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SECTION 221513 - GENERAL-SERVICE COMPRESSED-AIR PIPING

TIPS:

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To read **detailed research, technical information about products and materials, and coordination checklists**, click on MasterWorks/Supporting Information.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes piping and related specialties for general-service compressed-air systems operating at **200 psig (1380 kPa)** or less.

B. Related Sections include the following:

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

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. CR: Chlorosulfonated polyethylene synthetic rubber.
- C. EPDM: Ethylene-propylene-diene terpolymer rubber.
- D. HDPE: High-density polyethylene plastic.
- E. NBR: Acrylonitrile-butadiene rubber.
- F. PE: Polyethylene plastic.
- G. PVC: Polyvinyl chloride plastic.
- H. High-Pressure Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures between **150 and 200 psig (1035 and 1380 kPa)**.
- I. Low-Pressure Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures of **150 psig (1035 kPa)** or less.

1.4 PERFORMANCE REQUIREMENTS

- A. 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.>

1.5 ACTION SUBMITTALS

- A. Product Data: For the following:
 1. Plastic pipes, fittings, and valves.
 2. Dielectric fittings.
 3. Flexible pipe connectors.
 4. Safety valves.
 5. Pressure regulators. Include rated capacities and operating characteristics.
 6. Automatic drain valves.
 7. Filters. Include rated capacities and operating characteristics.
 8. Lubricators. Include rated capacities and operating characteristics.
 9. Quick couplings.
 10. Hose assemblies.

1.6 INFORMATIONAL SUBMITTALS

- A. **[Brazing] [Brazing and welding] [Welding]** certificates.
- B. Qualification Data: For Installers.
- C. Field quality-control test reports.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For general-service compressed-air piping specialties to include in emergency, operation, and maintenance manuals.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Extruded-Tee Outlet Procedure: Qualify operators according to training provided by T-DRILL Industries Inc., for making branch outlets.
 - 2. Pressure-Seal Joining Procedure for Copper Tubing: Qualify operators according to training provided by Viega; Plumbing and Heating Systems.
 - 3. Pressure-Seal Joining Procedure for Steel Piping. Qualify operators according to training provided by Victaulic Company.
- B. 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."
- C. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
- D. ASME Compliance:
 - 1. Comply with ASME B31.1, "Power Piping," for high-pressure compressed-air piping.
 - 2. Comply with ASME B31.9, "Building Services Piping," for low-pressure compressed-air piping.

1.9 PROJECT CONDITIONS

- A. Interruption of Existing Compressed-Air Service: Do not interrupt compressed-air service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary compressed-air service according to requirements indicated:
 - 1. Notify **[Architect] [Construction Manager] [Owner]** no fewer than **[two]** **<Insert number>** days in advance of proposed interruption of compressed-air service.
 - 2. Do not proceed with interruption of compressed-air service without **[Architect's] [Construction Manager's] [Owner's]** written permission.

1.10 WARRANTY

- .Manufacturer's Special Warranty on Domestic Products: Conbraco Industries, Inc. warrants products to be free of defects in workmanship or material for a period of five years. This warranty applies to Apollo brand products with "Made in the USA" markings only. Conbraco will correct such defects by suitable repair or replacement at Conbraco's discretion.
- B. Manufacturer's Special Warranty on International Products: APOLLO INTERNATIONAL products will be free of defects in workmanship or material for a period of two years. Conbraco will correct such defects by suitable repair or replacement at Conbraco's discretion.
- C. Elkhart Products Corporation warranties our fittings to be free from defects in materials and workmanship for a period of fifty (50) years. The Elkhart Product Corporation Water Heater hoses carry a two (2) year warranty against defects in materials and workmanship. Any fitting which proves to be defective will be replaced or a credit issued, but no incidental labor charges, expenses or damages will be allowed.
- D. Manufacturer's Special Warranty on Shurjoint Piping Products: The 10 Year Limited Warranty applies to manufacturing defects only and does not cover severe service/temperature applications or wear parts. Shurjoint will correct such defects by suitable repair or replacement at Shurjoint's discretion.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Schedule 40, Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B, black or hot-dip zinc coated with ends threaded according to ASME B1.20.1.
1. Steel Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, galvanized seamless steel pipe. Include ends matching joining method.
 2. Malleable-Iron Fittings: ASME B16.3, Class 150 or 300, threaded.
 3. Malleable-Iron Unions: ASME B16.39, Class 150 or 300, threaded.
 4. Steel Flanges: ASME B16.5, Class 150 or 300, carbon steel, threaded.
 5. Wrought-Steel Butt-Welding Fittings: ASME B16.9, Schedule 40.
 6. Steel Flanges: ASME B16.5, Class 150 or 300, carbon steel.
 7. Grooved-End Fittings and Couplings:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide products by Shurjoint Piping Products USA Inc.; [**Threaded Models 811, 812, 813, 814, 815, 815**] [**Bull Head Models 816, 817, 818, 819, 820, 825, 827, 831, 832, 841**] [**Grooved Coupling Models Z05, Z07, K-9, 7771, XH-1000, 7705, 7707, 7706, G28, C-7, 7041, 7043, 7170, 7180, 7181**] [**Grooved Fitting Models 7110, 7111, 7112, 7112G, 7113, 7120, 7121, 7125, 7130, 7135, 7137, 7150, 7150F, 7150M, 7151, 7160, 7160P, 7160T, 7160H, 901, 903**] [**Adapter Nipple Models 55, 57, 58, 59**], or comparable products by one of the following:
 - 1) Victaulic Company.
 - 2) <Insert manufacturer's name>.

- b. Grooved-End Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron casting; with grooves according to AWWA C606 and dimensions matching steel pipe.
 - c. Couplings: AWWA C606 or UL 213, for steel-pipe dimensions and rated for **300-psig (2070-kPa)** minimum 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.
- B. Schedule 5, Steel Pipe: ASTM A 135, carbon steel with plain ends and zinc-plated finish.
1. Pressure-Seal Fittings: Listed and labeled by a qualified testing agency and FMG-approved, carbon-steel, pressure-seal housing with O-ring end seals suitable for compressed-air piping and rated for **300-psig (2070-kPa)** minimum working pressure. Provide EDPM seals for oil-free compressed air. Provide NBR seals if compressed air contains oil or oil vapor.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Grinnell Mechanical Products.
 - 2) Victaulic Company.
 - 3) **<Insert manufacturer's name>**.
- C. Copper Tube: [**ASTM B 88, Type K or L (ASTM B 88M, Type A or B)**] [**and**] [**ASTM B 88, Type M (ASTM B 88M, Type C)**] seamless, drawn-temper, water tube.
1. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, wrought copper with dimensions for brazed joints.
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide products by Elkhart Products Corporation, made in USA, or comparable products by one of the following:
 - 1) NIBCO INC.
 - 2) **<Insert manufacturer's name>**
 2. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150 or 300.
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide products by Elkhart Products Corporation or comparable products by one of the following:
 - 1) NIBCO INC.
 - 2) Lee Brass.
 - 3) **<Insert manufacturer's name>**.
 3. Copper Unions: ASME B16.22 or MSS SP-123.

- a. Basis-of-Design Product: Subject to compliance with requirements, provide products by Elkhart Products Corporation, made in USA, or comparable products by one of the following:
 - 1) NIBCO INC.
 - 2) <Insert manufacturer's name>
4. Press-Type Fittings, **NPS 2 (DN 50)** and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide Elkhart Products Corporation; ApolloXpress fittings, made in USA, or comparable products by one of the following:
 - 1) NIBCO INC.
 - 2) <Insert manufacturer's name>
 - b. For Types K, L, and M hard copper tubing **NPS 1/2 (DN 15)** to **NPS 4 (DN 100)** and soft copper tubing in **NPS 1/2 (DN 15)** to **NPS 1-1/4 (DN 32)**.
 - c. Housing: Copper or bronze.
 - d. Sealing Element: EPDM.
 - e. Multiple leak path detection system.
 - f. Tools: Manufacturer's special tools.
 - g. Maximum **200 psig (1379 kPa)** working-pressure rating at **250 deg F (121 deg C)**.
5. Press-Type Fittings, **NPS 2-1/2 to NPS 4 (DN 65 to DN 100)**: Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide Elkhart Products Corporation; ApolloXpress fittings, made in USA, or comparable products by one of the following:
 - 1) Viega LLC.
 - 2) <Insert manufacturer's name>.
 - b. For Types K, L, and M hard copper tubing **NPS 1/2 (DN 15)** to **NPS 4 (DN 100)**.
 - c. Housing: Copper or bronze.
 - d. Multiple leak path detection system.
 - e. Sealing Element: EPDM.
 - f. Tools: Manufacturer's special tools.
6. Copper Push-on-Joint Fittings:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide Elkhart Products Corporation; Copper Loc non-removable pressure fittings, made in USA, or comparable products by one of the following:
 - 1) Victaulic Company.
 - 2) <Insert manufacturer's name>.
 - b. Description:

- 1) Cast-copper fitting complying with ASME B16.18 or wrought-copper fitting complying with ASME B 16.22.
 - 2) Maximum **200 psig (1379 kPa)** working-pressure rating at **250 deg F (121 deg C)**.
 - 3) Stainless-steel grip ring and EPDM-rubber O-ring seal.
7. Extruded-Tee Outlets: Procedure for making branch outlets in copper tube according to ASTM F 2014.
- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) T-DRILL Industries Inc.
 - 2) **<Insert manufacturer's name>**.
8. Grooved-End Fittings and Couplings:
- a. Basis-of-Design Product: Subject to compliance with requirements, provide products by Shurjoint Piping Products USA Inc.; Model C305, C306, C307, C341, C10, C11, C20, C21, C26, C50, C52, C55, C55T, C60, or comparable products by one of the following:
 - 1) Anvil International.
 - 2) Grinnell Mechanical Products.
 - 3) Victaulic Company.
 - 4) **<Insert manufacturer's name>**.
 - b. Grooved-End Fittings: **ASTM B 75 (ASTM B 75M)**, copper tube or ASTM B 584, bronze castings.
 - c. Couplings: Copper-tube dimensions and design similar to AWWA C606. 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.
- D. 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.
- E. PVC Pipe: ASTM D 1785, Schedule 40.
1. PVC Fittings: ASTM D 2466, Schedule 40, socket type.
- F. Blue ABS Piping System: Made of ASTM D 3965, ABS-resin modified to provide shatter-resistant pipe for compressed-air service. Pipe and fittings are light blue and sizes are in millimeters.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. IPEX USA LLC.
 - b. **<Insert manufacturer's name>**.

2. Transition Fittings, 20 to 63 mm: 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.
 3. Transition Fittings, 90 to 110 mm: Flange assembly with ABS flange, CR gasket, and metal flange of material matching piping to be connected.
 4. Valves, 20 to 63 mm: ABS union ball valve with socket ends.
 5. Valves, 90 to 110 mm: ABS butterfly valve with lever handle.
- G. Green ABS Piping System: Made of ASTM D 3965, 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 A 53/A 53M, steel pipe.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. NIBCO INC.
 - b. <Insert manufacturer's name>.
 2. Transition Fittings, **NPS 1/2 to NPS 2 (DN 15 to DN 50)**: 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.
 3. Transition Fittings, **NPS 2-1/2 to NPS 4 (DN 65 to DN 100)**: ABS flange, CR gasket, and metal flange of material matching piping to be connected.
 4. Valves, **NPS 1/2 to NPS 2 (DN 15 to DN 50)**: Union ball valve with socket ends.
 5. Valves, **NPS 2-1/2 to NPS 4 (DN 65 to DN 100)**: Union ball valve with flanged ends. Include safety exhaust feature in Part 3 "Valve Applications" Article if required.
- H. HDPE Piping System: Made of ASTM D 1248, 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 D 3035, PE pipe.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Asahi/America.
 - b. <Insert manufacturer's name>.
 2. Transition Fittings, **NPS 1/2 to NPS 2 (DN 15 to DN 50)**: HDPE adapter with one socket end and one end with threaded brass insert.
 3. Transition Fittings, **NPS 2-1/2 to NPS 4 (DN 65 to DN 100)**: HDPE flange, CR gasket, and metal flange of material matching piping to be connected.
 4. Valves, **NPS 1/2 to NPS 3 (DN 15 to DN 80)**: HDPE union ball valve with socket ends.

2.2 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for compressed-air piping system contents.
1. ASME B16.21, nonmetallic, flat, asbestos free, **1/8-inch (3.2-mm)** maximum thickness unless thickness or specific material is indicated.

- a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- G. Solvent Cements for Joining Plastic Piping:
1. ABS Piping: ASTM D 2235.
 2. PVC Piping: ASTM D 2564. Include primer complying with ASTM F 656.

2.3 VALVES

- A. 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."

2.4 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. Capitol Manufacturing Company.
 - c. Central Plastics Company.
 - d. HART Industrial Unions, LLC.
 - e. Jomar Valve.
 - f. Matco-Norca.
 - g. WATTS.
 - h. Wilkins.
 - i. <Insert manufacturer's name>.

2. Description:

- a. Standard: ASSE 1079.
- b. Pressure Rating: [**125 psig (860 kPa) minimum at 180 deg F (82 deg C)**] [**150 psig (1035 kPa)**] [**250 psig (1725 kPa)**].
- c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Capitol Manufacturing Company.
- b. Central Plastics Company.
- c. Matco-Norca.
- d. WATTS.
- e. Wilkins.
- f. <**Insert manufacturer's name**>.

2. Description:

- a. Standard: ASSE 1079.
- b. Factory-fabricated, bolted, companion-flange assembly.
- c. Pressure Rating: [**125 psig (860 kPa) minimum at 180 deg F (82 deg C)**] [**150 psig (1035 kPa)**] [**175 psig (1200 kPa)**] [**300 psig (2070 kPa)**].
- d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Advance Products & Systems, Inc.
- b. Calpico, Inc.
- c. Central Plastics Company.
- d. Pipeline Seal and Insulator, Inc.
- e. <**Insert manufacturer's name**>.

2. Description:

- a. Nonconducting materials for field assembly of companion flanges.
- b. Pressure Rating: [**150 psig (1035 kPa)**] <**Insert pressure**>.
- c. Gasket: Neoprene or phenolic.
- d. Bolt Sleeves: Phenolic or polyethylene.
- e. Washers: Phenolic with steel backing washers.

2.5 FLEXIBLE PIPE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Flex-Hose Co., Inc.
 2. Flexicraft Industries.
 3. Hyspan Precision Products, Inc.
 4. Mercer Rubber Co.
 5. Metraflex Company (The).
 6. Proco Products, Inc.
 7. Unaflex.
 8. Universal Metal Hose.
 9. **<Insert manufacturer's name>**.
- B. Bronze-Hose Flexible Pipe Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
1. Working-Pressure Rating: **[200 psig (1380 kPa)] [250 psig (1725 kPa)]** minimum.
 2. End Connections, **NPS 2 (DN 50)** and Smaller: Threaded copper pipe or plain-end copper tube.
 3. End Connections, **NPS 2-1/2 (DN 65)** and Larger: Flanged copper alloy.
- C. Stainless-Steel-Hose Flexible Pipe Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
1. Working-Pressure Rating: **[200 psig (1380 kPa)] [250 psig (1725 kPa)]** minimum.
 2. End Connections, **NPS 2 (DN 50)** and Smaller: Threaded steel pipe nipple.
 3. End Connections, **NPS 2-1/2 (DN 65)** and Larger: Flanged steel nipple.

2.6 SPECIALTIES

- A. 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.
1. Pressure Settings: Higher than discharge pressure and same or lower than receiver pressure rating.
 1. Basis-of-Design Product: Subject to compliance with requirements, provide Conbraco Industries, Inc.; **[15] [19M] [19K] [19L] [19S] [29] [510] [520] [530] [540]** or a comparable product by one of the following:
 - a. **<Insert manufacturer's name>**.
- B. Air-Main Pressure Regulators: Bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for **[250-psig (1725-kPa)] <Insert pressure>** inlet pressure, unless otherwise indicated.
1. Type: Pilot operated.

- C. 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 (1380-kPa)**] <Insert pressure> minimum inlet pressure, unless otherwise indicated.
- D. Air-Line Pressure Regulators: Diaphragm operated, aluminum alloy or plastic body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for [**200-psig (1380-kPa)**] <Insert pressure> minimum inlet pressure, unless otherwise indicated.
- E. Automatic Drain Valves: Stainless-steel body and internal parts, rated for [**200-psig (1380-kPa)**] <Insert pressure> minimum working pressure, capable of automatic discharge of collected condensate. [**Include mounting bracket if wall mounting is indicated.**]
- F. 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.**]
- G. 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.**]
- H. 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.**]
 - 1. Provide with automatic feed device for supplying oil to lubricator.

2.7 QUICK COUPLINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Aeroquip Corporation.
 - 2. Bowes Manufacturing Inc.
 - 3. Foster Manufacturing, Inc.
 - 4. Milton Industries, Inc.
 - 5. Parker Hannifin Corp.
 - 6. Rectus Corp.
 - 7. Schrader-Bridgeport/Standard Thomson.
 - 8. TOMCO Products Inc.
 - 9. Tuthill Corporation.
 - 10. <Insert manufacturer's name>.
- B. General Requirements for Quick Couplings: Assembly with locking-mechanism feature for quick connection and disconnection of compressed-air hose.
- C. Automatic-Shutoff Quick Couplings: Straight-through brass body with O-ring or gasket seal and stainless-steel or nickel-plated-steel operating parts.

1. Socket End: With one-way valve and threaded inlet for connection to piping or threaded hose fitting.
 2. Plug End: [**Flow-sensor-bleeder, check-valve**] [**Straight-through**] type with barbed outlet for attaching hose.
- D. Valveless Quick Couplings: Straight-through brass body with stainless-steel or nickel-plated-steel operating parts.
1. Socket End: With O-ring or gasket seal, without valve, and with barbed inlet for attaching hose.
 2. Plug End: With barbed outlet for attaching hose.

2.8 HOSE ASSEMBLIES

- A. Description: Compatible hose, clamps, couplings, and splicers suitable for compressed-air service, of nominal diameter indicated, and rated for [**300-psig (2070-kPa)**] <Insert pressure> minimum working pressure, unless otherwise indicated.
1. Hose: Reinforced [**single**] [**single- or double**] [**double**]-wire-braid, CR-covered hose for compressed-air service.
 2. Hose Clamps: Stainless-steel clamps or bands.
 3. 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.
 4. Hose Splicers: One-piece, straight-through brass or stainless-steel fitting with barbed ends for connecting two sections of hose.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Compressed-Air Piping between Air Compressors and Receivers: Use[**one of**] the following piping materials for each size range:
1. [**NPS 2 (DN 50)**] <Insert pipe size> and Smaller: Schedule 40, [**black**] [**galvanized**]-steel pipe; threaded, malleable-iron fittings; and threaded joints.
 2. [**NPS 2 (DN 50)**] <Insert pipe size> and Smaller: Schedule 5, galvanized-steel pipe; pressure-seal fittings; and pressure-sealed joints.
 3. [**NPS 2 (DN 50)**] <Insert pipe size> and Smaller: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.
 4. [**NPS 1 (DN 25)**] <Insert pipe size> and Smaller: **Type K or L (Type A or B)**, copper tube; wrought-copper fittings; copper pressure-seal-joint fittings; copper-push fittings; and brazed joints.
 5. [**NPS 2 (DN 50)**] <Insert pipe size> and Smaller: **Type K or L (Type A or B)**, copper tube; wrought-copper fittings; copper pressure-seal-joint fittings; and brazed joints.
 6. [**NPS 2-1/2 to NPS 4 (DN 65 to DN 100)**] <Insert pipe size range>: Schedule 40, [**black**] [**galvanized**]-steel pipe; threaded, malleable-iron fittings; and threaded joints.
 7. [**NPS 2-1/2 to NPS 4 (DN 65 to DN 100)**] <Insert pipe size range>: Schedule 40, [**black**] [**galvanized**]-steel pipe; grooved-end fittings; couplings; and grooved joints.

8. [NPS 2-1/2 to NPS 4 (DN 65 to DN 100)] <Insert pipe size range>: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.
 9. [NPS 2-1/2 to NPS 4 (DN 65 to DN 100)] <Insert pipe size range>: Type K or L (Type A or B), copper tube; wrought-copper fittings; and brazed joints.
 10. [NPS 2-1/2 to NPS 4 (DN 65 to DN 100)] <Insert pipe size range>: Type K or L (Type A or B), copper tube; grooved-end copper fittings; couplings; and grooved joints.
 11. [NPS 5 (DN 125)] <Insert pipe size> and Larger: Schedule 40, [black] [galvanized]-steel pipe; threaded, malleable-iron fittings; and threaded joints.
 12. [NPS 5 (DN 125)] <Insert pipe size> and Larger: Schedule 40, [black] [galvanized]-steel pipe; grooved-end fittings; couplings; and grooved joints.
 13. [NPS 5 (DN 125)] <Insert pipe size> and Larger: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.
 14. [NPS 5 (DN 125)] <Insert pipe size> and Larger: Grooved-end, Type K or L (ASTM B 88M Type A or B), copper tube; grooved-end copper fittings; couplings; and grooved joints.
- B. Low-Pressure Compressed-Air Distribution Piping: Use[**one of**] the following piping materials for each size range:
1. [NPS 2 (DN 50)] <Insert pipe size> and Smaller: Schedule 40, [black] [galvanized]-steel pipe; threaded, malleable-iron fittings; and threaded joints.
 2. [NPS 2 (DN 50)] <Insert pipe size> and Smaller: Schedule 5, galvanized-steel pipe; pressure-seal fittings; and pressure-sealed joints.
 3. [NPS 1 (DN 25)] <Insert pipe size> and Smaller: Type K or L (Type A or B), copper tube; copper-push fittings.
 4. [NPS 2 (DN 50)] <Insert pipe size> and Smaller: Type K or L (Type A or B), copper tube; wrought-copper fittings; and brazed[**or soldered**] joints.
 5. [NPS 2 (DN 50)] <Insert pipe size> and Smaller: Type K or L (Type A or B), copper tube; press-type fittings; and pressure-sealed joints.
 6. [NPS 2 (DN 50)] <Insert pipe size> and Smaller: 63-mm and smaller, blue ABS pipe and fittings; transition fittings; valves; and solvent-cemented joints.
 7. [NPS 2 (DN 50)] <Insert pipe size> and Smaller: Green ABS pipe and fittings, transition fittings, and valves; and solvent-cemented joints.
 8. [NPS 2 (DN 50)] <Insert pipe size> and Smaller: HDPE pipe, fittings, and valves; and heat-fusion joints.
 9. [NPS 2-1/2 to NPS 4 (DN 65 to DN 100)] <Insert pipe size range>: Schedule 40, [black] [galvanized]-steel pipe; threaded, malleable-iron fittings; and threaded joints.
 10. [NPS 2-1/2 to NPS 4 (DN 65 to DN 100)] <Insert pipe size range>: Schedule 40, [black] [galvanized]-steel pipe; grooved-end fittings; couplings; and grooved joints.
 11. [NPS 2-1/2 to NPS 4 (DN 65 to DN 100)] <Insert pipe size range>: Type K or L (Type A or B), copper tube; wrought-copper fittings; and brazed[**or soldered**] joints.
 12. [NPS 2-1/2 to NPS 4 (DN 65 to DN 100)] <Insert pipe size range>: Type K or L (Type A or B), copper tube; grooved-end copper fittings; couplings; and grooved joints.
 13. [NPS 2-1/2 to NPS 4 (DN 65 to DN 100)] <Insert pipe size range>: Type K or L (Type A or B), copper tube; press-type fittings; and pressure-sealed joints.
 14. [NPS 2-1/2 to NPS 4 (DN 65 to DN 100)] <Insert pipe size range>: 90- and 110-mm, blue ABS pipe and fittings; transition fittings; and solvent-cemented joints. Include butterfly valves and flanged joints.
 15. [NPS 2-1/2 to NPS 4 (DN 65 to DN 100)] <Insert pipe size range>: NPS 3 and NPS 4 (DN 80 and DN 100), green ABS pipe and fittings; transition fittings; and solvent-cemented joints. Include ball valves and flanged joints.

16. **[NPS 2-1/2 to NPS 4 (DN 65 to DN 100)]** <Insert pipe size range>: **NPS 3 and NPS 4 (DN 80 and DN 100)**, HDPE pipe and fittings; valves; and heat-fusion joints.
 17. **[NPS 5 and NPS 6 (DN 125 and DN 150)]** <Insert pipe size range>: Schedule 40, **[black] [galvanized]**-steel pipe; threaded, malleable-iron fittings; and threaded joints.
 18. **[NPS 5 (DN 125)]** <Insert pipe size> and Larger: Schedule 40, **[black] [galvanized]**-steel pipe; grooved-end fittings; couplings; and grooved joints.
 19. **[NPS 5 to NPS 8 (DN 125 to DN 200)]** <Insert pipe size range>: **Type K or L (Type A or B)**, copper tube; grooved-end copper fittings; couplings; and grooved joints.
- C. High-Pressure Compressed-Air Distribution Piping: Use[**one of**] the following piping materials for each size range:
1. **[NPS 2 (DN 50)]** <Insert pipe size> and Smaller: Schedule 40, **[black] [galvanized]**-steel pipe; threaded, malleable-iron fittings; and threaded joints.
 2. **[NPS 2 (DN 50)]** <Insert pipe size> and Smaller: Schedule 5, galvanized-steel pipe; pressure-seal fittings; and pressure-sealed joints.
 3. **[NPS 2 (DN 50)]** <Insert pipe size> and Smaller: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.
 4. **[NPS 1 (DN 25)]** <Insert pipe size> and Smaller: **Type K or L (Type A or B)**, copper tube; copper-push fittings.
 5. **[NPS 2 (DN 50)]** <Insert pipe size> and Smaller: **Type K or L (Type A or B)**, copper tube; copper pressure-seal-joint fittings.
 6. **[NPS 2 (DN 50)]** <Insert pipe size> and Smaller: **Type K or L (Type A or B)**, copper tube; wrought-copper fittings; and brazed[**or soldered**] joints.
 7. **[NPS 2-1/2 to NPS 6 (DN 65 to DN 150)]** <Insert pipe size range>: Schedule 40, **[black] [galvanized]**-steel pipe; threaded, malleable-iron fittings; and threaded joints.
 8. **[NPS 2-1/2 to NPS 6 (DN 65 to DN 150)]** <Insert pipe size range>: Schedule 40, **[black] [galvanized]**-steel pipe; grooved-end fittings; couplings; and grooved joints.
 9. **[NPS 2-1/2 to NPS 6 (DN 65 to DN 150)]** <Insert pipe size range>: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.
 10. **[NPS 2-1/2 to NPS 4 (DN 65 to DN 100)]** <Insert pipe size range>: **Type K or L (Type A or B)**, copper tube; wrought-copper fittings; and brazed[**or soldered**] joints.
 11. **[NPS 2-1/2 to NPS 6 (DN 65 to DN 150)]** <Insert pipe size range>: **Type K or L (Type A or B)**, copper tube; wrought-copper fittings; and brazed joints.
 12. **[NPS 2-1/2 to NPS 6 (DN 65 to DN 150)]** <Insert pipe size range>: **Type K or L (Type A or B)**, copper tube; grooved-end copper fittings; couplings; and grooved joints.
 13. **[NPS 8 (DN 200)]** <Insert pipe size> and Larger: Schedule 40, **[black] [galvanized]**-steel pipe; grooved-end fittings; couplings; and grooved joints.
 14. **[NPS 8 (DN 200)]** <Insert pipe size> and Larger: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.
 15. **[NPS 8 (DN 200)]** <Insert pipe size>: **Type K or L (Type A or B)**, copper tube; grooved-end copper fittings; couplings; and grooved joints.
- D. Drain Piping: Use[**one of**] the following piping materials for each size range:
1. **[NPS 1 (DN 25)]** <Insert pipe size> and Smaller: **Type M (Type C)** copper tube; copper-push fittings.
 2. **[NPS 2 (DN 50)]** <Insert pipe size> and Smaller: **Type M (Type C)** copper tube; copper pressure-seal-joint fittings.
 3. **[NPS 2 (DN 50)]** <Insert pipe size> and Smaller: **Type M (Type C)** copper tube; wrought-copper fittings; and brazed or soldered joints.

4. [NPS 2 (DN 50)] <Insert pipe size> and Smaller: PVC pipe and fittings; and solvent-cemented joints.

3.2 VALVE APPLICATIONS

- A. 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:
 1. Low-Pressure Compressed Air: Valve types specified for low-pressure compressed air.
 2. High-Pressure Compressed Air: Valve types specified for medium-pressure compressed air.
 3. Equipment Isolation NPS 2 (DN 50) and Smaller: Safety-exhaust, copper-alloy ball valve with exhaust vent and pressure rating at least as great as piping system operating pressure.
 4. Grooved-end valves may be used with grooved-end piping and grooved joints.
- B. 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.
 1. Blue ABS Piping System: Ball and butterfly valves.
 2. Green ABS Piping System: Ball valves.
 3. HDPE Piping System: Ball valves.

3.3 PIPING INSTALLATION

- A. 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.
- B. Install piping concealed from view and protected from physical contact by building occupants, unless otherwise indicated and except in equipment rooms and service areas.
- C. 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.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and to coordinate with other services occupying that space.
- E. Install piping adjacent to equipment and machines to allow service and maintenance.
- F. Install air and drain piping with 1 percent slope downward in direction of flow.
- G. Install nipples, flanges, unions, transition and special fittings, and valves with pressure ratings same as or higher than system pressure rating, unless otherwise indicated.
- H. Equipment and Specialty Flanged Connections:

1. Use steel companion flange with gasket for connection to steel pipe.
 2. 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.
- I. Flanged joints may be used instead of specified joint for any piping or tubing system.
 - J. 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 F 2014.
 - K. Install eccentric reducers where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
 - L. 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.
 - M. 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."
 - N. Install piping to permit valve servicing.
 - O. Install piping free of sags and bends.
 - P. Install fittings for changes in direction and branch connections.
 - Q. Install seismic restraints on piping. Seismic-restraint devices are specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
 - R. 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."
 - S. 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."
 - T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."
- 3.4 JOINT CONSTRUCTION
- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
 - B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
 - C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. 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:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 2. 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.
- D. Welded Joints for Steel Piping: Join according to AWS D10.12/D10.12M.
- E. Brazed Joints for Copper Tubing: Join according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
- F. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Join according to ASTM B 828 or CDA's "Copper Tube Handbook."
- G. Extruded-Tee Outlets for Copper Tubing: Form branches according to ASTM F 2014, with tools recommended by procedure manufacturer, and using operators qualified according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Use asbestos-free, nonmetallic gasket suitable for compressed air. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.
- I. Grooved Joints: Assemble couplings with housing, gasket, lubricant, and bolts. Join according to AWWA C606 for grooved joints. Do not apply lubricant to prelubricated gaskets.
- J. Heat-Fusion Joints for PE Piping: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657 for socket-fusion joints.
- K. Pressure-Sealed Joints: Join with tools recommended by fitting manufacturer, using operators qualified according to Part 1 "Quality Assurance" Article.
- L. Solvent-Cemented Joints for ABS Piping: Clean and dry joining surfaces. Join according to the following:
1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 2. Join according to ASME B31.9 for solvent-cemented joints and to ASTM D 2235 Appendix.
- M. Solvent-Cemented Joints for PVC Piping: Clean and dry joining surfaces. Join according to the following:
1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 2. Apply primer and join according to ASME B31.9 for solvent-cemented joints and to ASTM D 2672.
- N. Dissimilar Metal Piping Material Joints: Use dielectric fittings.

3.5 VALVE INSTALLATION

- A. 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."
- B. Install shutoff valves and unions or flanged joints at compressed-air piping to air compressors.
- C. Install shutoff valve at inlet to each automatic drain valve, filter, lubricator, and pressure regulator.
- D. Install check valves to maintain correct direction of compressed-air flow to and from compressed-air piping specialties and equipment.

3.6 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. [NPS 2 (DN 50)] <Insert pipe size> and Smaller: Use dielectric unions.
- C. [NPS 2-1/2 to NPS 4 (DN 65 to DN 100)] <Insert pipe size range>: Use dielectric flanges.
- D. [NPS 5 (DN 125)] <Insert pipe size> and Larger: Use dielectric flange kits.

3.7 FLEXIBLE PIPE CONNECTOR INSTALLATION

- A. Install flexible pipe connectors in discharge piping[**and in inlet air piping from remote air-inlet filter**] of each air compressor.
- B. Install bronze-hose flexible pipe connectors in copper compressed-air tubing.
- C. Install stainless-steel-hose flexible pipe connectors in steel compressed-air piping.

3.8 SPECIALTY INSTALLATION

- A. Install safety valves on receivers in quantity and size to relieve at least the capacity of connected air compressors.
- B. Install air-main pressure regulators in compressed-air piping at or near air compressors.
- C. Install air-line pressure regulators in branch piping to equipment[**and tools**].
- D. Install automatic drain valves on aftercoolers, receivers, and dryers. Discharge condensate onto nearest floor drain.
- E. Install coalescing filters in compressed-air piping at or near air compressors and upstream from mechanical filters.[**Mount on wall at locations indicated.**]

- F. Install mechanical filters in compressed-air piping at or near air compressors and downstream from coalescing filters.[**Mount on wall at locations indicated.**]
- G. Install air-line lubricators in branch piping to machine tools.[**Mount on wall at locations indicated.**]
- H. Install quick couplings at piping terminals for hose connections.
- I. Install hose assemblies at hose connections.

3.9 CONNECTIONS

- A. Install unions, in piping **NPS 2 (DN 50)** and smaller, adjacent to each valve and at final connection to each piece of equipment and machine.
- B. Install flanges, in piping **NPS 2-1/2 (DN 65)** and larger, adjacent to flanged valves and at final connection to each piece of equipment and machine.

3.10 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.
- B. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.
- C. Vertical Piping: MSS Type 8 or 42, clamps.
- D. Individual, Straight, Horizontal Piping Runs:
 - 1. **100 Feet (30 m)** or Less: MSS Type 1, adjustable, steel clevis hangers.
 - 2. **Longer Than 100 Feet (30 m):** MSS Type 43, adjustable roller hangers.
- E. Multiple, Straight, Horizontal Piping Runs **100 Feet (30 m)** or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
- F. Base of Vertical Piping: MSS Type 52, spring hangers.
- G. Support horizontal piping within [**12 inches (300 mm)**] <Insert dimension> of each fitting and coupling.
- H. Rod diameter may be reduced 1 size for double-rod hangers, with **3/8-inch (10-mm)** minimum rods.
- I. Install hangers for Schedule 40, steel piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. **NPS 1/4 to NPS 1/2 (DN 8 to DN 15): 96 inches (2400 mm)** with **3/8-inch (10-mm)** rod.
 - 2. **NPS 3/4 to NPS 1-1/4 (DN 20 to DN 32): 84 inches (2100 mm)** with **3/8-inch (10-mm)** rod.

3. NPS 1-1/2 (DN 40): 12 feet (3.7 m) with 3/8-inch (10-mm) rod.
 4. NPS 2 (DN 50): 13 feet (4 m) with 3/8-inch (10-mm) rod.
 5. NPS 2-1/2 (DN 65): 14 feet (4.3 m) with 1/2-inch (13-mm) rod.
 6. NPS 3 (DN 80): 15 feet (4.6 m) with 1/2-inch (13-mm) rod.
 7. NPS 3-1/2 (DN 90): 16 feet (4.9 m) with 1/2-inch (13-mm) rod.
 8. NPS 4 (DN 100): 17 feet (5.2 m) with 5/8-inch (16-mm) rod.
 9. NPS 5 (DN 125): 19 feet (5.8 m) with 5/8-inch (16-mm) rod.
 10. NPS 6 (DN 150): 21 feet (6.4 m) with 3/4-inch (19-mm) rod.
 11. NPS 8 (DN 200): 24 feet (7.3 m) with 3/4-inch (19-mm) rod.
 12. NPS 10 (DN 250): 26 feet (7.9 m) with 7/8-inch (22-mm) rod.
 13. NPS 12 (DN 300): 30 feet (9.1 m) with 7/8-inch (22-mm) rod.
- J. Install supports for vertical, Schedule 40, steel piping every 15 feet (4.6 m).
- K. Install hangers for Schedule 5, steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1/2 (DN 15): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
 2. NPS 3/4 (DN 20): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
 3. NPS 1 (DN 25): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
 4. NPS 1-1/4 (DN 32): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
 5. NPS 1-1/2 (DN 40): 10 feet (3 m) with 3/8-inch (10-mm) rod.
 6. NPS 2 (DN 50): 11 feet (3.4 m) with 3/8-inch (10-mm) rod.
- L. Install supports for vertical, Schedule 5, steel piping every 10 feet (3 m).
- M. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1/4 (DN 8): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
 2. NPS 3/8 and NPS 1/2 (DN 10 and DN 15): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
 3. NPS 3/4 (DN 20): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
 4. NPS 1 (DN 25): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
 5. NPS 1-1/4 (DN 32): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
 6. NPS 1-1/2 (DN 40): 10 feet (3 m) with 3/8-inch (10-mm) rod.
 7. NPS 2 (DN 50): 11 feet (3.4 m) with 3/8-inch (10-mm) rod.
 8. NPS 2-1/2 (DN 65): 13 feet (4 m) with 1/2-inch (13-mm) rod.
 9. NPS 3 (DN 80): 14 feet (4.3 m) with 1/2-inch (13-mm) rod.
 10. NPS 3-1/2 (DN 90): 15 feet (4.6 m) with 1/2-inch (13-mm) rod.
 11. NPS 4 (DN 100): 16 feet (4.9 m) with 1/2-inch (13-mm) rod.
 12. NPS 5 (DN 125): 18 feet (5.5 m) with 1/2-inch (13-mm) rod.
 13. NPS 6 (DN 150): 20 feet (6 m) with 5/8-inch (16-mm) rod.
 14. NPS 8 (DN 200): 23 feet (7 m) with 3/4-inch (19-mm) rod.
- N. Install supports for vertical copper tubing every 10 feet (3 m).
- O. Install vinyl-coated hangers for ABS piping with the following maximum horizontal spacing and minimum rod diameters:

1. All Sizes: Install continuous support for piping with compressed air at normal operating temperature above [**100 deg F (38 deg C)**] <Insert temperature>.
 2. **NPS 3/8 and NPS 1/2 (DN 10 and DN 15): 30 inches (760 mm)** with **3/8-inch (10-mm)** rod.
 3. **NPS 3/4 (DN 20): 38 inches (975 mm)** with **3/8-inch (10-mm)** rod.
 4. **NPS 1 (DN 25): 40 inches (1015 mm)** with **3/8-inch (10-mm)** rod.
 5. **NPS 1-1/4 (DN 32): 45 inches (1140 mm)** with **3/8-inch (10-mm)** rod.
 6. **NPS 1-1/2 (DN 40): 52 inches (1330 mm)** with **3/8-inch (10-mm)** rod.
 7. **NPS 2 (DN 50): 58 inches (1470 mm)** with **3/8-inch (10-mm)** rod.
 8. **NPS 3 (DN 80): 68 inches (1730 mm)** with **1/2-inch (13-mm)** rod.
 9. **NPS 4 (DN 100): 76 inches (1900 mm)** with **1/2-inch (13-mm)** rod.
- P. Install supports for vertical ABS piping every **48 inches (1220 mm)**.
- Q. Install vinyl-coated hangers for HDPE piping with the following maximum horizontal spacing and minimum rod diameters:
1. All Sizes: Install continuous support for piping with compressed air at normal operating temperature above [**100 deg F (38 deg C)**] <Insert temperature>.
 2. **NPS 1/2 (DN 15): 30 inches (760 mm)** with **3/8-inch (10-mm)** rod.
 3. **NPS 3/4 (DN 20): 35 inches (890 mm)** with **3/8-inch (10-mm)** rod.
 4. **NPS 1 (DN 25): 40 inches (1015 mm)** with **3/8-inch (10-mm)** rod.
 5. **NPS 1-1/4 (DN 32): 43 inches (1090 mm)** with **3/8-inch (10-mm)** rod.
 6. **NPS 1-1/2 (DN 40): 49 inches (1245 mm)** with **3/8-inch (10-mm)** rod.
 7. **NPS 2 (DN 50): 55 inches (1400 mm)** with **3/8-inch (10-mm)** rod.
 8. **NPS 3 and NPS 4 (DN 80 and DN 100): 96 inches (2440 mm)** with **1/2-inch (13-mm)** rod.
- R. Install supports for vertical HDPE piping every **48 inches (1220 mm)**.
- 3.11 LABELING AND IDENTIFICATION
- A. 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."
- 3.12 FIELD QUALITY CONTROL
- A. Perform field tests and inspections.
- B. Tests and Inspections:
1. 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 (345 kPa)** above system operating pressure, but not less than [**150 psig (1035 kPa)**] <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.
 2. 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 (43 deg C) or less, to pressure of [40 psig (275 kPa)] <Insert pressure> above system operating pressure, but not less than [80 psig (550 kPa)] [100 psig (690 kPa)] <Insert pressure> or more than 120 psig (825 kPa). 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.
3. 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 (38 deg C) or less, to pressure of [40 psig (275 kPa)] <Insert pressure> above system operating pressure, but not less than [100 psig (690 kPa)] [125 psig (860 kPa)] [150 psig (1035 kPa)] <Insert pressure> or more than 180 psig (1240 kPa). 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.
 4. Repair leaks and retest until no leaks exist.
 5. Inspect [filters] [lubricators] [and] [pressure regulators] for proper operation.
- C. Prepare test reports.

END OF SECTION 221513