

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. Carbon dioxide piping, designated "medical carbon dioxide."
2. Helium piping, designated "medical helium."
3. Nitrogen piping, designated "medical nitrogen."
4. Nitrous oxide piping, designated "medical nitrous oxide."
5. Oxygen piping, designated "medical oxygen."
6. <Insert specialty gas> piping, designated "specialty <Insert designation>."

- B. Owner-Furnished Material:

1. Patient-service consoles.
2. Ceiling columns.
3. Ceiling-hose assemblies.
4. Medical gas manifolds.
5. Bulk medical gas storage tanks.
6. <Insert product>.
7. Owner will furnish gases for medical gas concentration testing specified in this Section.

- C. Related Requirements:

1. Division 11.
2. Division 12.
3. Division 22.

1.3 DEFINITIONS

- A. CR: Chlorosulfonated polyethylene synthetic rubber.
- B. Medical gas piping systems include medical carbon dioxide, medical helium, medical nitrogen, medical nitrous oxide, and medical oxygen <Insert other medical and combination gases> for healthcare facility patient care.

1.4 CODES AND STANDARDS

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

1.5 SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Include diagrams for power, signal, and control wiring.

- C. Qualification Data: For [Installer] [and] [testing agency].
- D. Seismic Qualification Certificates: For [gas manifolds] [and] [bulk gas storage tanks], 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 gas piping materials comply with requirements in NFPA 99 for positive-pressure medical gas systems.
- F. Brazing certificates.
- G. Certificates of Shop Inspection and Data Report for Bulk Gas Storage Tanks: As required by ASME Boiler and Pressure Vessel Code.
- H. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For [medical] [and] [specialty] gas 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 gas pressure outlets and suction inlets.
 - a. Medical Carbon Dioxide: Equal to <Insert number> percent of quantity installed, but no fewer than <Insert number> units.
 - b. Medical Nitrous Oxide: Equal to <Insert number> percent of quantity installed, but no fewer than <Insert number> units.
 - c. Medical Oxygen: Equal to <Insert number> percent of quantity installed, but no fewer than <Insert number> units.
 - d. <Insert medical gas>: Equal to <Insert number> percent of quantity installed, but no fewer than <Insert number> units.
 - e. Medical Air: Equal to <Insert number> percent of quantity installed, but no fewer than <Insert number> units.
 - f. Instrument Air: Equal to <Insert number> percent of quantity installed, but no fewer than <Insert number> units.
 - g. Medical Vacuum: Equal to <Insert number> percent of quantity installed, but no fewer than <Insert number> units.
 - h. WAGD: Equal to <Insert number> percent of quantity installed, but no fewer than <Insert number> units.

2. D.I.S.S. Service Connections: Furnish complete medical gas pressure outlets and suction inlets complying with CGA V-5.
 - a. Medical Carbon Dioxide D.I.S.S. No. 1080: Equal to <Insert number> percent of quantity installed, but no fewer than <Insert number> units.
 - b. Medical Helium D.I.S.S. No. 1060: Equal to <Insert number> percent of quantity installed, but no fewer than <Insert number> units.
 - c. Medical Nitrogen D.I.S.S. No. 1120: Equal to <Insert number> percent of quantity installed, but no fewer than <Insert number> units.
 - d. Medical Nitrous Oxide D.I.S.S. No. 1040: Equal to <Insert number> percent of quantity installed, but no fewer than <Insert number> units.
 - e. Medical Oxygen D.I.S.S. No. 1240: Equal to <Insert number> percent of quantity installed, but no fewer than <Insert number> units.
 - f. <Insert medical gas and D.I.S.S. No.>: Equal to <Insert number> percent of quantity installed, but no fewer than <Insert number> units.
 - g. Medical Air D.I.S.S. No. 1160: Equal to <Insert number> percent of quantity installed, but no fewer than <Insert number> units.
 - h. Instrument Air D.I.S.S. No. 1160: Equal to <Insert number> percent of quantity installed, but no fewer than <Insert number> units.
 - i. Medical Vacuum D.I.S.S. No. 1220: Equal to <Insert number> percent of quantity installed, but no fewer than <Insert number> units.
 - j. WAGD D.I.S.S. No. 2220: Equal to <Insert number> percent of quantity installed, but no fewer than <Insert number> units.

1.8 QUALITY ASSURANCE

A. Installer Qualifications:

1. Medical Gas Piping Systems for Healthcare Facilities: According to ASSE Standard #6010 for medical-gas-system installers.
2. Bulk Medical Gas Systems for Healthcare Facilities: According to ASSE Standard #6015 for bulk-medical-gas-system installers.
3. 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 medical gas 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 carbon dioxide operating at [50 to 55 psig] <Insert values>.

- B. Medical helium operating at [50 to 55 psig] <Insert values>.
- C. Medical nitrogen operating at [160 to 185 psig] [higher than 200 psig] <Insert values>.
- D. Medical nitrous oxide operating at [50 to 55 psig] <Insert values>.
- E. Medical oxygen operating at [50 to 55 psig] <Insert values>.
- F. Specialty <Insert designation> operating at [50 to 55 psig] <Insert values>.

2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: [Medical gas manifolds] [and] [bulk medical gas storage tanks] shall withstand the effects of earthquake motions determined according to [ASCE/SEI 7] <Insert requirement>.
 - 1. The term "withstand" means "the [medical gas manifolds] [and] [bulk medical gas storage tanks] will remain in place without separation of any parts when subjected to the seismic forces specified [and the manifolds and tanks 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 gas piping materials.
- B. 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 blue for Type L tube.
- C. 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.
- D. Copper Unions: ASME B16.22 or MSS SP-123, wrought-copper or cast-copper alloy.
- E. 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.
- F. 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.
- G. PVC Pipe: ASTM D 1785, [Schedule 40] [Schedule 80].
- H. PVC Fittings: [ASTM D 2466, Schedule 40] [ASTM D 2467, Schedule 80]; socket type.

2.4 JOINING MATERIALS

- A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.
- B. Threaded-Joint Tape: PTFE.
- C. Solvent Cement for Joining PVC Piping: ASTM D 2564. Include primer complying with ASTM F 656.

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. Emergency Oxygen Connections: Low-pressure oxygen inlet assembly for connection to building oxygen piping systems.
1. Manufacturers:
 - a. Allied Healthcare.
 - b. BeaconMedaes.
 - c. Squire Cogswell.
 - d. Tri-Tech.
 - e. Amico.
 - f. Or Approved Equal.
 2. Enclosure: Weatherproof hinged locking cover with caption similar to "Emergency Low-Pressure Gaseous Oxygen Inlet."

3. Inlet: Manufacturer-installed, NPS 1 or NPS 1-1/4, ASTM B 819, copper tubing with NPS 1 minimum ball valve.
4. Safety Valve: Bronze-body pressure relief valve set at 75 or 80 psig.
5. Instrumentation: Pressure gage.

F. Safety Valves:

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

G. Pressure Regulators:

1. [Bronze] [Stainless-steel] 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 gas pressure within 0.5 psig for each 10-psig inlet pressure.

2.6 MEDICAL GAS SERVICE CONNECTIONS

A. General Requirements for Medical Gas Service Connections:

1. Suitable for specific medical gas pressure and suction service listed.
2. Include roughing-in assemblies, finishing assemblies, and cover plates.
3. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate.
4. Recessed-type units made for concealed piping unless otherwise indicated.

B. Roughing-in Assembly:

1. Steel outlet box for recessed mounting and concealed piping.
2. Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed. Suction inlets to be without secondary valve.
3. Double seals that will prevent gas leakage.
4. ASTM B 819, NPS 3/8 copper outlet tube brazed to valve with service marking and tube-end dust cap.

C. Finishing Assembly:

1. Brass housing with primary check valve.
2. Double seals that will prevent gas leakage.
3. Cover plate with gas-service label.

D. Quick-Coupler Pressure Service Connections: Outlets for [carbon dioxide] [nitrous oxide] [and] [oxygen] <Insert medical gas> 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.

E. Quick-Coupler Pressure Service Connections: Outlets for [medical air] [and] [instrument air] with noninterchangeable keyed indexing to prevent interchange between services, construct

- ed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.
- F. Quick-Coupler Suction Service Connections: Inlets for [medical vacuum] [and] [WAGD] 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.
- G. D.I.S.S. Pressure Service Connections: Outlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.
1. Medical Carbon Dioxide: D.I.S.S. No. 1080.
 2. Medical Helium: D.I.S.S. No. 1060.
 3. Medical Nitrogen: D.I.S.S. No. 1120.
 4. Medical Nitrous Oxide: D.I.S.S. No. 1040.
 5. Medical Oxygen: D.I.S.S. No. 1240.
 6. <Insert medical gas>: <Insert D.I.S.S. No.>.
- H. D.I.S.S. Pressure Service Connections: Outlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.
1. Medical Air: D.I.S.S. No. 1160.
 2. Instrument Air: D.I.S.S. No. 1160.
- I. D.I.S.S. Suction Service Connections: Inlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.
1. Medical Vacuum: D.I.S.S. No. 1220.
 2. WAGD: D.I.S.S. No. 2220.
- J. Cover Plates: One piece, [aluminum] [or] [stainless steel] and permanent, color-coded, identifying label matching corresponding service.

2.7 PATIENT-SERVICE CONSOLES

- A. Patient-Service Consoles <Insert drawing designation>: [Recessed] [Semirecessed] [Surface] mounted.
1. Standard: UL 60601.
 2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 3. General Requirements for Patient-Service Consoles: Wall units with service connections. Include labels indicating services, and the following:
 - a. Steel console box or mounting bracket.
 - b. Concealed supplies.
 - c. Cover: One piece, [aluminum] [plastic] [or] [stainless steel] and permanent identifying label.

- d. Medical gas service connections as specified in "Medical Gas Service Connections" Article.
 - 1) Medical Oxygen: [One] <Insert number> [quick-coupler] [D.I.S.S. No. 1240] pressure outlet(s).
 - 2) Medical Air: [One] <Insert number> [quick-coupler] [D.I.S.S. No. 1160] Quick-coupler pressure outlet(s).
 - 3) Medical Vacuum: [One] <Insert number> [quick-coupler] [D.I.S.S. No. 1220] suction inlet(s).
 - 4) Medical Vacuum Bottle Bracket(s): [One] <Insert number>.
- e. Electrical Service Connections:
 - 1) General Requirements for 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.
 - 2) Power Outlets: UL 498, Hospital Grade, 125-V ac, [single] [duplex] receptacle(s) [; in color selected by Architect]. Include the following configurations complying with NEMA WD 1:
 - a) [One] <Insert number> L5-20R, locking type, 20 A, single or duplex.
 - b) [One] <Insert number> L5-20R, isolated ground, locking type, 20 A, single or duplex.
 - c) <Insert outlet type>.
 - 3) Electrical Accessory Outlets: Provide the following configured receptacles [in color selected by Architect]:
 - a) Patient Equipment Ground Jack: [One] <Insert number>, single pole, 30 A.
 - b) Patient Monitoring: [One] <Insert number>, single, [five] [and] [37] <Insert number> pin.
 - c) <Insert outlet type>.
 - 4) Outlet Cover Plates: One piece, [aluminum] [or] [stainless steel] and permanent identifying label.

2.8 MEDICAL NITROGEN PRESSURE CONTROL PANELS

A. Description:

- 1. Steel box and support brackets for recessed roughing-in with stainless-steel or anodized-aluminum cover plate with printed operating instructions.
- 2. 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.
- 3. Minimum Working Pressure: [200 psig] <Insert value>.
- 4. Line-Pressure Control Regulator: Self-relieving diaphragm type with precision manual adjustment.
- 5. Pressure Gages: 0 to 300 psig.
- 6. Service Connection: CGA V-5, D.I.S.S. No. 1120, nitrogen outlet.
- 7. Before final assembly, provide temporary dust shield and U-tube for testing.
- 8. Label cover plate "Nitrogen Pressure Control."

2.9 CEILING COLUMNS

A. Ceiling Columns <Insert drawing designation>: [Retractable] [Stationary].

1. Standard: UL 60601.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. General Requirements for Ceiling Columns: Ceiling-mounted units with service connections. Include labels indicating services.
4. Ceiling-Mounted Plate: Manufacturer's standard plate or roughing-in assembly.
5. Exposed Surfaces: Minimum 0.0375-inch- thick stainless steel.
6. Servicing: Include access panels or means of removing shroud.
7. Blank cover plates for cutouts not having service connections.
8. ASTM B 819, NPS 3/8 copper-tube extensions for connection to medical gas systems.
9. Service Connections: Type and number indicated.
10. Dust Covers: For medical gas service connections.
11. Description: Manually adjustable using release and lock handles capable of locking column in all positions from fully retracted to fully extended; [15-inch-] <Insert dimension> long, rectangular, counterbalanced, telescoping section with [two] [four] <Insert number> double intravenous medication hooks; and [36-inch-] <Insert dimension> long fixed column section. Include 0.078-inch-thick, stainless-steel bottom plate with medical gas and electrical service connections as required.
12. Description: [44-inch-] <Insert dimension> long, rectangular stationary column section with [two] [four] <Insert number> double intravenous medication hooks. Include 0.078-inch- thick, stainless-steel bottom plate with medical gas and electrical service connections as required.
13. Medical Gas Service Connections: As specified in "Medical Gas Service Connections" Article.
 - a. Medical Carbon Dioxide: [One] <Insert number> [quick-coupler] [D.I.S.S. No. 1080] pressure outlet(s).
 - b. Medical Helium: [One] <Insert number> D.I.S.S. No. 1060 pressure outlet(s).
 - c. Medical Nitrogen: [One] <Insert number> D.I.S.S. No. 1120 pressure outlet(s).
 - d. Medical Nitrous Oxide: [One] <Insert number> [quick-coupler] [D.I.S.S. No. 1040] pressure outlet(s).
 - e. Medical Oxygen: [Two] <Insert number> [quick-coupler] [D.I.S.S. No. 1240] pressure outlets.
 - f. Instrument Air: [One] <Insert number> D.I.S.S. No. 1160 pressure outlet(s).
 - g. Medical Air: [One] <Insert number> [quick-coupler] [D.I.S.S. No. 1160] pressure outlet(s).
 - h. Medical Vacuum: [Two] <Insert number> [quick-coupler] [D.I.S.S. No. 1220] suction inlets.
 - i. Medical Vacuum Bottle Brackets: [Two] <Insert number>.
 - j. WAGD: [One] <Insert number> [quick-coupler] [D.I.S.S. No. 2220] suction inlet(s).
 - k. <Insert medical gas>: <Insert number and type>.
14. Electrical Service Connections:
 - a. General Requirements for 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.

- b. Power Outlets: UL 498, Hospital Grade, 125-V ac, [single] [duplex] receptacle(s) [; in color selected by Architect]. Include the following configurations complying with NEMA WD 1:
 - 1) [One] [Two] <Insert number> L5-20R, locking type, 20 A, single or duplex.
 - 2) [One] [Two] <Insert number> L5-20R, isolated ground, locking type, 20 A, single or duplex.
 - 3) <Insert outlet type>.
 - 4) [One] [Two] <Insert number> explosion proof, 20 A, two pole, three wire, single; suitable for Class I, Group C hazardous location and interchangeable with receptacles used in nonhazardous areas; flush mounted.
 - 5) <Insert outlet type>.
 - 6) [One] [Two] <Insert number> 5-20R, straight blade, 20 A, duplex.
 - 7) [One] [Two] <Insert number> 5-20R, isolated ground, straight blade, 20 A, duplex.
 - 8) <Insert outlet type>.
- c. Electrical Accessory Outlets: Provide the following configured receptacles [in color selected by Architect]:
 - 1) Patient Equipment Ground Jack: [One] <Insert number>, single pole, 30 A.
 - 2) Patient Monitoring: [One] <Insert number>, single, [five] [and] [37] <Insert number> pin.
 - 3) <Insert outlet type>.
- d. Outlet Cover Plates: One piece, [aluminum] [or] [stainless steel] and permanent identifying label.

2.10 CEILING-HOSE ASSEMBLIES

- A. Ceiling-Hose Assemblies <Insert drawing designation>: [Fixed-position, suspended hose] [Hose-reel retractable hose].
 - 1. General Requirements for Ceiling-Hose Assemblies: Ceiling-mounted units with service connections. Include labels indicating services.
 - 2. Ceiling-Mounted Plate: Manufacturer's standard plate or roughing-in assembly.
 - 3. Exposed Surfaces: Minimum 0.0375-inch- thick stainless steel.
 - 4. Servicing: Include access panels or means of removing shroud.
 - 5. Blank cover plates for cutouts not having service connections.
 - 6. ASTM B 819, NPS 3/8 copper-tube extensions for connection to medical gas systems.
 - 7. Service Connections: Type and number indicated.
 - 8. Dust Covers: For medical gas service connections.
 - 9. Description: Individual, concealed, suspended-hose connection with stainless-steel faceplates, steel mounting boxes, factory- or field-fabricated mounting brackets, and color-coded service hoses with retractor device and service connections matching hoses. Include [72 inches] <Insert dimension> of conductive, CR, 1/4- or 5/16-inch ID, medical gas hoses rated for 200-psig minimum working pressure, and medical gas and electrical service-hose connections as required.
 - 10. Description: Individual, concealed, hose reel with retractable hose with stainless-steel faceplates, steel mounting boxes, factory- or field-fabricated mounting brackets, and color-coded service hoses with adjustable stops and service connections matching hoses. Include [15 feet] <Insert dimension> minimum of conductive, CR, 1/4- or 5/16-

inch ID, medical gas hoses rated for 200-psig minimum working pressure, and medical gas and electrical service-hose connections as required.

11. Medical Gas Service Connections: As specified in "Medical Gas Service Connections" Article.
 - a. Medical Carbon Dioxide: [Quick-coupler] [D.I.S.S. No. 1080] pressure outlet.
 - b. Medical Nitrogen: D.I.S.S. No. 1120 pressure outlet.
 - c. Medical Nitrous Oxide: [Quick-coupler] [D.I.S.S. No. 1040] pressure outlet.
 - d. Medical Oxygen: [Quick-coupler] [D.I.S.S. No. 1240] pressure outlet.
 - e. Instrument Air: D.I.S.S. No. 1160 pressure outlet.
 - f. Medical Air: [Quick-coupler] [D.I.S.S. No. 1160] pressure outlet.
 - g. Medical Vacuum: [Quick-coupler] [D.I.S.S. No. 1220] suction inlet.
 - h. WAGD: [Quick-coupler] [D.I.S.S. No. 2220] suction inlet.
 - i. <Insert medical gas>: <Insert number and type>.
12. Electrical Service Connections:
 - a. General Requirements for 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.
 - b. Power Outlets: UL 498, Hospital Grade, 125-V ac, NEMA WD 1, [L5-20R, locking-type, 20-A] [L5-20R, isolated-ground, locking-type, 20-A] single-receptacle configuration.

2.11 MEDICAL GAS MANIFOLDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Acme Cryogenics.
 2. Airgas, Inc.
 3. Air Products and Chemicals, Inc.
 4. BeaconMedaes.
 5. BOC Group, Inc.; BOC Gases.
 6. Linde Gas LLC.
 7. Matheson Tri-Gas.
 8. MG Industries.
 9. Praxair Technology, Inc.
 10. Scott Specialty Gases, Inc.
 11. Spectra Gases, Inc.
 12. Or Approved Equal.
- B. Comply with NFPA 99 for high-pressure medical gas cylinders.
- 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] <Insert value> minimum inlet pressure except nitrous oxide manifolds may be designed for [800 psig] <Insert value> and carbon dioxide manifolds may be designed for [1500 psig] <Insert value>.
 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. 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.
- G. Mounting: [Wall with mounting brackets for manifold control cabinet and headers] [Floor with support legs for manifold control cabinet].
- H. Label manifold control unit with permanent label identifying medical gas type and system operating pressure.
- I. Medical Carbon Dioxide Manifolds: For [two] [four] <Insert number> cylinders and [55-psig] <Insert value> line pressure.
- J. Medical Helium Manifolds: For [two] [four] <Insert number> cylinders and [55-psig] <Insert value> line pressure.
- K. Medical Nitrogen Manifolds: For [eight] [12] <Insert number> cylinders and [180-psig] [higher than 200-psig] <Insert value> line pressure.
- L. Medical Nitrous Oxide Manifolds: For [eight] [12] <Insert number> cylinders and [55-psig] <Insert value> line pressure, with electric heater or orifice design that will prevent freezing during high demand.
- M. Medical Oxygen Manifolds: For [12] [20] <Insert number> cylinders and [55-psig] <Insert value> line pressure.
- N. Medical Gas Cylinders: [Furnished by Owner] [Number and type of medical gas cylinders required for complete manifold systems] <Insert requirement>.

2.12 SIMPLEX SPECIALTY GAS MANIFOLDS

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

2. Airgas, Inc.
 3. Air Products and Chemicals, Inc.
 4. BeaconMedaes.
 5. BOC Group, Inc.; BOC Gases.
 6. Linde Gas LLC.
 7. Matheson Tri-Gas.
 8. MG Industries.
 9. Praxair Technology, Inc.
 10. Scott Specialty Gases, Inc.
 11. Spectra Gases, Inc.
 12. Or Approved Equal.
- B. 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.
- C. Control-Panel Unit: Weatherproof cabinet, supply and delivery pressure gages, electrical alarm-system connections and transformer, indicator lights or devices, manifold connection, line-pressure regulator, shutoff valves, and safety valve.
- D. Manifold and Header: Nonferrous-metal header for number of cylinders indicated. Units include design for [2000-psig] <Insert value> minimum inlet pressure, cylinder-bank header with inlet (pigtail) connections complying with CGA V-1, individual inlet check valves, shutoff valve, pressure regulator, check valve, and pressure gage.
- E. Mounting: [Wall with mounting brackets for manifold control cabinet and header] [Floor with support legs for manifold control cabinet].
- F. Label manifold control unit with permanent label identifying specialty gas type and system operating pressure.
- G. <Insert specialty gas> Manifold: For one cylinder and [55-psig] <Insert value> line pressure, with electric heater or orifice design that will prevent freezing during high demand.
- H. Specialty Gas Cylinders: [Furnished by Owner] [Number and type of specialty gas cylinders required for complete manifold systems] <Insert requirement>.

2.13 DUPLEX SPECIALTY GAS MANIFOLDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Acme Cryogenics.
 2. Airgas, Inc.
 3. Air Products and Chemicals, Inc.
 4. BeaconMedaes.
 5. BOC Group, Inc.; BOC Gases.
 6. Linde Gas LLC.
 7. Matheson Tri-Gas.
 8. MG Industries.
 9. Praxair Technology, Inc.
 10. Scott Specialty Gases, Inc.
 11. Spectra Gases, Inc.

12. Or Approved Equal.

- B. 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.
- C. Central Control-Panel Unit: Weatherproof cabinet, supply and delivery pressure gages, electrical alarm-system connections and transformer, indicator lights or devices, manifold connection, line-pressure regulator, shutoff valves, and safety valve.
- D. Manifold and Headers: Duplex, nonferrous-metal header for number of cylinders indicated, divided into two equal banks. Units include design for [2000-psig] <Insert value> minimum inlet pressure, cylinder-bank headers with inlet (pigtail) connections complying with CGA V-1, individual inlet check valves, shutoff valve, pressure regulator, check valve, and pressure gage.
- E. 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.
- F. Mounting: [Wall with mounting brackets for manifold control cabinet and headers] [Floor with support legs for manifold control cabinet].
- G. Label manifold control unit with permanent label identifying specialty gas type and system operating pressure.
- H. <Insert specialty gas> Manifold: For two cylinders and [55-psig] <Insert value> line pressure, with electric heater or orifice design that will prevent freezing during high demand.
- I. Specialty Gas Cylinders: [Furnished by Owner] [Number and type of specialty gas cylinders required for complete manifold systems] <Insert requirement>.

2.14 BULK MEDICAL GAS STORAGE TANKS

A. General Requirements for Bulk Medical Gas Storage Tanks:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acme Cryogenics.
 - b. Andonian Cryogenics.
 - c. Chart Industries.
 - d. Cryofab.
 - e. Taylor-Wharton; a division of Harsco Corporation.
 - f. Or Approved Equal.
- 2. Comply with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1; and NFPA 99.
- 3. Include bulk storage tank with connections for alarm system, continuous supply, and reserve supply that will operate only during emergencies.
- 4. Controls: Include actuating switch for alarm-system connection and means for automatic actuating of reserve supply.

5. Bulk Medical Gas Storage Tanks: Vertical mounted, double-wall construction with inner vessel fabricated according to ASME Boiler and Pressure Vessel Code for unfired pressure vessels and suitable for medical gas service. Include insulation and vacuum seal between walls. Fabricate outer shell from carbon steel with factory-applied manufacturer's standard protective paint finish suitable for exterior installation. Include the following features, specialties, and components:
 - a. Safety Valves: ASME construction with pressure setting to correspond to tank working pressure and as required for component or system being protected.
 - b. Pressure Gages: For tank pressure and facility service-line pressure.
 - c. Contents Gage: High- and low-level indicator with electric signal circuit connection.
 - d. Drain Valves: For piping, inner vessel, and outer shell.
 - e. Fill Assembly: Fill connection, piping, valves, relief devices, and controls.
 - f. Facility Service Assembly: Piping, valves, relief devices, vaporizer, shutoff valve, pressure regulator, line shutoff valve or check valve, and reserve supply connection for connection to building service piping.
 - g. Permanent label showing medical gas type, storage-tank capacity, tank pressure rating, vaporizer capacity, and operating instructions.
- B. Liquid Oxygen Storage Tank:
 1. Comply with NFPA 50 for bulk oxygen storage tanks.
 2. Construction: Nickel-steel or stainless-steel inner vessel with [250-psig] <Insert value> minimum working pressure.
 3. Vaporizer Type: [Electric] [Steam] [Ambient].
 4. Storage-Tank Capacity: [As indicated] <Insert value>.
 5. Vaporizer Capacity: [As indicated] <Insert value>.
- C. Oxygen Reserve Supply: Manifold header for high-pressure cylinders fabricated from copper-tube or brass pipe and fittings and suitable for pressures up to [4000 psig] <Insert value>. Include header inlet connections complying with CGA V-1, with individual inlet check valves, header shutoff valve, header pressure regulator, line shutoff valve or check valve, pressure gage, and inlet connections for <Insert number> cylinders indicated.
- D. Liquid Nitrous Oxide Storage Tank:
 1. Comply with CGA G-8.1 for bulk nitrous oxide storage tanks.
 2. Construction: Steel-alloy inner vessel with [300-psig] <Insert value> minimum working pressure.
 3. Vaporizer Type: [Electric] [Steam].
 4. Storage Tank Capacity: [As indicated] <Insert value>.
 5. Vaporizer Capacity: [As indicated] <Insert value>.
- E. Nitrous Oxide Reserve Supply: Manifold header for high-pressure cylinders fabricated from copper-tube or brass pipe and fittings and suitable for pressures up to [4000 psig] <Insert value>. Include header inlet connections complying with CGA V-1, with individual inlet check valves, header shutoff valve, header pressure regulator, line shutoff valve or check valve, pressure gage, inlet connections for <Insert number> cylinders indicated, and electric heater.

2.15 GAS 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.

2.16 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 EARTHWORK

- A. Comply with requirements in Division 31 for excavating, trenching, and backfilling and for underground warning tapes.

3.3 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of gas piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, 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 medical gas 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 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.
- H. Install piping to permit valve servicing.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and for branch connections.
- K. Install medical gas piping to medical gas service connections specified in this Section, to medical gas service connections in equipment specified in this Section, and to equipment specified in other Sections requiring medical gas service.
- L. Install exterior, buried medical gas piping in protective conduit fabricated with PVC pipe and fittings. Do not extend conduit through foundation wall.
- M. Piping Restraint Installation: Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 22.
- N. Install medical gas service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
- O. Connect gas piping to gas sources and to gas outlets and equipment requiring gas service.
- P. Install unions in copper tubing adjacent to each valve and at final connection to each specialty and piece of equipment.
- Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22.
- R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22.
- S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22.

3.4 VALVE INSTALLATION

- A. Install shutoff valve at each connection to gas laboratory and healthcare equipment and specialties.
- B. Install check valves to maintain correct direction of gas flow from laboratory and healthcare gas supplies.
- 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. Arrange valves so largest valve is lowest. Rotate valves to angle that prevents closure of cover when valve is in closed position.

- E. Install pressure regulators on gas piping where reduced pressure is required.
- F. Install emergency oxygen connection with pressure relief valve and full-size discharge piping to outside, with check valve downstream from pressure relief valve, and with ball valve and check valve in supply main from bulk oxygen storage tank.

3.5 JOINT CONSTRUCTION

- A. Ream ends of PVC pipes and remove burrs.
- B. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
- C. Threaded Joints: Apply appropriate tape to external pipe threads.
- D. 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.
- 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.
- F. Solvent-Cemented Joints: Clean and dry joining surfaces. Join PVC pipe and fittings 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 and ASTM D 2672 for solvent-cemented joints.

3.6 GAS SERVICE COMPONENT INSTALLATION

- A. Assemble patient-service console with service connections. Install with supplies concealed in walls. Attach console box or mounting bracket to substrate.
- B. Install nitrogen pressure-control panels in walls. Attach to substrate.
- C. Assemble ceiling columns and install anchored to substrate. Provide structural steel, hanger rods, anchors, and fasteners in addition to components furnished with specialties necessary to fabricate supports.
- D. Assemble ceiling-hose assemblies and install anchored to substrate. Provide structural steel, hanger rods, anchors, and fasteners in addition to components furnished with specialties necessary to fabricate supports.
- E. Install gas manifolds [on concrete base] anchored to substrate.
- F. Install gas cylinders and connect to manifold piping.
- G. Install gas manifolds with seismic restraints.
- H. Install bulk gas storage tanks and reserve supply tanks level on concrete bases. Set tanks and connect gas piping to tanks [according to applicable requirements in NFPA 50 for bulk

oxygen storage systems]. Install tanks level and plumb, firmly anchored to concrete bases; maintain NFPA 50 and tank manufacturer's recommended clearances. Orient tanks so controls and devices are accessible for servicing.

- I. Install bulk gas storage tanks and reserve supply tanks with seismic restraints.

3.7 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 Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" 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.

3.8 IDENTIFICATION

- A. Install identifying labels and devices for specialty gas piping, valves, and specialties. Comply with requirements in Division 22.

- B. Install identifying labels and devices for healthcare medical gas piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
1. Carbon Dioxide: Black or white letters on gray background.
 2. Helium: White letters on brown background.
 3. Nitrogen: White letters on black background.
 4. Nitrous Oxide: White letters on blue background.
 5. Oxygen: White letters on green background or green letters on white background.

3.9 FIELD QUALITY CONTROL FOR HEALTHCARE FACILITY MEDICAL GAS

- A. Testing Agency: [Owner will engage] [Engage] a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
1. Medical Gas Piping Testing Coordination: Perform tests, inspections, verifications, and certification of medical gas piping systems concurrently with tests, inspections, and certification of [medical compressed-air 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 gas piping.
 - f. Standing pressure test for vacuum systems.
 - g. 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 gas concentration test.
 - k. Medical air purity test.
 - l. Verify correct labeling of equipment and components.
 - m. Verify medical gas supply sources.
 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.
- D. Prepare test and inspection reports.

3.10 FIELD QUALITY CONTROL FOR LABORATORY FACILITY SPECIALTY GAS

- A. Testing Agency: [Owner will engage] [Engage] a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
 - 1. Piping Leak Tests for Specialty Gas Piping: Test new and modified parts of existing piping. Cap and fill specialty gas 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 specialty gas regulators for proper operation.
- C. Remove and replace components that do not pass tests and inspections and retest as specified above.
- D. Prepare test and inspection reports.

3.11 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.

3.12 DEMONSTRATION

- A. [Engage factory-authorized service representative to train] [Train] Owner's maintenance personnel to adjust, operate, and maintain bulk gas storage tanks.

3.13 PIPING SCHEDULE

- A. Connect new tubing to existing tubing with memory-metal couplings.
- B. Medical Gas Piping except Medical Nitrogen Piping Larger Than NPS 3 and Operating at More Than 185 psig: Type L, copper tube; wrought-copper fittings; and brazed joints.
- C. Medical Nitrogen Piping Larger Than NPS 3 and Operating at More Than 185 psig: Type K, copper tube; wrought-copper fittings; and brazed joints.

- D. Specialty Gas Piping except Specialty Gas Larger Than NPS 3 and Operating at More Than 185 psig: Type L, copper tube; wrought-copper fittings; and brazed joints.
- E. Specialty Gas Piping Larger Than NPS 3 and Operating at More Than 185 psig: Type K, copper tube; wrought-copper fittings; and brazed joints.
- F. Protective Conduit: PVC pipe, PVC fittings, and solvent-cemented joints.

3.14 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