PART 1 GENERAL

1.01 DESCRIPTION

A. Provide all piping to outlets, zone valves, alarm panels, and to all other appurtenances, for the following medical gas systems:
   1. Medical Air
   2. Medical Oxygen
   3. Medical Vacuum
   4. Waste Anesthesia Gas Disposal (WAGD)

B. Rough-in, hook-up and final connections to medical gas wall outlets, zones valves and alarm panels by the Plumbing Contractor.

C. Connect to source and extend piping to areas of the building where shown on Drawings.

1.02 QUALITY ASSURANCE

A. Standards: National Fire Protection Association (NFPA 99) and Compressed Gas Association (CGA).

B. All wrought copper fittings and brazing materials shall be certified lead-free and meet EPA standards.

C. Brazing:
   1. The installation of medical gas systems shall be made by qualified, competent technicians who are experienced in making such installations.
   2. Installers of medical gas systems shall meet the requirements of ANSI/ASSE Standard 6010, Professional Qualification Standard for Medical Gas and Vacuum System Installers.
   3. Brazing procedures and brazer performance for the installation of medical gas piping shall be qualified in accordance with either Section IX, Welding and Brazing Qualifications, of the ASME Boiler and Pressure Vessel Code, or AWS B2.2, Standard for Brazing Procedure and Performance Qualifications and as modified as follows:
      a. Brazers shall be qualified by visual examination of the test coupon followed by sectioning.
      b. The brazing procedure specification shall address cleaning, joint clearance, overlap, internal purge gas, purge gas flow rate, and filler metal.
      c. The brazing procedure specification and the record of brazer performance qualification shall document filler metal used, cleaning, joint clearance, overlap, internal purge gas and flow rate during brazing of coupon, and the absence of internal oxidation in the completed coupon.
d. Brazing procedures qualified by a technically competent group or agency shall be permitted under the following conditions:
   1) The brazing procedure specification and the procedure qualification record meets the requirements of this standard.
   2) The employer obtains a copy of both the brazing procedure specification and the supporting qualification records from the group or agency and signs and dates these records, thereby accepting responsibility for the qualifications that were performed by the group or agency.
   3) The employer qualified at least one brazer following each brazing procedure specification used.

4. Prior to any installation work, the installer of medical gas piping shall provide and maintain documentation on the job site for the qualification of brazing procedures and individual brazers.

1.03 CROSS-CONNECTION CERTIFICATION

A. Provide an independent medical gas certifier to test and adjust all new medical gas piping systems after installation to ensure that no crossed lines exist and that the proper gas emanates from each service outlet. The choice of the independent medical gas certifier must be submitted for approval and acceptable to the Owner. The tests shall be performed in accordance with NFPA Standard 99, "Installation and Testing of Piping Systems." Any deficiencies shall be corrected by the installing contractor at no extra cost to the Owner.

A. The Owner shall provide an independent medical gas certifier to test and adjust all new medical gas piping systems after installation to ensure that no crossed lines exist and that the proper gas emanates from each service outlet. The tests shall be performed in accordance with NFPA Standard 99, "Installation and Testing of Piping Systems." Any deficiencies shall be corrected by the installing contractor at no extra cost to the Owner.

B. The independent medical gas certifier shall furnish a written Certification, signed by an Officer of the Company, stating that the systems have been checked and are free of cross-connections, delivering recommended gas concentrations or vacuum, are installed and tested in accordance with NFPA 99 and are safe for patient use.

C. Cross-Connection Certification shall not be affected by the Contractor's decision to mix piping and devices of differing manufacturers. Written certification shall cover the total installation.

PART 2 PRODUCTS

2.01 PIPING

A. Tubes shall be hard-drawn seamless copper ASTM B 819 medical gas tube, Type L, except that where operating pressures are above a gauge pressure of 185 psig Type K shall be used for sizes larger than NPS 3 (3 1/8 inches O.D.).

B. ASTM B 819 medical gas tube shall be identified by the manufacturer's markings "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in blue (Type L) or green (Type K).
C. The installer shall furnish documentation certifying that all installed piping materials comply with the requirements as follows:
   1. Tubes, valves, fittings, station outlets, and other piping components in medical gas systems shall have been cleaned for oxygen service by the manufacturer prior to installation in accordance with CGA 4.1, Cleaning Equipment for Oxygen Service, except that fittings shall be permitted to be cleaned by a supplier or agency other than the manufacturer.

2.02 JOINTS

A. Turns, offsets, and other changes in direction in medical gas piping shall be made with brazed wrought copper capillary fittings complying with ANSI B16.22, Wrought Copper and Copper Alloy Solder-Joint Fittings; or brazed fittings complying with MSS SP-73, Brazed Joints for Wrought and Cast Copper Alloy Solder Joint Pressure Fittings.

B. Cast copper alloy fittings shall not be permitted.

C. Threaded joints in medical gas distribution piping shall meet the following requirements:
   1. Be limited to connections to pressure indicators, alarm devices, and source equipment.
   2. Be tapered pipe threads complying with ANSI B1.20.1, Pipe Threads, General Purpose.
   3. Be made up with polytetrafluoroethylene (such as Teflon™) tape or other thread sealant recommended for oxygen service, with the sealant applied to the male threads only.

2.03 BRAZING MATERIALS

A. Brazed joints shall be made using a brazing alloy that exhibits a melting temperature in excess of 1,000 degree F to retain the integrity of the piping system in the event of fire exposure.

B. Filler metals shall bond with and be metallurgically compatible with the base metals being joined.

C. Filler metals shall comply with ANSI/AWS A.5.8, Specification for Brazing Filler Metal.

D. Copper-to-copper joints shall be brazed using a copper-phosphorus or copper-phosphorus-silver brazing filler metal (BCuP series) without flux.

PART 3 EXECUTION

3.01 INSTALLATION

A. Cutting tube ends:
   1. Tube ends shall be cut square using a sharp tubing cutter to avoid deforming the tube.
   2. The cutting wheels on tubing cutters shall be free from grease, oil, or other lubricant not suitable for oxygen service.
   3. The cut ends of the tube shall be deburred with a sharp, clean deburring tool, taking care to prevent chips from entering the tube.
B. Brazing dissimilar metals:
1. Flux shall only be used when brazing dissimilar metals such as copper and bronze or brass, using a silver (Bag series) brazing filler metal.
2. Surfaces shall be cleaned for brazing in accordance with all provisions of this Specification.
3. Flux shall be applied sparingly to minimize contamination of the inside of the tube with flux.
4. The flux shall be applied and worked over the cleaned surfaces to be brazed using a stiff bristle brush to ensure complete coverage and wetting of the surfaces with flux.
5. Where possible, short sections of copper tube shall be brazed onto the non-copper component and the interior of the subassembly shall be cleaned of flux prior to installation in the piping system.
6. On joints NPS 3/4 (7/8 inch O.D.) size and smaller, flux-coated brazing rods shall be permitted to be used in lieu of applying flux to the surfaces being joined.

C. Nitrogen purge:
1. While being brazed, joints shall be continuously purged with oil-free, dry Nitrogen NF to prevent the formation of copper oxide on the inside surfaces of the joint.
2. The source of the purge gas shall be monitored and the installer shall be audibly alerted when the source content is low.
3. The purge gas flow rate shall not produce a positive pressure in the piping system.
4. The purge gas flow rate shall be controlled by the use of a pressure regulator and flow meter or combination thereof.
5. Pressure regulators alone shall not be used to control purge gas flow rates.
6. During and after installation, openings in the piping system shall be kept sealed to maintain a nitrogen atmosphere within the piping to prevent debris or other contaminants from entering the system.
7. While a joint is being brazed, a discharge opening shall be provided on the opposite side of the joint from where the purge gas is being introduced.
8. The flow or purge gas shall be maintained until the joint is cool to the touch.
9. After the joint has cooled, the purge discharge opening shall be sealed to prevent contamination of the inside of the tube and maintain the nitrogen atmosphere within the piping system.

D. Assembly and heating joints:
1. Tube ends shall be inserted fully into the socket of the fitting.
2. Where flux is permitted, the joint shall be heated slowly until the flux has liquefied.
3. After flux is liquefied, or where flux is not permitted to be used, the joint shall be heated quickly to the brazing temperature, taking care not to overheat the joint.
4. Techniques for heating the joint, applying the brazing filler metal, and making horizontal, vertical, and large-diameter joints shall be as stated in sections on "Applying Heat and Brazing" and Horizontal and Vertical Joints" in Chapter VII, "Brazed Joints," in the CDA Copper Tube Handbook.

E. Inspection of brazed joints:
1. After brazing, the outside of all joints shall be cleaned by washing with water and a wire brush to remove any residue and permit clear visual inspection of the joint.
2. Where flux has been used, the wash water shall be hot.
3. Each brazed joint shall be visually inspected after cleaning the outside surfaces.
SECTION 22 61 13
MEDICAL GAS PIPING SYSTEM

4. Joints exhibiting the following conditions shall not be permitted:
   a. Flux or flux residue (when flux or flux coated Bag series rods are used with dissimilar metals).
   b. Base metal melting or erosion.
   c. Unmelted filler metal.
   d. Failure of the filler metal to be clearly visible all the way around the joint at the interface between the socket and the tube.
   e. Cracks in the tube or components.
   f. Cracks in the braze filler metal.
   g. Failure of the joint to hold the test pressure under the installer-performed initial pressure test and standing pressure test. Refer to the "Testing" provisions of these Specifications.

5. Brazed joints that are identified by the following criteria, as defective shall be replaced:
   a. Base metal melting or erosion.
   b. Cracks in the tube or component.

6. Brazed joints that are identified as defective by the following criteria shall be permitted to be repaired, except that no joint shall be reheated more than once before being replaced:
   a. Flux or flux residue (when flux or flux coated Bag series rods are used with dissimilar metals).
   b. Unmelted filler metal.
   c. Failure of the filler metal to be clearly visible all the way around the joint at the interface between the socket and the tube.
   d. Cracks in the braze filler metal.
   e. Failure of the joint to hold the test pressure under the installer-performed initial pressure test and standing pressure test. Refer to the "Testing" provisions of these Specifications.

F. Piping buried or located in mechanical shafts or areas where it may be subject to physical damage, shall be wrapped with dielectric tape and installed in pipe or conduit.

3.02 CLEANING

A. The interior surfaces of tubes, fittings, and other components that are cleaned for oxygen service shall be stored and handled to avoid contamination prior to assembly and brazing.

B. The exterior surfaces of tube ends shall be cleaned prior to brazing to remove any surface oxides.

C. When cleaning the exterior surfaces of tube ends, no matter shall be permitted to enter the tube.

D. If the interior surfaces of fitting sockets become contaminated prior to brazing, they shall be recleaned for oxygen in accordance with all provisions of these Specifications and be cleaned for brazing with a clean, oil-free wire brush.

E. Non-abrasive pads shall be used to clean the exterior surfaces of tube ends.

F. The use of steel wool or sand cloth shall be prohibited.
G. The cleaning process shall not result in grooving of the surfaces to be joined.

H. After being abraded, the surfaces shall be wiped using a clean, lint-free white cloth.

I. Tubes, fittings, valves, and other components shall be visually examined internally before being joined to verify that they have not become contaminated for oxygen service and that they are free of obstructions or debris.

J. The interior surfaces of tube ends, fittings, and other components that were cleaned for oxygen service by the manufacturer, but become contaminated prior to being installed, shall be permitted to be recleaned on-site by the installer by thoroughly scrubbing the interior surfaces with a clean, hot water-alkaline solution, such as sodium carbonate or trisodium phosphate 1 lb. to 3 gallons of potable water and thoroughly rinsing them with clean, hot potable water.

K. Other aqueous cleaning solutions shall be permitted to be used for on-site recleaning permitted as follows, provided that they are as recommended in CGA Pamphlet G-4.1, Cleaning Equipment for Oxygen Service, and are listed in CGA Pamphlet O2-DIR, Directory of Cleaning Agents for Oxygen Service.

L. Material that has become contaminated internally and is not clean for oxygen service shall not be installed. Joints shall be brazed within one hour after the surfaces are cleaned for brazing.

3.03 TESTING

A. The tests shall be performed before concealing pipe.

B. The tests required by this section shall be performed and documented by the Contractor prior to verification by an independent medical gas certifier.

C. The test gas shall be oil-free, dry Nitrogen NF.

D. Where manufactured assemblies are to be installed, the tests as required by this section shall be performed as follows:
   1. After completion of the distribution piping but before the standing pressure test.
   2. Prior to installation of manufactured assemblies supplied through flexible hose or flexible tubing.
   3. At all station outlets/inlets on installed manufactured assemblies supplied through copper tubing.

E. Initial Blow Down: Piping in medical gas distribution systems shall be blown clear by means of oil-free, dry Nitrogen NF as follows:
   1. After installation of the distribution piping.
   2. Before installation of station outlets/inlets and other system components (e.g. pressure alarm devices, pressure indicators, pressure relief valves, manifolds, source equipment).
SECTION 22 61 13
MEDICAL GAS PIPING SYSTEM

F. Initial Pressure Test
1. Each section of the piping in medical gas systems shall be pressure tested.
2. Initial pressure tests shall be conducted as follows:
   a. After installation of station outlets/inlets rough-in assemblies. Test caps shall be permitted to be used.
   b. Prior to the installation of components of the distribution that could be damaged by the test pressure (e.g. pressure alarm devices, pressure indicators, line pressure relief valves, manufactured assemblies with flexible hose, hose, etc).
3. The source shutoff valve shall remain closed during these tests.
4. The test pressure for pressure gases shall be 1.5 times the working pressure but not less than a gauge pressure of 150 psig.
5. The test pressure shall be maintained until each joint has been examined for leakage by means of soapy water or other equally effective means of leak detection that is considered safe for use with medical compressed air systems.
6. Leaks, if any, shall be located, repaired or replaced (as required) and re-tested at no extra cost to the Owner.

G. Cross-connection Test
1. It shall be determined that no cross connection exists between the various medical gas systems.
2. All piping system shall be reduced to atmospheric pressure.
3. Sources of test gas shall be disconnected from all piping systems except from the one being tested.
4. The system under test shall be charged with oil-free dry Nitrogen NF to a gauge pressure of 50 psig.
5. After the installation of the individual faceplates, with appropriate adapters matching inlet/outlet labels, each individual inlet/outlet in each installed medical gas piping system shall be checked to determine that the test gas is being dispensed only from the piping system being tested.
6. The proper labeling and identification of system inlets/outlets shall be confirmed during the tests.

H. Piping Purge Test
1. The outlets in each medical gas piping system shall be purged to remove any particulate matter from the distribution piping.
2. Using appropriate adapters, each outlet shall be purged with an intermittent high-volume flow of test gas until the purge produces no discoloration in a clean white cloth.
3. This purging shall be started at the furthest point from the zone valve.

I. Standing Pressure Test
1. After successful completion of the initial pressure tests, medical gas distribution piping shall be subject to a standing pressure test.
2. Tests shall be conducted after the final installation of station outlet valve bodies, faceplates and other distribution components (e.g. pressure alarm devices, pressure indicators, line pressure relief valves, manufactured assemblies with flexible hose, hose, etc).
3. The source valve shall be closed during this test.
4. The piping systems shall be subjected to a twenty-four (24) hour standing pressure test using oil-free dry Nitrogen NF.
5. Test pressures shall be 20% above the normal system operating line pressure.
SECTION 22 61 13
MEDICAL GAS PIPING SYSTEM

6. At the conclusion of the tests, there shall be no change in the test pressure other than that attributed to changes in ambient temperature as permitted in NFPA 99.

7. Leaks, if any, shall be located, repaired or replaced (as required) and re-tested at no extra cost to the Owner.

J. The date(s) and result(s) of all tests shall be recorded, witnessed, and submitted to the Architect.

3.04 PIPE LABELING

A. Piping shall be labeled by stenciling or adhesive markers that identify the medical gas system.

B. Pipe labels shall show the name of the gas system, operating pressure and direction of flow system or the chemical symbol.

C. Where positive pressure gas piping systems operate at pressures other than the standard gauge pressure of 50 to 55 psig or a gauge pressure of 160 to 185 psig for nitrogen, the pipe labels shall include the nonstandard operating pressure in addition to the name of the gas.

D. Pipe labels shall be located as follows:
   1. At intervals of not more than 20 feet
   2. At least once in or above every room
   3. On both sides of walls or partitions penetrated by the piping
   4. At least once in every story height traversed by risers

3.05 SHUTOFF VALVES

A. Shutoff valves shall be identified as follows:
   1. The name or chemical symbol for the specific medical gas or vacuum system.
   2. The room or areas served.
   3. A caution to not close or open the valve except in emergency.
   4. The system operating pressure.

B. Source valves shall be labeled in substance as follows:
   1. SOURCE VALVE FOR THE (SOURCE NAME)

C. Main line valves shall be labeled in substance as follows:
   1. MAIN LINE VALVE FOR THE (GAS NAME) SERVING THE (NAME OF THE BUILDING).

D. Riser valve(s) shall be labeled in substance as follows:
   1. RISER FOR THE (GAS NAME) SERVING (NAME OF THE AREA/BUILDING SERVED BY THE PARTICULAR RISER).

E. Service valve(s) shall be labeled in substance as follows:
   1. SERVICE VALVE FOR THE (GAS NAME) SERVING (NAME OF THE AREA/BUILDING SERVED BY THE PARTICULAR VALVE).

END OF SECTION