SECTION 221513 - GENERAL-SERVICE COMPRESSED GASES AND VACUUM PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes piping and related specialties for general-service compressed-air, nitrogen, argon, and vacuum systems, as follows:

1. Pipes, tubes, and fittings.
2. Joining materials.
3. Valves.
4. Dielectric fittings.
5. Flexible pipe connectors.
6. Specialties.
7. Quick couplings.
8. Hose assemblies.

B. Related Requirements:

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

1.2 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. HDPE: High-density polyethylene plastic.

D. High-Pressure, Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures between 150 and 200 psig.

E. Low-Pressure, Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures of 150 psig or less.

F. NBR: Nitrile butadiene rubber.

G. PE: Polyethylene plastic.

1.3 ACTION SUBMITTALS

A. Product Data:

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.

1.4 INFORMATIONAL SUBMITTALS

A. Certificates:

1. Brazing and welding certificates.

B. Field Quality-Control Submittals:

1. Field quality-control reports.

C. Qualification Statements: For Installer.

1.5 CLOSEOUT SUBMITTALS

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

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

1. Extruded-Tee Outlet Procedure: Qualify operators according to training provided by respective manufacturer, for making branch outlets.
2. Press-Seal Joining Procedure for Copper Tubing: Qualify operators according to training provided by respective manufacturer.
3. Pressure-Seal Joining Procedure for Steel Piping. Qualify operators according to training provided by respective manufacturer.
4. Joining Procedures for Aluminum Piping Systems: Qualify installers according to training provided by respective manufacturer.

B. Brazing: Qualify processes and operators in accordance with ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or with AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

C. Welding: Qualify processes and operators in accordance with ASME Boiler and Pressure Vessel Code: Section IX.

1.7 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 Owner no fewer than five days in advance of proposed interruption of compressed-air service.
2. Do not proceed with interruption of compressed-air service without Owner's written permission.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each product type from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Piping system to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7. See Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

1. The term "withstand" means "the piping system will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
2. Component Importance Factor: 1.0.

B. ASME Compliance:

1. Comply with ASME B31.1, "Power Piping," for high-pressure, compressed-air piping.
2. Comply with ASME B31.3, "Process Piping," for high- and low-pressure, compressed-air piping.
3. Comply with ASME B31.9, "Building Services Piping," for low-pressure, compressed-air piping.

2.3 PIPES, TUBES, AND FITTINGS

A. Schedule 40, Steel Pipe: ASTM A53/A53M, Type E or S, Grade B, black or hot-dip zinc coated with ends threaded in accordance with ASME B1.20.1.

1. Steel Nipples: ASTM A733, made of ASTM A53/A53M or ASTM A106, 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, Threaded: 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.

B. Copper Tube: ASTM B88, Type K or L 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.
2. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150 or 300.
3. Copper Unions: ASME B16.22 or MSS SP-123.
4. Extruded-Tee Outlets: Procedure for making branch outlets in copper tube in accordance with ASTM F2014.

C. 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.

D. Aluminum Piping System: Aluminum pipe, Alloy Grade AA 6035-T5, for push-connect bite ring couplings.

1. 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.
2. Tubing, 14 to 273 mm: Aluminum pipe, Alloy Grade AA 6063-T5.
3. Pipe Coating: Powder-coated paint that is certified nontoxic to AAMA 603 and AAMA 605, blue for compressed air.
4. Provide tubing that is quality controlled to comply with tolerances specified by push-to-connect coupling manufacturer. Tubing manufacturer follows ISO 9001:2000 quality standards.
5. Pipe Identification: Decal with maximum working pressure and temperature on each length of pipe.
6. Push-Connect Bite Ring Couplings, 14 to 63 mm: Solid-brass and nickel-plated body, NBR O-ring seal in excess of 36 percent, and AISI Type 304 stainless steel clamping washer.
7. Fittings: Solid brass and nickel plated.
8. Ball Valves, 20 to 63 mm: NPT ends, or push-connect bite ring ends.
9. Flanges, 73 to 273 mm: ASME B16.5, Class 150.

E. HDPE Piping System: Made of ASTM D1248, 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, PE pipe.

1. Transition Fittings, NPS 1/2 to NPS 2: HDPE adapter with one socket end and one end with threaded brass insert.
2. Transition Fittings, NPS 2-1/2 to NPS 4: HDPE flange, CR gasket, and metal flange of material matching piping to be connected.
3. Valves, NPS 1/2 to NPS 3: HDPE union ball valve with socket ends.

2.4 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 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 B32, lead-free alloys. Include water-flushable flux in accordance with ASTM B813.

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.

2.5 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."

2.6 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. Description:

a. Standard: ASSE 1079.
b. Pressure Rating: 150 psig.
c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Description:

a. Standard: ASSE 1079.
b. Factory-fabricated, bolted, companion-flange assembly.
c. Pressure Rating: 150 psig.
d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Description:

a. Nonconducting materials for field assembly of companion flanges.
b. Pressure Rating: 150 psig.
c. Gasket: Neoprene or phenolic.
d. Bolt Sleeves: Phenolic or polyethylene.
e. Washers: Phenolic with steel backing washers.

2.7 FLEXIBLE PIPE CONNECTORS

A. 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 minimum.
2. End Connections, NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
3. End Connections, NPS 2-1/2 and Larger: Flanged copper alloy.

B. 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 minimum.
2. End Connections, NPS 2 and Smaller: Threaded steel pipe nipple.
3. End Connections, NPS 2-1/2 and Larger: Flanged steel nipple.

2.8 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.

B. Air-Main Pressure Regulators: Bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 250 psig inlet pressure, unless otherwise indicated.

1. Type: Pilot operated.

C. Air-Line Pressure Regulators, Bronze Body: Diaphragm or pilot operated, bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 200 psig minimum inlet pressure, unless otherwise indicated.

D. Air-Line Pressure Regulators, Aluminum Alloy or Plastic Body: Diaphragm operated, aluminum alloy or plastic body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 200 psig minimum inlet pressure, unless otherwise indicated.

E. Automatic Drain Valves: Stainless steel body and internal parts, rated for 200 psig 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, air-line filters. Equip with deflector plates, resin-impregnated-ribbon 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 airstream; 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.

2.9 QUICK COUPLINGS

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

B. 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 or Straight-through type with barbed outlet for attaching hose.

C. 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.

2.10 HOSE ASSEMBLIES

A. Description: Compatible hose, clamps, couplings, and splicers suitable for compressed-air service, of nominal diameter indicated, and rated for 300 psig minimum working pressure, unless otherwise indicated.

1. Hose: Reinforced single- or 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 and Smaller, Threaded: Schedule 40, black or galvanized-steel pipe; threaded, malleable-iron fittings; and threaded joints.
2. NPS 2 and Smaller, Welded: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.
3. NPS 2 and Smaller, Brazed: Type K or L, copper tube; wrought-copper fittings; and brazed joints.
4. NPS 2-1/2 to NPS 4, Threaded: Schedule 40, black or galvanized-steel pipe; threaded, malleable-iron fittings; and threaded joints.
5. NPS 2-1/2 to NPS 4, Welded: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.
6. NPS 2-1/2 to NPS 4, Brazed: Type K or L, copper tube; wrought-copper fittings; and brazed joints.
7. NPS 5 and Larger, Threaded: Schedule 40, black or galvanized-steel pipe; threaded, malleable-iron fittings; and threaded joints.
8. NPS 5 and Larger, Welded: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.

B. Low-Pressure Compressed-Air Distribution Piping: Use one of the following piping materials for each size range:

1. NPS 2 and Smaller, Threaded: Schedule 40, black or galvanized-steel pipe; threaded, malleable-iron fittings; and threaded joints.
2. NPS 2 and Smaller, Welded: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.
3. NPS 2 and Smaller, Brazed: Type K or L, copper tube; wrought-copper fittings; and brazed joints.
4. NPS 2-1/2 to NPS 4, Threaded: Schedule 40, black or galvanized-steel pipe; threaded, malleable-iron fittings; and threaded joints.
5. NPS 2-1/2 to NPS 4, Welded: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.
6. NPS 2-1/2 to NPS 4, Brazed: Type K or L, copper tube; wrought-copper fittings; and brazed joints.
7. NPS 5 and Larger, Threaded: Schedule 40, black or galvanized-steel pipe; threaded, malleable-iron fittings; and threaded joints.
8. NPS 5 and Larger, Welded: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.

C. High-Pressure Compressed-Air Distribution Piping: Use one of the following piping materials for each size range:

1. NPS 2 and Smaller, Threaded: Schedule 40, black or galvanized-steel pipe; threaded, malleable-iron fittings; and threaded joints.

2. NPS 2 and Smaller, Welded: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.
3. NPS 2 and Smaller, Brazed: Type K or L, copper tube; wrought-copper fittings; and brazed joints.
4. NPS 2-1/2 to NPS 6, Welded: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.
5. NPS 2-1/2 to NPS 4: Type K or L, copper tube; wrought-copper fittings; and brazed or soldered joints.
6. NPS 2-1/2 to NPS 6, Brazed: Type K or L, copper tube; wrought-copper fittings; and brazed joints.

D. Nitrogen, Argon, and Vacuum Piping

1. Nitrogen all sizes: 300 series stainless steel tubing with swagelock fittings.
2. Argon all sizes: 300 series stainless steel tubing with swagelock fittings.
3. Vacuum 1-1/2” and smaller: 300 series stainless steel tubing with swagelock fittings.
4. Vacuum 2” and larger: Schedule 40, black steel pipe; threaded, malleable-iron fittings; and threaded joints.
5. Vacuum 2” and larger: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.

E. Drain Piping: Use one of the following piping materials:

1. NPS 2 and Smaller: Type M copper tube; wrought-copper fittings; and brazed or soldered joints.

3.2 VALVE APPLICATIONS

A. Metal General-Duty Valves: Comply with requirements and use valve types specified in "Valve Applications" Article 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 high-pressure compressed air.
3. Equipment Isolation NPS 2 and Smaller: Safety-exhaust, copper-alloy ball valve with exhaust vent and pressure rating at least as great as piping system operating pressure.

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

1. Ball Valves, NPS 2 and Smaller: NPT ends, or push-connect bite ring ends.
2. Butterfly Valves, NPS 2-1/2 and Larger: NPT ends, or push-connect bite ring ends.

C. 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. HDPE Piping System: Ball valves.

3.3 INSTALLATION OF PIPING, GENERAL

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. Where installing piping adjacent to equipment and machines, allow space for 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. 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, in accordance with Extruded Tee Connections Sizes and Wall Thickness for Copper Tube (Inches) Table in ASTM F2014.

J. Install eccentric reducers where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.

K. 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.

L. Install pressure gauge on discharge piping from each air compressor and on each receiver. Comply with requirements in Section 220519 "Meters and Gages for Plumbing Piping."

M. Install piping to permit valve servicing.

N. Install piping free of sags and bends.

O. Install fittings for changes in direction and branch connections.

P. Install seismic restraints on piping. Seismic-restraint devices are specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

Q. 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."

R. 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."

S. 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 in accordance with 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 in accordance with AWS D10.12/D10.12M.

E. Brazed Joints for Copper Tubing: Join in accordance with AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Join in accordance with ASTM B828 or CDA's "Copper Tube Handbook."

G. Extruded-Tee Outlets for Copper Tubing: Form branches in accordance with ASTM F2014, with tools recommended by procedure manufacturer, and using operators qualified in accordance with "Quality Assurance" Article.

H. Flanged Joints: Use asbestos-free, nonmetallic gasket suitable for compressed air. Join flanges with gasket and bolts in accordance with ASME B31.9 for bolting procedure.

I. Heat-Fusion Joints for PE Piping: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join in accordance with ASTM D2657 for socket-fusion joints.

J. Dissimilar Metal Piping Material Joints: Use dielectric fittings.

3.5 INSTALLATION OF VALVES

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."

3.6 INSTALLATION OF DIELECTRIC FITTINGS

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. NPS 2 and Smaller: Use dielectric unions.

C. NPS 2-1/2 to NPS 4: Use dielectric flanges.

D. NPS 5and Larger: Use dielectric flange kits.

3.7 INSTALLATION OF FLEXIBLE PIPE CONNECTORS

A. Install flexible pipe connectors in discharge piping 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 INSTALLATION OF SPECIALTIES

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 mechanical filters in compressed-air piping at or near air compressors and downstream from coalescing filters. Mount on wall at locations indicated.

E. Install air-line lubricators in branch piping to machine tools. Mount on wall at locations indicated.

F. Install quick couplings at piping terminals for hose connections.

G. Install hose assemblies at hose connections.

3.9 PIPING CONNECTIONS

A. Install unions, in piping NPS 2 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 and larger, adjacent to flanged valves and at final connection to each piece of equipment and machine.

3.10 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

B. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for hangers, supports, and anchor devices.

C. Install hangers for copper tubing and steel piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Install hangers for HDPE and aluminum piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support horizontal piping within 12 inches of each fitting and coupling.

F. Support vertical runs of copper tubing and steel piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

G. Support vertical runs of HDPE and aluminum piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

H. Individual, Straight, Horizontal Piping Runs:

1. 100 Ft. or Less: MSS Type 1, adjustable, steel clevis hangers.
2. Longer Than 100 Ft.: MSS Type 43, adjustable roller hangers.

I. Multiple, Straight, Horizontal Piping Runs 100 Ft. or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

J. Base of Vertical Piping: MSS Type 52, spring hangers.

K. Install vinyl-coated hangers for HDPE piping.

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, Gas, and Vacuum 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. 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 Aluminum Compressed-Air, Gas, and Vacuum 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.
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 or less, to pressure of 40 psig above system operating pressure, but not less than 100 psig 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.
4. Repair leaks and retest until no leaks exist.
5. Inspect filters lubricators and pressure regulators for proper operation.

C. Prepare test and inspection reports.

END OF SECTION 221513