASTM A53 “Standard Specification for Pipe, Steel, Black and Hot-Dipper, Zinc-Coated, Welded and Seamless”, Type E or S, Grade B, black or hot-dip zinc coated with ends threaded according to ASME B1.20.1 Pipe Threads, General Purpose, Inch.

Steel Nipples: ASTM A733 “Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples”, made of ASTM A53 “Standard Specification for Pipe, Steel, Black and Hot-Dipper, Zinc-Coated, Welded and Seamless” or ASTM A106 “Standard Specification for Seamless Pressure Pipe”, Schedule 40, galvanized seamless steel pipe. Include ends matching joining method.

Malleable-Iron Fittings: ASME B16.3 “Malleable Iron Threaded Fittings Classes 150 and 300”, Class 150 or 300, threaded.

Malleable-Iron Unions: ASME B16.39 “Malleable Iron Threaded Pipe Unions: Classes 150, 250, and 300”, Class 150 or 300, threaded.

Steel Flanges: ASME B16.5 “Pipe Flanges & Flanged Fittings”, Class 150 or 300, carbon steel, threaded.

Wrought-Steel Butt-Welding Fittings: ASME B16.9 “Factory-Made Wrought Buttwelding Fittings”, Schedule 40.

Steel Flanges: ASME B16.5 “Pipe Flanges & Flanged Fittings”, Class 150 or 300, carbon steel.

Grooved-End Fittings and Couplings:

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:

Grinnell Supply Sales Co., Grinnell Corp.

Stockham Valves & Fittings, Inc.

Victaulic Co. of America

Approved equivalent.

Grooved-End Fittings: ASTM A47 “Standard Specification for Ferritic Malleable Iron Castings”, malleable-iron castings or ASTM A536 “Standard Specification for Ductile Iron Castings”, ductile-iron casting; with grooves according to AWWA C606 “Standard for Grooved and Shouldered Joints” and dimensions matching steel pipe.

Couplings: AWWA C606 “Standard for Grooved and Shouldered Joints” or UL 213 “Standard for Rubber Gasketed Fittings for Fire-Protection Service”, for steel-pipe dimensions and rated for 300-psigminimum working pressure. Include ferrous housing sections, gasket suitable for compressed air, and bolts and nuts. Provide EDPM gaskets for oil-free compressed air. Provide NBR gaskets if compressed air contains oil or oil vapor.

* + - * 1. Copper Tube: [**ASTM B88, Type K or L]** [**and**] [**ASTM B88, Type M**] seamless, drawn-temper, water tube.

Wrought-Copper Fittings: ASME B16.22 “Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings”, solder-joint pressure type or MSS SP-73 “Brazing Joints for Copper and Copper Alloy Pressure Fittings”, wrought copper with dimensions for brazed joints.

Cast-Copper-Alloy Flanges: ASME B16.24 “Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves: Classes 150, 300, 600, 900, 1500 and 2500”, Class 150 or 300.

Copper Unions: ASME B16.22 “Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings” or MSS SP-123 “Non-Ferrous Threaded and Solder-Joint Unions for Use with Copper Water Tube”.

Press-Type Fittings, 2 inch and Smaller: Wrought-copper fitting with EPDM O- ring seal in each end.

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:

Grinnell Supply Sales Co., Grinnell Corp

Stockham Valves & Fittings, Inc.

Victaulic Co. of America

Approved equivalent

Press-Type Fittings, 2-1/2 inch to 4 inch: Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.

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:

Grinnell Supply Sales Co., Grinnell Corp.

Stockham Valves & Fittings, Inc.

Victaulic Co. of America

Approved equivalent.

Grooved-End Fittings and Couplings:

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.

Grinnell Supply Sales Co., Grinnell Corp.

Stockham Valves & Fittings, Inc.

Victaulic Co. of America

Approved equivalent.

Grooved-End Fittings: ASTM B75 “Standard Specification for Seamless Copper Tube”, copper tube or ASTM B584 “Standard Specification for Copper Alloy Sand Castings for General Applications”, bronze castings.

Couplings: Copper-tube dimensions and design similar to AWWA C606 “Standard for Grooved and Shouldered Joints”. Include ferrous housing sections, gasket suitable for compressed air, and bolts and nuts. Provide EDPM gasket for oil-free compressed air. Provide NBR gasket if compressed air contains oil or oil vapor.

* + - * 1. Transition Couplings for Metal Piping: Metal coupling or other manufactured fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
				2. Aluminum Piping System: Aluminum pipe, Alloy Grade AA 6035-T5, for push-connect bite ring couplings, and roll-groove couplings.

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:

Grinnell Supply Sales Co., Grinnell Corp.

Stockham Valves & Fittings, Inc.

Victaulic Co. of America

Approved equivalent.

Source Limitations: Obtain aluminum piping systems and components from single source from single manufacturer.

Pressure and Temperature Range: Aluminum piping and related specialties for general- service compressed-air systems operating at 220 psig or less, across a temperature range of minus 4 to plus 176 deg F.

Tubing,1/2 inch to 10 inch: Aluminum pipe, Alloy Grade AA 6063-T5.

Pipe Coating: Powder-coated paint certified nontoxic to AAMA 603 and AAMA 605, blue for compressed air.

Tubing shall be quality controlled to comply with tolerances specified by roll-groove or push-to-connect coupling manufacturer. Tubing manufacturer shall follow ISO 9001:2000 quality standards.

Pipe Identification: Decal with maximum working pressure and temperature on each length of pipe.

Available sizes of couplings in first subparagraph below, which correspond approximately to 1/4 inch, 1/2 inch, 3/4 inch, NPS 1, 1-1/4 inch, 1-1/2 inch, and 2 inch (DN 8, DN 15, DN 20, DN 25, DN 32, DN 40, and DN 50).

Push-Connect Bite Ring Couplings, 1/2 inch to 2 inch: Solid-brass and nickel-plated body, high nitrile rubber O-ring seal in excess of 36 percent, and AISI Type 304 stainless-steel clamping washer.

Fittings: Solid brass and nickel plated.

Available sizes of couplings in first subparagraph below, which correspond approximately to 2-1/2 inch, 3 inch, 4 inch, 6 inch, 8 inch, and 10 inch (DN 65, DN 80,DN 100, DN 150, DN 200, and DN 250).

Roll-Groove Couplings, 2-1/2 inch to 10 inch: Solid ductile-iron, galvanized, ASTM A536 “Standard Specification for Ductile Iron Castings” Grade 65-45-12, nitrile rubber standard seals, and fluoroelastomer seals for high- temperature applications.

Retain first two subparagraphs below if valves are supplied with aluminum piping system or delete both if specified in "Valves" Article.

Ball Valves, 3/4 inch to 2 inch3/4 inch to 2-1/2 inch: NPT threaded ends, or push-connect bite ring ends.

Butterfly Valves, 3 inch to 10 inch: Tube to tube, with two roll-groove end couplings.

Flanges, ASME B16.5 “Pipe Flanges & Flanged Fittings”, Class 150.

* + - * 1. PVC Pipe: ASTM D1785 “Standard Specification for Poly(Vinyl Chloride) Plastic Pipe, Schedules 40, 80, and 120”, Schedule 40.

PVC Fittings: ASTM D2466 “Standard Specification for Threaded Poly(Vinyl Chloride) Plastic Pipe Fittings, Schedule 40”, Schedule 40, socket type.

Retain only one of three paragraphs and associated subparagraphs remaining in this Article if plastic piping is required. Do not combine different plastic piping.

Sizes of piping in first paragraph and subparagraphs below, which correspond approximately to 1/2 inch, 3/4 inch, NPS 1, 1-1/2 inch, 2 inch, 3 inch, and 4 inch (DN 15, DN 20, DN 25, DN 40, DN 50, DN 80, and DN 100).

* + - * 1. Blue ABS Piping System: Made of ASTM D3965 “Standard Classification System and Basis for Specifications for Rigid Acrylonitrile-Butadiene-Styrene Materials for Pipe and Fittings”, ABS-resin modified to provide shatter- resistant pipe for compressed-air service. Pipe and fittings are light blue and sizes are in millimeters.

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:

Charlotte Pipe Co.

IPEX USA LLC

Approved equivalent.

Transition Fittings, 3/4 inch to 2 inch 3/4 inch to 2 inch: Composite union with ABS socket end, CR O-ring, and malleable-iron union nut and threaded end; with construction similar to MSS SP-107 “Transition Union Fittings for Joining Metal and Plastic Products”, transition union.

Transition Fittings, 3 inch to 4 inch: Flange assembly with ABS flange, CR gasket, and metal flange of material matching piping to be connected.

Retain first subparagraph below if metal valves are not required for this system.

Valves, 3/4 inch to 2 inch: ABS union ball valve with socket ends.

Valves, 3 inch to 4 inch: ABS butterfly valve with lever handle.

* + - * 1. Green ABS Piping System: Made of ASTM D3965 “Standard Classification System and Basis for Specifications for Rigid Acrylonitrile-Butadiene-Styrene Materials for Pipe and Fittings”, ABS-resin modified to provide shatter- resistant pipe for compressed-air service. Pipe and fittings are dark green with SDR of 9.0 and same OD as ASTM A53 “Standard Specification for Pipe, Steel, Black and Hot-Dipper, Zinc-Coated, Welded and Seamless”, steel pipe.

Manufacturer: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

Charlotte Pipe Co.

IPEX by aliaxis

Approved equivalent.

Transition Fittings, 1/2 inch to 2 inch: Composite union with ABS socket end, CR O-ring, ABS union nut, and brass solder-joint end; with construction similar to MSS SP-107 “Transition Union Fittings for Joining Metal and Plastic Products”, transition union.

Transition Fittings, 2-1/2 inch to 4 inch: ABS flange, CR gasket, and metal flange of material matching piping to be connected.

Retain first subparagraph below if metal valves are not required for this system.

Valves, 1/2 inch to 2 inch : Union ball valve with socket ends.

Valves, 2-1/2 inch to 4 inch: Union ball valve with flanged ends. Include safety exhaust feature in Part 3 "Valve Applications" Article if required.

* + - * 1. HDPE Piping System: Made of ASTM D1248 “Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable”, HDPE resin to provide shatter-resistant pipe for compressed-air service. Pipe and fittings are dark blue with pipe dimensions about the same OD as ASTM D3035 “Standard Specification for Polyethylene Plastic Pipe Based on Controlled Outside Diameter”, PE pipe.

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:

Charlotte Pipe Co

ASAHI/America, Inc.

Approved equivalent.

Transition Fittings, 1/2 inch to 2 inch: HDPE adapter with one socket end and one end with threaded brass insert.

Transition Fittings, 2-1/2 inch to 4 inch: HDPE flange, CR gasket, and metal flange of material matching piping to be connected.

Retain subparagraph below if metal valves are not required for this system. Use metal valves for 4 inch (DN 100).

Valves, 1/2 inch to 3 inch: HDPE union ball valve with socket ends.

* + - 1. JOINING MATERIALS
				1. Pipe-Flange Gasket Materials: Suitable for compressed-air piping system contents.

ASME B16.21 “Nonmetallic Flat Gaskets for Pipe Flanges”, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.

Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

* + - * 1. Flange Bolts and Nuts: ASME B18.2.1 “Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws”, carbon steel, unless otherwise indicated.
				2. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
				3. Solder Filler Metals: ASTM B32 “Standard Specification for Solder Metal”, lead-free alloys. Include water-flushable flux according to ASTM B813 “Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube”.
				4. Brazing Filler Metals: AWS A5.8 “Filler Metals for Brazing & Braze Welding”, BCuP Series, copper-phosphorus alloys for general- duty brazing, unless otherwise indicated.
				5. Welding Filler Metals: Comply with AWS D10.12 “Guide for Welding Mild Steel Pipe” for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
				6. Solvent Cements for Joining Plastic Piping:

ABS Piping: ASTM D2235 “Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings”.

PVC Piping: ASTM D2564 “Standard Specification for Solvent Cements for Poly(Vinyl Chloride) Plastic Piping Systems”. Include primer complying with ASTM F656 “Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) Plastic Pipe and Fittings”.

* + - 1. VALVES
				1. Metal Ball, Butterfly, Check, and Gate Valves: Comply with requirements in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," Section 220523.14 "Check Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping."
			2. DIELECTRIC FITTINGS

Use of Dielectric Unions are not recommended. Although they are good in theory, they have proven to be problematic in the field due to leakage problems, and improper gasket material selection for each specific piping application. Use paragraph below for threaded or soldered piping as required.

* + - * 1. Dielectric Fitting: Bronze ball valve with end connections and pressure rating to match associated piping.

Nipples with inert non-corrosive thermoplastic linings are not acceptable.

Use paragraph below with flanged piping as required.

* + - * 1. Flange Electrical Insulation Kit: Consisting of dielectric sleeves and washers, and dielectric gasket.

Rated 150 psi at 250 degrees F. ANSI Class 150, full faced neoprene gasket with bolt holes double phenolic washer, and mylar sleeves; Model 150 by APS, Lafayette, LA 70596, (337) 233-6116.

* + - 1. FLEXIBLE PIPE CONNECTORS
				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:

Engineered Flexible Products

Flexicraft Industries

Metraflex Co.

Approved equivalent.

* + - * 1. Bronze-Hose Flexible Pipe Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

Working-Pressure Rating: [**200 psig** ] [**250 psig** ] minimum.

End Connections, 2 inch and Smaller: Threaded copper pipe or plain-end copper tube.

End Connections, 2-1/2 inch and Larger: Flanged copper alloy.

* + - * 1. Stainless-Steel-Hose Flexible Pipe Connectors: Corrugated-stainless-steel tubing with stainless- steel wire-braid covering and ends welded to inner tubing.

Working-Pressure Rating: [**200 psig]** [**250 psig**] minimum.

End Connections, 2 inch and Smaller: Threaded steel pipe nipple.

End Connections, 2-1/2 inch and Larger: Flanged steel nipple.

* + - 1. SPECIALTIES
				1. Safety Valves: ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," construction; National Board certified, labeled, and factory sealed; constructed of bronze body with poppet-type safety valve for compressed-air service.

Pressure Settings: Higher than discharge pressure and same or lower than receiver pressure rating.

Retain first paragraph and subparagraph below for large-capacity regulators on compressed-air mains. Show capacities on Drawings.

* + - * 1. Air-Main Pressure Regulators: Bronze body, direct acting, spring-loaded manual pressure- setting adjustment, and rated for [**250-psig]** <**Insert pressure**> inlet pressure, unless otherwise indicated.

Type: Pilot operated.

Retain one of first two paragraphs below for regulators on compressed-air branch piping to equipment. Show capacities on Drawings.

* + - * 1. Air-Line Pressure Regulators: [**Diaphragm**] [**Diaphragm or pilot**] [**Pilot**] operated, bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for [**200-psig**] <**Insert pressure**> minimum inlet pressure, unless otherwise indicated.
				2. Air-Line Pressure Regulators: Diaphragm operated, aluminum alloy or plastic body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for [**200-psig** ]
				3. <**Insert pressure**> minimum inlet pressure, unless otherwise indicated.
				4. Automatic Drain Valves: Stainless-steel body and internal parts, rated for [**200-psig]** <**Insert pressure**> minimum working pressure, capable of automatic discharge of collected condensate.[ **Include mounting bracket if wall mounting is indicated.**]

Show capacities of filters in first two paragraphs below on Drawings.

* + - * 1. Coalescing Filters: Coalescing type with activated carbon capable of removing water and oil aerosols; with color-change dye to indicate when carbon is saturated and warning light to indicate when selected maximum pressure drop has been exceeded.[ **Include mounting bracket if wall mounting is indicated.]**
				2. Mechanical Filters: Two-stage, mechanical-separation-type, air-line filters. Equip with deflector plates, resin-impregnated-ribbon-type filters with edge filtration, and drain cock.[ **Include mounting bracket if wall mounting is indicated.**]

Retain paragraph and subparagraph below if oil feed is required in compressed air for air-operated valve, cylinder, or tool lubrication. Show capacities of lubricators on Drawings.

* + - * 1. Air-Line Lubricators: With drip chamber and sight dome for observing oil drop entering air stream; with oil-feed adjustment screw and quick-release collar for easy bowl removal.[ **Include mounting bracket if wall mounting is indicated.**]

Provide with automatic feed device for supplying oil to lubricator.

* + - 1. QUICK COUPLINGS
				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:

Grinnell Corp., Grinnell Supply Sales Co

Stockham Valves & Fittings, Inc.

Victaulic Co. of America

Approved equivalent.

* + - * 1. General Requirements for Quick Couplings: Assembly with locking-mechanism feature for quick connection and disconnection of compressed-air hose.

Retain one or both paragraphs and associated subparagraphs below. Show location of each type on Drawings if both types of quick couplings are required.

* + - * 1. Automatic-Shutoff Quick Couplings: Straight-through brass body with O-ring or gasket seal and stainless-steel or nickel-plated-steel operating parts.

Socket End: With one-way valve and threaded inlet for connection to piping or threaded hose fitting.

Check-valve plug end in first option in subparagraph below is recommended for safety but is not available from all manufacturers.

Plug End: [**Flow-sensor-bleeder, check-valve**] [**Straight-through**] type with barbed outlet for attaching hose.

* + - * 1. Valveless Quick Couplings: Straight-through brass body with stainless-steel or nickel-plated- steel operating parts.

Socket End: With O-ring or gasket seal, without valve, and with barbed inlet for attaching hose.

Plug End: With barbed outlet for attaching hose.

* + - 1. HOSE ASSEMBLIES
				1. Description: Compatible hose, clamps, couplings, and splicers suitable for compressed-air service, of nominal diameter indicated, and rated for [**300-psig]** <**Insert pressure**> minimum working pressure, unless otherwise indicated.

Hose: Reinforced [**single**] [**single- or double**] [**double**]-wire-braid, CR-covered hose for compressed-air service.

Hose Clamps: Stainless-steel clamps or bands.

Hose Couplings: Two-piece, straight-through, threaded brass or stainless-steel O-ring or gasket-seal swivel coupling with barbed ends for connecting two sections of hose.

Hose Splicers: One-piece, straight-through brass or stainless-steel fitting with barbed ends for connecting two sections of hose.

1. EXECUTION
	* + 1. PIPING APPLICATIONS

Edit Part 2 to retain piping materials retained in this Article.

Delete first paragraph and subparagraphs below if receivers are factory packaged with air compressors.

Retain "one of" option in paragraph below to allow Contractor to select piping materials from those retained. Piping materials below are rated for at least 200 psig (1380 kPa).

* + - * 1. Compressed-Air Piping between Air Compressors and Receivers: Use[ **one of**] the following piping materials for each size range:

[**2 inch** <**Insert pipe size**> and Smaller: Schedule 40, [**black**] [**galvanized**]- steel pipe; threaded, malleable-iron fittings; and threaded joints.

Retain one or more of first five subparagraphs below.

[**2 inch**] <**Insert pipe size**> and Smaller: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.

[**2-inch**] <**Insert pipe size**> and Smaller: Type K or L, copper tube; wrought-copper fittings; and brazed joints.

Sizes in first subparagraph below which correspond approximately to 1/4 inch, 1/2 inch, 3/4 inch, NPS 1, 1-1/4 inch, 1-1/2 inch, and 2 inch (DN 8, DN 15, DN 20, DN 25, DN 32, DN 40, and DN 50).

[**2 inch]** <**Insert pipe size**> and Smaller: Aluminum pipe; solid-brass nickel-plated fittings; and push-connect bite ring couplings.

Retain one or more of first six subparagraphs below.

[**2-1/2 inch to 4 inch**] <**Insert pipe size range**>: Schedule 40, [**black**] [**galvanized**]-steel pipe; threaded, malleable-iron fittings; and threaded joints.

[**2-1/2 inch to 4 inch**] <**Insert pipe size range**>: Schedule 40, [**black**] [**galvanized**]-steel pipe; grooved-end fittings; couplings; and grooved joints.

[**2-1/2 inch to 4 inch**] <**Insert pipe size range**>: Schedule 40, black- steel pipe; wrought-steel fittings; and welded joints.

[**2-1/2 inch to 4 inch**] <**Insert pipe size range**>: Type K or L, copper tube; wrought-copper fittings; and brazed joints.

[**2-1/2 inch to 4 inch]** <**Insert pipe size range**>: Type K or L, copper tube; grooved-end copper fittings; couplings; and grooved joints.

Sizes in first subparagraph below which correspond approximately to 2-1/2 inch, 3 inch, and 4 inch (DN 65, DN 80, and DN 100).

**[2-1/2 inch to 4 inch ] <Insert pipe size**>: Aluminum pipe; and roll-groove couplings.

Retain one or more of five subparagraphs below.

[**5 inch]** <**Insert pipe size**> and Larger: Schedule 40, [**black**] [**galvanized**]- steel pipe; threaded, malleable-iron fittings; and threaded joints.

[**5 inch**] <**Insert pipe size**> and Larger: Schedule 40, [**black**] [**galvanized**]- steel pipe; grooved-end fittings; couplings; and grooved joints.

[**5 inch**] <**Insert pipe size**> and Larger: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.

[**5 inch**] <**Insert pipe size**> and Larger: Grooved-end, Type K or L, copper tube; grooved-end copper fittings; couplings; and grooved joints.

Sizes in subparagraph below which correspond approximately to 6 inch, 8 inch, and 10 inch (DN 150, DN 200, and DN 250).

[**6 inch** ] <**Insert pipe size**> and Larger: Aluminum pipe; and roll- groove couplings.

Retain "one of" option in first paragraph below to allow Contractor to select piping materials from those retained.

* + - * 1. Low-Pressure Compressed-Air Distribution Piping: Use[ **one of**] the following piping materials for each size range:

[**2 inch** <**Insert pipe size**> and Smaller: Schedule 40, [**black**] [**galvanized**]- steel pipe; threaded, malleable-iron fittings; and threaded joints.

Retain one or more of first eight subparagraphs below.

[**2 inch**]<**Insert pipe size**> and Smaller: Type K or L, copper tube; wrought-copper fittings; and brazed[ **or soldered**] joints.

[**2 inch**] <**Insert pipe size**> and Smaller: Type K or L, copper tube; press-type fittings; and pressure-sealed joints.

Sizes in first subparagraph below which correspond approximately to 1/4 inch, 1/2 inch, 3/4 inch, NPS 1, 1-1/4 inch, 1-1/2 inch, and 2 inch (DN 8, DN 15, DN 20, DN 25, DN 32, DN 40, and DN 50).

[**2 inch**] <**Insert pipe size**> and Smaller: Aluminum pipe; solid-brass nickel-plated fittings; and push-connect bite ring couplings.

[**2 inch**] <**Insert pipe size**> and Smaller: 63-mm and smaller, blue ABS pipe and fittings; transition fittings; valves; and solvent-cemented joints.

[**2 inch]** <**Insert pipe size**> and Smaller: Green ABS pipe and fittings, transition fittings, and valves; and solvent-cemented joints.

[**2 inch]** <**Insert pipe size**> and Smaller: HDPE pipe, fittings, and valves; and heat-fusion joints.

Retain one or more of first nine subparagraphs below.

[**2-1/2 inch to 4 inch**] <**Insert pipe size range**>: Schedule 40, [**black**] [**galvanized**]-steel pipe; threaded, malleable-iron fittings; and threaded joints.

[**2-1/2 inch to 4 inch**] <**Insert pipe size range**>: Schedule 40, [**black**] [**galvanized**]-steel pipe; grooved-end fittings; couplings; and grooved joints.

[**2-1/2 inch to 4 inch**] <**Insert pipe size range**>: Type K or L, copper tube; wrought-copper fittings; and brazed[ **or soldered**] joints.

[**2-1/2 inch to 4 inch**] <**Insert pipe size range**>: Type K or L, copper tube; grooved-end copper fittings; couplings; and grooved joints.

[**2-1/2 inch to 4 inch**] <**Insert pipe size range**>: Type K or L, copper tube; press-type fittings; and pressure-sealed joints.

Sizes in first subparagraph below which correspond approximately to 2-1/2 inch, 3 inch, and 4 inch (DN 65, DN 80, and DN 100).

[**2-1/2 inch to 4 inch] <Insert pipe size**>: Aluminum pipe; and roll-groove couplings.

Piping in first three subparagraphs below is available in 4 inch (DN 100) and smaller.

[**2-1/2 inch to 4 inch]** <**Insert pipe size range**>: blue ABS pipe and fittings; transition fittings; and solvent-cemented joints. Include butterfly valves and flanged joints.

[**2-1/2 inch to 4 inch]** <**Insert pipe size range**>: 3 inch and 4 inch, green ABS pipe and fittings; transition fittings; and solvent- cemented joints. Include ball valves and flanged joints.

[**2-1/2 inch to 4 inch]** <**Insert pipe size range**>: 3 inch and 4 inch, HDPE pipe and fittings; valves; and heat-fusion joints.

Retain one or more of four subparagraphs below.

[**5 inch and 6 inch]** <**Insert pipe size range**>: Schedule 40, [**black**] [**galvanized**]-steel pipe; threaded, malleable-iron fittings; and threaded joints.

[**5 inch]** <**Insert pipe size**> and Larger: Schedule 40, [**black**] [**galvanized**]- steel pipe; grooved-end fittings; couplings; and grooved joints.

[**5 inch to 8 inch]** <**Insert pipe size range**>: Type K or L, copper tube; grooved-end copper fittings; couplings; and grooved joints.

Sizes in subparagraph below which correspond approximately to 6 inch, 8 inch, and 10 inch (DN 150, DN 200, and DN 250).

[**6 inch to 10 inch] <Insert pipe size range**>: Aluminum pipe; and roll-groove couplings.

Retain "one of" option in first paragraph below to allow Contractor to select piping materials from those retained.

* + - * 1. High-Pressure Compressed-Air Distribution Piping: Use[ **one of**] the following piping materials for each size range:

[**2 inch]** <**Insert pipe size**> and Smaller: Schedule 40, [**black**] [**galvanized**]- steel pipe; threaded, malleable-iron fittings; and threaded joints.

Retain one or more of first five subparagraphs below.

[**2 inch]** <**Insert pipe size**> and Smaller: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.

[**2 inch]** <**Insert pipe size**> and Smaller: Type K or L, copper tube; wrought-copper fittings; and brazed[ **or soldered**] joints.

Sizes in first subparagraph below which correspond approximately to 1/4 inch, 1/2 inch, 3/4 inch, NPS 1, 1-1/4 inch, 1-1/2 inch, and 2 inch (DN 8, DN 15, DN 20, DN 25, DN 32, DN 40, and DN 50).

[**2 inch]** <**Insert pipe size**> and Smaller: Aluminum pipe; solid-brass nickel-plated fittings; and push-connect bite ring couplings.

Retain one or more of first seven subparagraphs below.

[**2-1/2 inch to 6 inch]** <**Insert pipe size range**>: Schedule 40, [**black**] [**galvanized**]-steel pipe; threaded, malleable-iron fittings; and threaded joints.

[**2-1/2 inch to 6 inch]** <**Insert pipe size range**>: Schedule 40, [**black**] [**galvanized**]-steel pipe; grooved-end fittings; couplings; and grooved joints.

[**2-1/2 inch to 6 inch]** <**Insert pipe size range**>: Schedule 40, black- steel pipe; wrought-steel fittings; and welded joints.

[**2-1/2 inch to 4 inch]** <**Insert pipe size range**>: Type K or L, copper tube; wrought-copper fittings; and brazed[ **or soldered**] joints.

[**2-1/2 inch to 6 inch]** <**Insert pipe size range**>: Type K or L, copper tube; wrought-copper fittings; and brazed joints.

[**2-1/2 inch to 6 inch]** <**Insert pipe size range**>: Type K or L, copper tube; grooved-end copper fittings; couplings; and grooved joints.

Sizes in first subparagraph below which correspond approximately to 2-1/2 inch, 3 inch, 4 inch, and 6 inch (DN 65, DN 80 DN 100, and DN 150).

**[2-1/2 inch to 6 inch] <Insert pipe size**>: Aluminum pipe; and roll-groove couplings.

Retain one or more of four subparagraphs below.

[**8 inch]** <**Insert pipe size**> and Larger: Schedule 40, [**black**] [**galvanized**]- steel pipe; grooved-end fittings; couplings; and grooved joints.

[**8 inch]** <**Insert pipe size**> and Larger: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.

[**8 inch]** <**Insert pipe size**>: Type K or L, copper tube; grooved-end copper fittings; couplings; and grooved joints.

Sizes in subparagraph below which correspond approximately to 8 inch and 10 inch (DN 200 and DN 250).

[**8 inch and 10 inch] <Insert pipe size range**>: Aluminum pipe; and roll-groove couplings.

Retain "one of" option in paragraph below to allow Contractor to select piping materials from those retained.

* + - * 1. Drain Piping: Use[ **one of**] the following piping materials:

Retain one or more of three subparagraphs below.

[**2 inch]** <**Insert pipe size**> and Smaller: Type M copper tube; wrought-copper fittings; and brazed or soldered joints.

[**2 inch]** <**Insert pipe size**> and Smaller: PVC pipe and fittings; and solvent- cemented joints.

Sizes in subparagraph below which correspond approximately to 1/4 inch, 1/2 inch, 3/4 inch, NPS 1, 1-1/4 inch, 1-1/2 inch, and 2 inch (DN 8, DN 15, DN 20, DN 25, DN 32, DN 40, and DN 50).

[**2 inch]** <**Insert pipe size**> and Smaller: Aluminum pipe; solid-brass nickel-plated fittings; and push-connect bite ring couplings.

* + - 1. VALVE APPLICATIONS
				1. Metal General-Duty Valves: Comply with requirements and use valve types specified in "Valve Applications” Articles in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," Section 220523.14 "Check Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping," according to the following:

Low-Pressure Compressed Air: Valve types specified for low-pressure compressed air.

High-Pressure Compressed Air: Valve types specified for medium-pressure compressed air.

Equipment Isolation 2 inch and Smaller: Safety-exhaust, copper-alloy ball valve with exhaust vent and pressure rating at least as great as piping system operating pressure.

Grooved-end valves may be used with grooved-end piping and grooved joints.

Retain "General-Duty Valves for Aluminum Piping System" Paragraph and associated subparagraphs below for valves to be provided with aluminum piping systems in this Section.

* + - * 1. General-Duty Valves for Aluminum Piping System: Provide valves, made by piping system manufacturer, that are compatible with piping.

Ball Valves, **2 inch** and Smaller: NPT threaded ends, or push- connect bite ring ends.

Butterfly Valves, **2-1/2 inch** and Larger: Tube to tube, with two roll- groove end couplings.

Retain paragraph and associated subparagraphs below if plastic valves are required. Use only plastic valves with plastic low-pressure compressed-air piping and within manufacturer's temperature and pressure limits.

* + - * 1. Plastic General-Duty Valves: Provide valves, made by piping manufacturer, that are compatible with piping. Do not use plastic valves between air compressors and receivers.

Blue ABS Piping System: Ball and butterfly valves.

Green ABS Piping System: Ball valves.

HDPE Piping System: Ball valves.

* + - 1. PIPING INSTALLATION, GENERAL

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

* + - * 1. Drawing plans, schematics, and diagrams indicate general location and arrangement of compressed-air piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
				2. Install piping concealed from view and protected from physical contact by building occupants, unless otherwise indicated and except in equipment rooms and service areas.
				3. 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 otherwise indicated.
				4. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and to coordinate with other services occupying that space.
				5. Install piping adjacent to equipment and machines to allow service and maintenance.
				6. Install air and drain piping with 1 percent slope downward in direction of flow.
				7. Install nipples, flanges, unions, transition and special fittings, and valves with pressure ratings same as or higher than system pressure rating, unless otherwise indicated.
				8. Equipment and Specialty Flanged Connections:

Use steel companion flange with gasket for connection to steel pipe.

Use cast-copper-alloy companion flange with gasket and brazed[ **or soldered**] joint for connection to copper tube. Do not use soldered joints for connection to air compressors or to equipment or machines producing shock or vibration.

* + - * 1. Flanged joints may be used instead of specified joint for any piping or tubing system.
				2. Extended-tee outlets with brazed branch connection may be used for copper tubing, within extruded-tee connection diameter to run tube diameter ratio for tube type, according to Extruded Tee Connections Sizes and Wall Thickness for Copper Tube (Inches) Table in ASTM F2014 “Standard Specifications for Non-Reinforced Extruded Tee Connections for Piping Applications”.
				3. Install eccentric reducers where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
				4. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.
				5. Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver. Comply with requirements in Section 220519 "Meters and Gages for Plumbing Piping."
				6. Install piping to permit valve servicing.
				7. Install piping free of sags and bends.
				8. Install fittings for changes in direction and branch connections.

Retain first paragraph below if piping is required to withstand specific design loads.

* + - * 1. Install seismic restraints on piping. Seismic-restraint devices are specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
				2. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing 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 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
				2. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."
			1. INSTALLATION OF ALUMINUM PIPING SYSTEMS
				1. Install aluminum piping systems according to manufacturer's written instructions, using manufacturer's recommended tools, accessories, and methods.
				2. Install branch connections **2-1/2 inch** and larger, to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.
				3. Install branch connections **2 inch** and smaller, to compressed-air mains using aluminum piping system reducing outlet tee with water trapping capabilities. Provide drain leg and drain trap at end of each main and branch and at low points.
				4. Install automatic drain valves on aftercoolers, receivers, and dryers. Discharge condensate shall be piped and connected to oil-water separator.
				5. Support aluminum pipe using manufacturer's hangers and supports, designed for use with the system.
				6. Allow for expansion and contraction of aluminum piping system.
				7. Do not use plastic components or plastic fittings of any kind within pressurized aluminum piping system. This applies to main headers, branches, and drops.
			2. 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. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1 “Pipe Threads, General Purpose, Inch”. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

* + - * 1. Welded Joints for Steel Piping: Join according to AWS D10.12 “Guide for Welding Mild Steel Pipe”.
				2. Brazed Joints for Copper Tubing: Join according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
				3. Soldered Joints: Apply ASTM B813 “Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube”, water-flushable flux, unless otherwise indicated, to tube end. Join according to ASTM B828 “Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings” or CDA's "Copper Tube Handbook."
				4. Extruded-Tee Outlets for Copper Tubing: Form branches according to ASTM F2014 “Standard Specifications for Non-Reinforced Extruded Tee Connections for Piping Applications”, with tools recommended by procedure manufacturer, and using operators qualified according to Part 1 "Quality Assurance" Article.
				5. Flanged Joints: Use asbestos-free, nonmetallic gasket suitable for compressed air. Join flanges with gasket and bolts according to ASME B31.9 “Building Services Piping” for bolting procedure.
				6. Grooved Joints: Assemble couplings with housing, gasket, lubricant, and bolts. Join according to AWWA C606 “Standard for Grooved and Shouldered Joints” for grooved joints. Do not apply lubricant to prelubricated gaskets.
				7. Heat-Fusion Joints for PE Piping: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D2657 “Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings” for socket-fusion joints.
				8. Pressure-Sealed Joints: Join with tools recommended by fitting manufacturer, using operators qualified according to Part 1 "Quality Assurance" Article.
				9. Solvent-Cemented Joints for ABS Piping: Clean and dry joining surfaces. Join according to the following:

Comply with ASTM F402 “Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings” for safe-handling practice of cleaners, primers, and solvent cements.

Join according to ASME B31.9 “Building Services Piping” for solvent-cemented joints and to ASTM D2235 “Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings” Appendix.

* + - * 1. Solvent-Cemented Joints for PVC Piping: Clean and dry joining surfaces. Join according to the following:

Comply with ASTM F402 “Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings” for safe-handling practice of cleaners, primers, and solvent cements.

Apply primer and join according to ASME B31.9 “Building Services Piping” for solvent-cemented joints and to ASTM D2672 “Standard Specification for Joints for IPS PVC Pipe Using Solvent Cement”.

* + - * 1. Dissimilar Metal Piping Material Joints: Use dielectric fittings.
			1. VALVE INSTALLATION
				1. General-Duty Valves: Comply with requirements in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," Section 220523.14 "Check Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping."
				2. Install shutoff valves and unions or flanged joints at compressed-air piping to air compressors.
				3. Install shutoff valve at inlet to each automatic drain valve, filter, lubricator, and pressure regulator.
				4. Install check valves to maintain correct direction of compressed-air flow to and from compressed-air piping specialties and equipment.
			2. DIELECTRIC FITTING INSTALLATION
				1. General Requirements: Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

Joining Dissimilar Threaded Piping: Make up connection with a threaded coupling or with companion flanges.

Joining Dissimilar Non-Threaded Piping: Make up connection with adapters recommended by the manufacturers of the piping to be joined.

Joining Galvanized Steel Pipe and Copper Tubing: Make up connection with a dielectric connector.

* + - * 1. Dielectric Fittings for [**2 inches**] <**Insert pipe size**> and Smaller: Use dielectric [**couplings**] [**couplings or nipples**] [**nipples**] [**unions**].
				2. Dielectric Fittings for [2-1/2 inch to 4 inch] <Insert pipe size range>: Use dielectric [flanges] [flange kits] [nipples].
				3. Dielectric Fittings for [**5 inch**] <**Insert pipe size**> and Larger: Use dielectric flange kits.
			1. FLEXIBLE PIPE CONNECTOR INSTALLATION
				1. Install flexible pipe connectors in discharge piping[ **and in inlet air piping from remote air- inlet filter**] of each air compressor.
				2. Install bronze-hose flexible pipe connectors in copper compressed-air tubing.
				3. Install stainless-steel-hose flexible pipe connectors in steel compressed-air piping.
			2. SPECIALTY INSTALLATION
				1. Install safety valves on receivers in quantity and size to relieve at least the capacity of connected air compressors.
				2. Install air-main pressure regulators in compressed-air piping at or near air compressors.
				3. Install air-line pressure regulators in branch piping to equipment[ **and tools**].
				4. Install automatic drain valves on aftercoolers, receivers, and dryers. Discharge condensate onto nearest floor drain.
				5. Install coalescing filters in compressed-air piping at or near air compressors and upstream from mechanical filters.[ **Mount on wall at locations indicated.**]
				6. Install mechanical filters in compressed-air piping at or near air compressors and downstream from coalescing filters.[ **Mount on wall at locations indicated.**]
				7. Install air-line lubricators in branch piping to machine tools.[ **Mount on wall at locations indicated.**]
				8. Install quick couplings at piping terminals for hose connections.
				9. Install hose assemblies at hose connections.
			3. CONNECTIONS
				1. Install unions, in piping 2 inch and smaller, adjacent to each valve and at final connection to each piece of equipment and machine.
				2. Install flanges, in piping 2-1/2 inch and larger, adjacent to flanged valves and at final connection to each piece of equipment and machine.
			4. HANGER AND SUPPORT INSTALLATION

Retain first paragraph below if Project requires seismic design.

* + - * 1. Comply with requirements in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.
				2. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.
				3. Vertical Piping: MSS Type 8 or 42, clamps.
				4. Individual, Straight, Horizontal Piping Runs:

100 Feet or Less: MSS Type 1, adjustable, steel clevis hangers.

Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.

* + - * 1. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
				2. Base of Vertical Piping: MSS Type 52, spring hangers.
				3. Support horizontal piping within [**12 inches]** <**Insert dimension**> of each fitting and coupling.
				4. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

Maximum spans in first two paragraphs and associated subparagraphs below were taken from MSS SP-69 for steel pipe and vapor service.

* + - * 1. Install hangers for Schedule 40, steel piping with the following maximum horizontal spacing and minimum rod diameters:

1/4 inch to 1/2 inch: 96 inches with 3/8-inch rod.

3/4 inch to 1-1/4 inch: 84 inches with 3/8-inch rod.

1-1/2 inch: 12 feet with 3/8-inch rod.

2 inch: 13 feet with 3/8-inch rod.

2-1/2 inch: 14 feet with 1/2-inch rod.

3 inch: 15 feet with 1/2-inch rod.

3-1/2 inch: 16 feet with 1/2-inch rod.

4 inch: 17 feet with 5/8-inch rod.

5 inch: 19 feet with 5/8-inch rod.

6 inch: 21 feet with 3/4-inch rod.

8 inch: 24 feet with 3/4-inch rod.

10 inch: 26 feet with 7/8-inch rod.

12 inch: 30 feet with 7/8-inch rod.

* + - * 1. Install supports for vertical, Schedule 40, steel piping every 15 feet.

Maximum spans in first two paragraphs and associated subparagraphs below were taken from MSS SP-69 for copper tube and vapor service.

* + - * 1. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

NPS 1/4: 60 inches with 3/8-inch rod.

3/8 inch and 1/2 inch: 72 inches with 3/8-inch rod.

3/4 inch: 84 inches with 3/8-inch rod.

NPS 1: 96 inches with 3/8-inch rod.

1-1/4 inch: 108 inches with 3/8-inch rod.

1-1/2 inch: 10 feet with 3/8-inch rod.

2 inch: 11 feet with 3/8-inch rod.

2-1/2 inch: 13 feet with 1/2-inch rod.

3 inches : 14 feet with 1/2-inch rod.

3-1/2 inch: 15 feet with 1/2-inch rod.

4 inch: 16 feet with 1/2-inch rod.

5 inch: 18 feet with 1/2-inch rod.

6 inch: 20 feet with 5/8-inch rod.

8 inch: 23 feet with 3/4-inch rod.

* + - * 1. Install supports for vertical copper tubing every 10 feet.

Retain first paragraph below for hangers and supports required for aluminum piping systems by manufacturer, or delete and retain "Comply with requirements in Section 220529" paragraph.

* + - * 1. Use manufacturer's recommended hangers and supports for aluminum piping system.

Description: Wire rope using adjustable camlock system with standard threaded stud for connection to provided hangers.

Hangers: UV-stabilized nylon and galvanized clevis style.

Install hangers for aluminum piping every 8 feet.

Install supports for vertical aluminum piping every 8 feet.

* + - * 1. Install vinyl-coated hangers for ABS piping with the following maximum horizontal spacing and minimum rod diameters:

All Sizes: Install continuous support for piping with compressed air at normal operating temperature above **[100 deg F] <Insert temperature**>.

Verify hanger spacing in subparagraphs below with ABS pipe manufacturer.

3/8 inch and 1/2 inch: 30 inches with 3/8-inch rod.

3/4 inch: 38 inches with 3/8-inch rod.

NPS 1: 40 inches with 3/8-inch rod.

1-1/4 inch: 45 inches with 3/8-inch rod.

1-1/2 inch: 52 inches with 3/8-inch rod.

2 inch: 58 inches with 3/8-inch rod.

3 inch: 68 inches with 1/2-inch rod.

4 inch: 76 inches with 1/2-inch rod.

* + - * 1. Install supports for vertical ABS piping every 48 inches.
				2. Install vinyl-coated hangers for HDPE piping with the following maximum horizontal spacing and minimum rod diameters:

All Sizes: Install continuous support for piping with compressed air at normal operating temperature above [**100 deg F]** <**Insert temperature>.**

Verify hanger spacing in subparagraphs below with HDPE pipe manufacturer.

1/2 inch: 30 inches with 3/8-inch rod.

3/4 inch: 35 inches with 3/8-inch rod.

NPS 1: 40 inches with 3/8-inch rod.

1-1/4 inch: 43 inches with 3/8-inch rod.

1-1/2 inch: 49 inches with 3/8-inch rod.

2 inch: 55 inches with 3/8-inch rod.

3 inch and 4 inch: 96 inches with 1/2-inch rod.

* + - * 1. Install supports for vertical HDPE piping every 48 inches.
			1. LABELING AND IDENTIFICATION
				1. Install identifying labels and devices for general-service compressed-air piping, valves, and specialties. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment."
			2. FIELD QUALITY CONTROL
				1. Perform field tests and inspections.
				2. Tests and Inspections:

Piping Leak Tests for Metal Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen to pressure of 50 psig above system operating pressure, but not less than [**150 psig**] <**Insert pressure**>. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.

Piping Leak Tests for Aluminum Compressed-Air Piping: Test new piping system and modified parts of existing piping system. Cap and fill general-service compressed-air piping system to pressure of 15 psig, hold pressure for 10 minutes. Repeat until reaching required operating pressure, not to exceed 220 psig. Once desired operating pressure is met, let stand for one hour.

Piping Leak Tests for ABS Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen, at temperature of 110 deg F or less, to pressure of [**40 psig**] <**Insert pressure**> above system operating pressure, but not less than [**80 psig**] [**100 psig**] <**Insert pressure**> or more than 120 psig. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.

Piping Leak Tests for HDPE Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen, at temperature of 100 deg F or less, to pressure of [**40 psig**] <**Insert pressure**> above system operating pressure, but not less than [**100 psig**] [**125 psig**] [**150 psig**] <**Insert pressure**> or more than 180 psig. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.

Repair leaks and retest until no leaks exist.

Inspect [**filters**] [**lubricators**] [**and**] [**pressure regulators**] for proper operation.

* + - * 1. Prepare test reports.

END OF SECTION 221513