

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and Division 00 and 01, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Medical compressed-air piping, designated "medical air."
2. Dental compressed-air piping, designated "dental air."
3. Gas-powered-tool compressed-air piping, designated "instrument air."
4. Healthcare laboratory compressed-air piping, designated "medical laboratory air."
5. Compressed-air piping and specialties for nonmedical laboratory facilities, designated "laboratory air."

- B. Related Requirements:

1. Division 22.

1.3 DEFINITIONS

- A. Medical compressed-air piping systems include medical air, dental air, instrument air, and medical laboratory air.
- B. Nonmedical compressed-air piping systems include laboratory air piping systems.

1.4 CODES AND STANDARDS

- A. Codes and Standards shall be the current version adopted by the Authority Having Jurisdiction.

1.5 SUBMITTALS

- A. General: See Division 23 for general requirements of Product Data, Shop Drawings, Reports and Certificates, and Operation and Maintenance data submittals.
- B. Product Data: For each type of product.
- C. Qualification Data: For [Installer] [and] [testing agency].
- D. Seismic Qualification Certificates: For medical compressed-air manifolds, accessories, and components, from manufacturer.
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

- E. Material Certificates: Signed by Installer certifying that medical compressed-air piping materials comply with requirements in NFPA 99 for positive-pressure medical gas systems.
- F. Brazing certificates.
- G. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

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

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Quick-Coupler Service Connections: Furnish complete noninterchangeable medical compressed-air pressure outlets.
 - a. Medical Air: Equal to <Insert number> percent of amount installed, but no fewer than <Insert number> units.
 - b. Instrument Air: Equal to <Insert number> percent of amount installed, but no fewer than <Insert number> units.
 - 2. D.I.S.S. Service Connections: Furnish complete medical compressed-air pressure outlets complying with CGA V-5.
 - a. Medical Air D.I.S.S. No. 1160: Equal to <Insert number> percent of amount installed, but no fewer than <Insert number> units.
 - b. Instrument Air D.I.S.S. No. 1160: Equal to <Insert number> percent of amount installed, but no fewer than <Insert number> units.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Medical Air Piping Systems for Healthcare Facilities: According to ASSE Standard #6010 for medical-gas-system installers.
 - 2. Shape-Memory-Metal Coupling Joints: An authorized representative who is trained and approved by manufacturer.
- B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum piping testing indicated, that is [a member of the Medical Gas Professional Healthcare Organization or is] an NRTL, and that is acceptable to authorities having jurisdiction.
 - 1. Qualify testing personnel according to ASSE Standard #6020 for medical-gas-system inspectors and ASSE Standard #6030 for medical-gas-system verifiers.
- C. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications"; or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

PART 2 – PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Medical air operating at [50 to 55 psig] <Insert values>.
- B. Dental air operating at [80 to 100 psig] <Insert values>.
- C. Instrument air operating at [175 psig] <Insert value>.
- D. Medical laboratory air operating at [100 psig] <Insert value>.
- E. Laboratory air operating at [50 psig] [100 psig] [125 psig] <Insert value>.

2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Medical compressed-air manifolds shall withstand the effects of earthquake motions determined according to [ASCE/SEI 7] <Insert requirement>.
 - 1. The term "withstand" means "the manifold will remain in place without separation of any parts when subjected to the seismic forces specified [and the manifold will be fully operational after the seismic event]."
 - 2. Component Importance Factor is [1.5] [1.0].
 - 3. <Insert requirements for Component Amplification Factor and Component Response Modification Factor>.

2.3 PIPES, TUBES, AND FITTINGS

- A. Comply with NFPA 99 for medical air piping materials.
- B. Comply with ASME B31.1, "Power Piping," for laboratory air piping operating at more than 150 psig.
- C. Comply with ASME B31.9, "Building Services Piping," for laboratory air piping operating at 150 psig or less.
- D. Copper Medical Gas Tube: ASTM B 819, [Type K] [and] [Type L], seamless, drawn temper, that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube and in blue for Type L tube.
- E. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type that has been manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.
- F. Copper Unions: ASME B16.22 or MSS SP-123, wrought-copper or cast-copper alloy.
- G. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150.
 - 1. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness, full-face type.
 - 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.

H. Shape-Memory-Metal Couplings:

1. Description: Cryogenic compression fitting made of nickel-titanium, shape-memory alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.

I. Flexible Pipe Connectors:

1. Description: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
 - a. Working-Pressure Rating: [200 psig] [250 psig] minimum.
 - b. End Connections: Plain-end copper tube.

2.4 JOINING MATERIALS

- A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.
- B. Threaded-Joint Tape: PTFE.

2.5 VALVES

- A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
- B. Zone-Valve Box Assemblies: Box with medical gas valves, tube extensions, and gages.
 1. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with vacuum gages and in sizes required to permit manual operation of valves.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Allied Healthcare Products, Inc.; Chemetron Div.
 - 2) Allied Healthcare Products, Inc.; Oxequip Health Industries.
 - 3) Amico Corporation.
 - 4) BeaconMedaes.
 - 5) Squire-Cogswell/Aeros Instruments, Inc.
 - 6) Or Approved Equal.
 - b. Interior Finish: Factory-applied white enamel.
 - c. Cover Plate: [Aluminum or extruded-anodized aluminum] [Satin-chrome finish steel] [Stainless steel with NAAMM AMP 503, No. 4 finish] with frangible or removable windows.
 - d. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.
 2. Zone Valve Boxes: Formed or extruded aluminum with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with vacuum gages and in sizes required to permit manual operation of valves.

- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Tri-Tech Medical.
 - 2) Or Approved Equal.
 - b. Interior Finish: Factory-applied white enamel.
 - c. Cover Plate: [Aluminum or extruded-anodized aluminum] [Stainless steel with NAAMM AMP 503, No. 4 finish] with frangible or removable windows.
 - d. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.
- C. Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Healthcare Products, Inc.; Chemetron Div.
 - b. Allied Healthcare Products, Inc.; Oxequip Health Industries.
 - c. Amico Corporation.
 - d. BeaconMedaes.
 - e. Conbraco Industries, Inc.
 - f. NIBCO INC.
 - g. Squire-Cogswell/Aeros Instruments, Inc.
 - h. Tri-Tech Medical.
 - i. Or Approved Equal.
 2. Pressure Rating: 300 psig minimum.
 3. Ball: Full-port, chrome-plated brass.
 4. Seats: PTFE or TFE.
 5. Handle: Lever [type with locking device].
 6. Stem: Blowout proof with PTFE or TFE seal.
 7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- D. Check Valves: In-line pattern, bronze.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Healthcare Products, Inc.; Chemetron Div.
 - b. Amico Corporation.
 - c. BeaconMedaes.
 - d. Conbraco Industries, Inc.
 - e. Squire-Cogswell/Aeros Instruments, Inc.
 - f. Tri-Tech Medical.
 - g. Or Approved Equal.
 2. Pressure Rating: 300 psig minimum.
 3. Operation: Spring loaded.
 4. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- E. Safety Valves:

1. Bronze body.
2. ASME-construction, poppet, pressure-relief type.
3. Settings to match system requirements.

F. Pressure Regulators:

1. Bronze body and trim.
2. Spring-loaded, diaphragm-operated, relieving type.
3. Manual pressure-setting adjustment.
4. Rated for [250-psig] <Insert value> minimum inlet pressure.
5. Capable of controlling delivered air pressure within 0.5 psig for each 10-psig inlet pressure.

2.6 MEDICAL COMPRESSED-AIR SERVICE CONNECTIONS

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

1. Allied Healthcare Products, Inc.; Chemetron Div.
2. Allied Healthcare Products, Inc.; Oxequip Health Industries.
3. Amico Corporation.
4. BeaconMedaes.
5. Squire-Cogswell/Aeros Instruments, Inc.
6. Tri-Tech Medical.
7. Or Approved Equal.

B. Connection Devices: For specific medical compressed-air pressure and service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.

1. Roughing-in Assembly:

- a. Steel outlet box for recessed mounting and concealed piping.
- b. Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed.
- c. Double seals that will prevent air leakage.
- d. ASTM B 819, NPS 3/8 copper outlet tube brazed to valve with service marking and tube-end dust cap.

2. Finishing Assembly:

- a. Brass housing with primary check valve.
- b. Double seals that will prevent air leakage.
- c. Cover plate with gas-service label.

3. Quick-Coupler Service Connections: Pressure outlet with noninterchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.

4. D.I.S.S. Service Connections: Pressure outlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.

- a. Medical Air Service Connections: CGA V-5, D.I.S.S. No. 1160.
 - b. Instrument Air Service Connections: CGA V-5, D.I.S.S. No. 1160.
5. Cover Plates: One piece, [stainless steel, with NAAMM AMP 503, No. 4 finish] [metal, with chrome-plated finish] [anodized aluminum] and permanent, color-coded, identifying label matching corresponding service.

2.7 MEDICAL COMPRESSED-AIR PRESSURE CONTROL PANELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Allied Healthcare Products, Inc.; Chemetron Div.
 2. Amico Corporation.
 3. BeaconMedaes.
 4. Or Approved Equal.
- B. Description: Steel box and support brackets for recessed roughing in with stainless-steel or anodized-aluminum cover plate with printed operating instructions. Include manifold assembly consisting of inlet supply valve, inlet supply pressure gage, line-pressure control regulator, outlet supply pressure gage, D.I.S.S. service connection, and piping outlet for remote service connection.
1. Minimum Working Pressure: [200 psig] <Insert pressure>.
 2. Line-Pressure Control Regulator: Self-relieving diaphragm type with precision manual adjustment.
 3. Pressure Gages: 0- to 300-psig range.
 4. Service Connection: CGA V-5, D.I.S.S. No. 1160, instrument air outlet.
 5. Before final assembly, provide temporary dust shield and U-tube for testing.
 6. Label cover plate "Air Pressure Control."

2.8 MEDICAL COMPRESSED-AIR MANIFOLDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Allied Healthcare Products, Inc.; Chemetron Div.
 2. Allied Healthcare Products, Inc.; Oxequip Health Industries.
 3. Amico Corporation.
 4. BeaconMedaes.
 5. Squire-Cogswell/Aeros Instruments, Inc.
 6. Tri-Tech Medical.
 7. Or Approved Equal.
- B. Comply with NFPA 99, Chapter 5 "Manifolds for Gas Cylinders without Reserve Supply."
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Central Control-Panel Unit:
1. Weatherproof cabinet.

2. Supply and delivery pressure gages.
 3. Electrical alarm-system connections and transformer.
 4. Indicator lights or devices.
 5. Manifold connection.
 6. Pressure changeover switch.
 7. Line-pressure regulator.
 8. Shutoff valves.
 9. Safety valve.
- E. Manifold and Headers:
1. Duplex, nonferrous-metal header for number of cylinders indicated, divided into two equal banks.
 2. Designed for 2000-psig minimum inlet pressure.
 3. Cylinder-bank headers with inlet (pigtail) connections complying with CGA V-1.
 4. Individual inlet check valves, shutoff valve, pressure regulator, check valve, and pressure gage.
- F. Compressed-Air Cylinders: [Will be furnished by Owner] [Number and type of compressed-air cylinders required for complete manifold systems].
- G. Operation: Automatic, pressure-switch-activated changeover from one cylinder bank to the other when first bank becomes exhausted, without line-pressure fluctuation or resetting of regulators and without supply interruption by shutoff of either cylinder-bank header.
- H. Mounting: [Wall with mounting brackets for manifold control cabinet and headers] [Floor with support legs for manifold control cabinet].
- I. Label manifold control unit with permanent label identifying compressed air and system operating pressure.
- J. Medical Air Manifolds: For [four] [eight] <Insert number> cylinders and [55-psig] <Insert value> line pressure.
- K. Instrument Air Manifolds: For [eight] [12] <Insert number> cylinders and [200-psig] <Insert value> minimum line pressure.
- L. Compressed-Air Cylinders: [Furnished by Owner] [Number and type of compressed-air cylinders required for complete manifold systems].

2.9 COMPRESSED-AIR-CYLINDER STORAGE RACKS

- A. Wall Storage Racks: Fabricate racks with chain restraints for upright cylinders as indicated or provide equivalent manufactured wall racks.
- B. Freestanding Storage Racks: Fabricate racks as indicated or provide equivalent manufactured storage racks.

2.10 NITROGEN

- A. Comply with USP 32 - NF 27 for oil-free dry nitrogen.

PART 3 – EXECUTION

3.1 PREPARATION

- A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing is not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:
 - 1. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1.
 - 2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb. of chemical to 3 gal. of water.
 - a. Scrub to ensure complete cleaning.
 - b. Rinse with clean, hot water to remove cleaning solution.

3.2 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. Comply with NFPA 99 for installation of compressed-air piping.
- C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
- F. Install piping adjacent to equipment and specialties to allow service and maintenance.
- G. Install compressed-air piping with 1 percent slope downward in direction of flow.
- H. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications specified in "Piping Schedule" Article unless otherwise indicated.
- I. Install eccentric reducers, if available, where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
- J. 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.
- K. Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver. Comply with requirements in Division 22.

- L. Install piping to permit valve servicing.
- M. Install piping free of sags and bends.
- N. Install fittings for changes in direction and for branch connections.
- O. Install medical air piping to medical air service connections specified in this Section, to medical air service connections in equipment specified in Division 22 and to equipment specified in other Divisions requiring medical air service.
- P. Piping Restraint Installation: Install seismic restraints on compressed-air piping. Seismic-restraint devices are specified in Division 22.
- Q. Install compressed-air service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
- R. Connect compressed-air piping to air compressors and to compressed-air outlets and equipment requiring compressed-air service.
- S. Install unions in copper compressed-air tubing adjacent to each valve and at final connection to each machine, specialty, and piece of equipment.
- T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22.
- U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22.

3.3 VALVE INSTALLATION

- A. Install shutoff valve at each connection to and from compressed-air equipment and specialties.
- B. Install check valves to maintain correct direction of compressed-air flow from compressed-air equipment.
- C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
- D. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.
- E. Install pressure regulators on compressed-air piping where reduced pressure is required.
- F. Install flexible pipe connectors in discharge piping [and in inlet air piping from remote air-inlet filter] of each air compressor.

3.4 JOINT CONSTRUCTION

- A. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
- B. Threaded Joints: Apply appropriate tape to external pipe threads.

- C. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" chapter. Continuously purge joint with oil-free dry nitrogen during brazing.
- D. Flanged Joints: Install flange on copper tubes. Use pipe-flange gasket between flanges. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.
- E. Shape-Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of shape-memory-metal coupling joints.

3.5 COMPRESSED-AIR SERVICE COMPONENT INSTALLATION

- A. Install compressed-air pressure control panel in walls. Attach to substrate.
- B. Install compressed-air manifolds [on concrete base] anchored to substrate.
- C. Install compressed-air cylinders and connect to manifold piping.
- D. Install compressed-air manifolds with seismic restraints as indicated.
- E. Install compressed-air-cylinder wall storage racks attached to substrate.

3.6 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Division 22 for seismic-restraint devices.
- B. Comply with requirements in Division 22 for pipe hanger and support devices.
- C. Vertical Piping: MSS Type 8 or Type 42, clamps.
- D. Individual, Straight, Horizontal Piping Runs:
 - 1. 100 Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
 - 2. Longer Than 100 Feet: MSS Type 43, adjustable, roller hangers.
- E. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Division 22 for trapeze hangers.
- F. Base of Vertical Piping: MSS Type 52, spring hangers.
- G. Support horizontal piping within [12 inches] <Insert dimension> of each fitting and coupling.
- H. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch- minimum rods.
- I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1/4: 60 inches with 3/8-inch rod.
 - 2. NPS 3/8 and NPS 1/2: 72 inches with 3/8-inch rod.
 - 3. NPS 3/4: 84 inches with 3/8-inch rod.
 - 4. NPS 1: 96 inches with 3/8-inch rod.
 - 5. NPS 1-1/4: 108 inches with 3/8-inch rod.
 - 6. NPS 1-1/2: 10 feet with 3/8-inch rod.

7. NPS 2: 11 feet with 3/8-inch rod.
8. NPS 2-1/2: 13 feet with 1/2-inch rod.
9. NPS 3: 14 feet with 1/2-inch rod.
10. NPS 3-1/2: 15 feet with 1/2-inch rod.
11. NPS 4: 16 feet with 1/2-inch rod.
12. NPS 5: 18 feet with 1/2-inch rod.
13. NPS 6: 20 feet with 5/8-inch rod.
14. NPS 8: 23 feet with 3/4-inch rod.

J. Install supports for vertical copper tubing every 10 feet.

3.7 IDENTIFICATION

- A. Install identifying labels and devices for nonmedical laboratory compressed-air piping, valves, and specialties. Comply with requirements in Division 22.
- B. Install identifying labels and devices for medical compressed-air piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
 1. Medical Air: Black letters on yellow background.
 2. Dental Air: [Black letters on yellow background] <Insert color code>.
 3. Instrument Air: White letters on red background.
 4. Medical Laboratory Air: Black letters on yellow-and-white checkerboard background.

3.8 FIELD QUALITY CONTROL FOR MEDICAL COMPRESSED-AIR PIPING IN HEALTHCARE FACILITIES

- A. Testing Agency: [Owner will engage] [Engage] a qualified testing agency to perform tests and inspections of medical compressed-air piping in healthcare facilities and to prepare test and inspection reports.
- B. Tests and Inspections:
 1. Medical Compressed-Air Testing Coordination: Perform tests, inspections, verifications, and certification of medical compressed-air piping systems concurrently with tests, inspections, and certification of [medical gas piping] [and] [medical vacuum piping] systems.
 2. Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
 - a. Initial blowdown.
 - b. Initial pressure test.
 - c. Cross-connection test.
 - d. Piping purge test.
 - e. Standing pressure test for positive-pressure medical compressed-air piping.
 - f. Repair leaks and retest until no leaks exist.
 3. System Verification: Perform the following tests and inspections according to NFPA 99, ASSE Standard #6020, and ASSE Standard #6030:
 - a. Standing pressure test.
 - b. [Individual-pressurization] [or] [pressure-differential] cross-connection test.

- c. Valve test.
 - d. Master and area alarm tests.
 - e. Piping purge test.
 - f. Piping particulate test.
 - g. Piping purity test.
 - h. Final tie-in test.
 - i. Operational pressure test.
 - j. Medical air purity test.
 - k. Verify correct labeling of equipment and components.
 - 4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
 - a. Inspections performed.
 - b. Procedures, materials, and gases used.
 - c. Test methods used.
 - d. Results of tests.
 - C. Remove and replace components that do not pass tests and inspections and retest as specified above.
- 3.9 FIELD QUALITY CONTROL FOR COMPRESSED-AIR PIPING IN NONMEDICAL LABORATORY FACILITIES
- A. Testing Agency: [Owner will engage] [Engage] qualified testing agency to perform tests and inspections of compressed-air piping in nonmedical laboratory facilities and to prepare test and inspection reports.
 - B. Tests and Inspections:
 - 1. Piping Leak Tests for Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill compressed-air piping with oil-free dry nitrogen to pressure of 50 psig above system operating pressure, but not less than [150 psig] <Insert value>. 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. Repair leaks and retest until no leaks exist.
 - 3. Inspect [filters] [and] [pressure regulators] for proper operation.
 - C. Remove and replace components that do not pass tests and inspections and retest as specified above.
- 3.10 PROTECTION
- A. Protect tubing from damage.
 - B. Retain sealing plugs in tubing, fittings, and specialties until installation.
 - C. Clean tubing not properly sealed, and where sealing is damaged, according to "Preparation" Article.
- 3.11 PIPING SCHEDULE
- A. Connect new tubing to existing tubing with memory-metal couplings.

- B. Flanges may be used where connection to flanged equipment is required.
- C. Medical Air Piping except Instrument Air Piping Larger Than NPS 3 and Operating at More Than 185 psig: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
- D. Instrument Air Piping Larger Than NPS 3 and Operating at More Than 185 psig: Type K, copper tube; wrought-copper fittings; and brazed joints.
- E. Laboratory Air Piping except Laboratory Air Piping Larger Than NPS 3 and Operating at More Than 185 psig: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
- F. Laboratory Air Piping Larger Than NPS 3 and Operating at More Than 185 psig: Type K, copper medical gas tube; wrought-copper fittings; and brazed joints.

3.12 VALVE SCHEDULE

- A. Shutoff Valves: Ball valve with manufacturer-installed ASTM B 819, copper-tube extensions.
- B. Zone Valves: Ball valve with manufacturer-installed ASTM B 819, copper-tube extensions with pressure gage on one copper-tube extension.

END OF SECTION