

SECTION 22 60 00
MEDICAL GAS SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Medical Oxygen System.
- B. Medical Compressed Air System.
- C. Medical Vacuum System.
- D. Waste Anesthetic Gas Disposal System.
- E. Nitrous Oxide System.
- F. Carbon Dioxide System.
- G. Nitrogen System.
- H. Medical Gas Alarm System.

1.2 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

1.3 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

1.4 REFERENCES

- A. ANSI B16.18 - Cast Copper Alloy Solder-Joint Pressure Fittings.
- B. ANSI B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- C. ANSI B40.1 - Gauges, Pressure and Vacuum, Indicating Dial Type Elastic Element.
- D. ASME - Boiler and Pressure Vessel Code - Section IX, Welding and Brazing Requirements.
- E. ASSE 6010 - Medical Gas Systems Installers Professional Qualification Standard.
- F. ASSE 6020 - Medical Gas Systems Inspectors.
- G. ASSE 6030 - Medical Gas Systems Verifiers.
- H. ASTM A167 - Stainless and Heat-Resisting Chromium - Nickel Steel Plate.
- I. ASTM A269 - Stainless and Welded Austenitic Stainless Steel Tubing for General Service.
- J. ASTM A403 - Wrought Austenitic Stainless Steel Piping Fittings.
- K. ASTM B32 - Solder Metal.
- L. ASTM B819 - Seamless Copper Tube for Medical Gas Systems.
- M. AWS A5.8 - Brazing Filler Metal.
- N. AWS B2.2 - Standard for Brazing Procedure and Performance Qualification.
- O. CGA G-4.1 - Cleaning Equipment for Oxygen Service.
- P. CGA G-7 - Compressed Air for Human Respiration.

- Q. CGA P-2.1 - Medical - Surgical Vacuum Systems in Health Care Facilities.
- R. CGA V-5 - Diameter Index Safety System Non-Interchangeable Low Pressure Connections for Medical Gas Applications.
- S. FM - FM Global System - Approval Guide.
- T. FS TT-P-645 - Primer, Paint, Zinc Chromate, Alkyd Type.
- U. FS W-C-596 - Electrical Power Connector, Plug, Receptacle, and Cable Outlet.
- V. FS WW-V-35 - Valve, Ball.
- W. FS WW-V-54 - Valve, Gate, Bronze (125, 150 and 200 Pound, Screwed, Flanged, Solder End, For Land Use).
- X. MIL-R-36557 - Regulator, Pressure, Medical Gas Administration Apparatus.
- Y. MIL-STD-101 - Color Code for Pipelines and for Compressed Gas Cylinders.
- Z. MIL-V-82026 - Valves, Diaphragm, Stop.
- AA. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture.
- BB. MSS SP-69 - Pipe Hangers and Supports - Selection and Application.
- CC. MSS SP-73 - Brazing Joints for Wrought and Cast Copper Alloy Solder Joint and Pressure Fittings.
- DD. NFPA 50 - Bulk Oxygen Systems at Consumer Sites.
- EE. NFPA 99 - Standard for Health Care Facilities.
- FF. UL - Underwriters' Laboratories, Inc.

1.5 QUALITY ASSURANCE

- A. Perform work in accordance with the 2005 edition of NFPA 99.
- B. Manufacturer: Company specializing in manufacture of products specified in this Section with minimum three years documented experience.
- C. Installer: Company specializing in performing the work of this Section with minimum three years documented experience, and certified in accordance with the 2005 edition of NFPA 99.
- D. Valves: Remanufactured valves are not acceptable.

1.6 REGULATORY REQUIREMENTS

- A. Conform to all applicable codes for medical gas systems.
- B. Conform to the 2005 edition of NFPA 99.

1.7 SUBMITTALS

- A. Submit under provisions of Section 22 05 00.
- B. Submit Medical Gas Installer certificate for all brazers on the project. Include proof of qualification per either ASME Section IX or AWS B2.2 for all brazers, and ASSE 6010 for all installers.
- C. Shop Drawings:
 - 1. Indicate general assembly of components, mounting and installation details, and general layout of control and alarm panels.
 - 2. Submit detailed medical wall assembly drawings. Provide manufacturers literature and illustrations for all components indicating size, dimensions and configuration.
 - 3. Provide complete system information, system drawings, alarm wiring diagrams, and detailed installation instructions.
- D. Manufacturer's Installation Instruction: Indicate requirements for equipment and systems.
- E. Independent Testing Agency Reports: Provide documentation upon completion of the testing to include: all test results, names of the individuals performing the work for the testing agency, detailed procedures followed for all tests, certification that all results of the test were within limits allowed by the 2005 edition of NFPA - 99 and system integrity has been achieved or maintained. Submit documentation of completed tests to Owner, Engineer, and Authority Having Jurisdiction.
- F. Submit certification that all medical gas equipment, accessories, and components will withstand seismic forces defined in Specification Section 22 05 50. Include the following:
 - 1. Basis for Certification: Indicate whether certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 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.

1.8 OPERATION AND MAINTENANCE DATA

- A. Operation Data: Include installation instructions, lubrication instructions, and assembly views.
- B. Maintenance Data: Include maintenance and inspection data, replacement part numbers and availability, and service depot location and telephone.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site. Accept material on site in factory containers and packing. Inspect for damage. Protect from damage and contamination by maintaining factory packaging and caps in place until installation.

1.10 WARRANTY

- A. Provide one year warranty on parts and labor.
- B. Provide three year warranty on compressors and pumps.

1.11 EXTRA STOCK

- A. Provide one extra set of air filters for medical vacuum pump, medical air compressor, and instrument air compressor.
- B. Provide oil and oil filter for one complete change of oil for medical vacuum pump.

PART 2 - PRODUCTS

2.1 OXYGEN MEDICAL AIR NITROUS OXIDE CARBON DIOXIDE WASTE ANESTHETIC GAS DISPOSAL

- A. Design Pressure: 200 psig.
Maximum Design Temperature: 130°F
- B. Piping - 3' and Under:
 - 1. Tubing: Type L hard drawn seamless copper tube, ASTM B819, cleaned and capped "for oxygen service". Tube size indicated is nominal designation.
 - 2. Joints: BCuP silver braze, AWS A5.8.
 - 3. Fittings: Wrought copper solder joint, ANSI B16.22, cleaned and bagged for oxygen service.
- C. Shut-Off Valves - 3' and Under:
 - 1. VS-2: MSS SP-110, three-piece body, full port, double-seal bolted union ball type, 400 psi WOG, bronze body, chrome plated brass ball, blowout proof stem, cleaned, tested, lockable, plugged and tagged at factory for required service, with type L copper tube extensions brazed to flanges. Provide a standard keyed padlock with each valve. Review padlock type with Owner prior to installation. Beacon/Medaes, Allied Healthcare/Chemetron, Amico.

2.2 VACUUM

- A. Design Pressure: 200 psig.
Maximum Design Temperature: 130°F

- B. Piping - All Sizes:
 - 1. Tubing: Type K or L hard drawn seamless copper tube, ASTM B819, cleaned and capped "for oxygen service". Tube size indicated is nominal designation.
 - 2. Joints: BCuP silver braze, AWS A5.8.
 - 3. Fittings: Wrought copper solder joint, ANSI B16.22, cleaned and bagged for oxygen service.
- C. Shut-Off Valves:
 - 1. VS-2: 4" and under, MSS SP-110, three-piece body, full port, double-seal bolted union ball type, 400 psi WOG, bronze body, chrome plated brass ball, blowout proof stem, cleaned, tested, lockable, plugged and tagged at factory for required service, with type K copper tube extensions brazed to flanges. Provide a standard keyed padlock with each valve. Review padlock type with Owner prior to installation. Beacon/Medaes, Allied Healthcare/Chemetron, Amico.

2.3 NITROGEN

- A. Design Pressure: 300 psig.
Maximum Design Temperature: 130°F.
- B. Piping - All Sizes:
 - 1. Tubing: Type K hard drawn seamless copper tube, ASTM B819, cleaned and capped "for oxygen service". Tube size indicated is nominal designation.
 - 2. Joints: BCuP silver braze, AWS A5.8.
 - 3. Fittings: Wrought copper solder joint, ANSI B16.22, cleaned and bagged "for oxygen service".
- C. Shut-Off Valves:
 - 1. VS-2: 4" and under, MSS SP-110, three-piece body, full port, double-seal bolted union ball type, 400 psi WOG, bronze body, chrome plated brass ball, blowout proof stem, cleaned, tested, lockable, plugged and tagged at factory for required service, with type K copper tube extensions brazed to flanges. Provide a standard keyed padlock with each valve. Review padlock type with Owner prior to installation. Beacon/Medaes, Chemetron, Amico.

2.4 PIPING AND ACCESSORIES

- A. Hangers and Supports: See Section 22 05 29.
- B. Pressure and Vacuum Gauges: ANSI B40.1, white dials and black lettering with restrictor. Gauges cleaned for oxygen service: Manufactured and labeled expressly for intended service, UL listed. Select gauge range for normal reading near center of gauge. Gauge shall be installed adjacent to the master alarm pressure actuating switch for the specific gas and in other locations designated or required by the 1999 edition of NFPA 99. Gauges are to be provided with a demand check fitting to facilitate service, testing, or replacement.

- C. Pressure and Vacuum Switches:
 - 1. General purpose, contact type, allowing both high and low pressure set points, provide with a protective dust cover; adjustable range set by inside or outside adjustment; switches activate when indicated by alarm requirements. Switches are to be provided with a demand check fitting to facilitate service, testing, or replacement.
- D. Valve Cabinets:
 - 1. Extruded aluminum, flush-mounted and rigidly assembled to accommodate valves and fittings, punched or drilled sides to receive tubing, anchors to secure to wall.
 - 2. Cover Plates: Extruded aluminum, with replaceable plastic windows with pull ring to remove window.
 - 3. Cabinet Labels: Labeled and color coded for intended service and area served.
 - 4. Valves: Pre-assemble and mount valves and tubing extensions.
 - 5. Gauges: Provide downstream of all isolating valves.

2.5 OUTLETS

- A. Outlet Units: NFPA 99 compliant, non-interchangeable connectors, automatic valves, secondary check valves on positive pressure outlets, and capped 3/8" tubing stubs for supply connections, color coded and labeled for intended service. Provide and install outlets as listed in the Medical Gas Material List.

2.6 MEDICAL GAS MANIFOLD (EXCEPT NITROGEN)

- A. Central supply of medical gas shall be duplex fully automatic manifold with wall mounted control cabinet and necessary header connections and pigtailed arranged for cylinders in service and cylinders in reserve. Refer to drawings for cylinder quantities.
- B. Manifold shall deliver design capacity continuously at 50 psig. Provide automatic changeover from primary to secondary bank and allow replacing depleted cylinders with no change in line pressure. Manual resetting of the control panel shall not be required. Provide manifold relief valve set at 50% above design pressure.
- C. Provide nitrous oxide manifolds with electric heater or orifice device that will prevent freezing during high demand. Single point electrical connection to manifold is required.
- D. Provide bypass system between regulators to service regulator or switch over system without interrupting supply of gas. Bleed valves piped to vent connector within cabinet shall allow adjustment of pressure reducing regulators.
- E. House components in lockable cabinet with baked enamel finish. Three front mounted gauges shall indicate bank and hospital line pressures. Green indicator light shall indicate service bank in use and red light shall indicate reserve bank in use. Provide terminal block connections for remote alarms.
- F. Individually secure gas cylinders to a rigid structure in accordance with the 1999 edition of NFPA-99. Cylinder restraints shall allow removal and reinstallation of cylinders on a regular basis.

- G. Acceptable Manufacturers: Beacon/Medaes, Chemetron, Amico.

2.7 NITROGEN MANIFOLD

- A. Duplex fully automatic nitrogen manifold with wall mounted control cabinet and necessary header connection and pigtails arranged for cylinders in service and cylinders in reserve. Refer to drawings for cylinder quantities.
- B. Manifold shall deliver design capacity continuously at 180 psig. Provide automatic changeover from primary to secondary bank and allow replacing depleted cylinders with no change in line pressure. Manual resetting of the control panel shall not be required. Provide bank regulators to reduce cylinder pressure for line regulator set at 160 psig delivery pressure. Provide manifold relief valve set at 50% above design pressure.
- C. Provide bypass system between regulators to service regulator or switch over system without interrupting supply of gas. Bleed valves shall allow adjustment of pressure reducing regulators.
- D. House components in lockable cabinet with baked enamel finish. Three front mounted gauges shall indicate bank and hospital line pressures. Green indicator light shall indicate service bank in use and red light shall indicate reserve bank in use. Provide terminal block connections for remote alarm.
- E. Individually secure gas cylinders to a rigid structure in accordance with the 1999 edition of NFPA-99. Cylinder restraints shall allow removal and reinstallation of cylinders on a regular basis.
- F. Acceptable Manufacturers: Beacon/Medaes, Chemetron, Amico.

2.8 MEDICAL GAS ALARM SYSTEM

- A. Provide all medical gas alarm panels shown on the drawings and in the Medical Gas Material List.
- B. All power wiring to central equipment and alarm panels is by the electrical contractor. Coordinate all items requiring power with the electrical contractor.
- C. All alarm wiring from central equipment, pressure switches, and monitors to alarm panels is this contractor's responsibility. Coordinate exact requirements with equipment supplier. All wiring shall be minimum #18 gauge insulated and shielded in metallic conduit and meet requirements of the Electrical Specifications.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all systems in accordance with manufacturer's instructions and the 2005 edition of NFPA 99.
- B. Braze joints in pipe and tubing. DURING BRAZING OF PIPE CONNECTIONS, PURGE INTERIOR OF PIPE CONTINUOUSLY WITH NITROGEN. Make joint without adding flux.
- C. Branch takeoffs from horizontal piping shall be taken off above the centerline of the main or branch pipe and rise vertically or at an angle of not less than 45° from vertical.

- D. Change pipe size with reducing fittings. Change direction with fittings.
- E. Cut pipe and tubing accurately and install without springing or forcing.
- F. Install exposed oxygen piping in wall-mounted sheet steel raceways and junction boxes.
- G. Pitch piping down in direction of flow.
- H. Provide pipe sleeves per Specification Section 22 05 29.
- I. Coordinate utility warning and identification tape with backfill operation and NFPA 99 requirements. See Section 22 05 53 for type and installation.
- J. Provide identification for all piping. See Section 22 05 53.
- K. Label all valve boxes and area alarm panels with engraved plastic labels indicating area or rooms served. Label service valves with valve tags as listed in Section 22 05 53 and tag listing area served by the valve.
- L. Support gas piping in accordance with the 2005 edition of NFPA-99 requirements with pipe hooks or hangers suitable for size of pipe. All hangers for copper tube shall have a copper finish and plastic coated hangers shall be used in potential damp locations. Maximum support spacing shall be as listed below:
 - 1. 1/4" pipe or tubing: 60" O.C.
 - 2. 3/8" pipe or tubing: 72" O.C.
 - 3. 1/2" pipe or tubing: 72" O.C.
 - 4. 3/4" pipe or tubing: 84" O.C.
 - 5. 1" pipe or tubing: 96" O.C.
 - 6. 1-1/4" pipe or tubing: 108" O.C.
 - 7. 1-1/2" or larger (horizontal): 120" O.C.
 - 8. 1-1/2" or larger (vertical): 10' at every floor not to exceed 15'.
- M. Install shut-off valves at base of each riser. Install shut-off valves at branch connections to risers on individual floors. Install lateral pipes feeding shut off valves:
 - 1. Locate immediately adjacent to main or riser.
 - 2. Ensure not accessible to unauthorized personnel.
 - 3. Identify gas and function of zone valves outside cabinets.
 - 4. Leave in open position with handle locked.
- N. Install valved connections on mains for pressure switches and main pressure gauges.
- O. Except where indicated or in flush wall mounted cabinets, install manual shut off valves with stem vertical and accessible for operation and maintenance.
- P. Install pressure gauges in valve boxes on the patient service side of the shutoff valve.
- Q. Install strainers on inlet side of pressure reducing valves. Provide main gas valves (pressure reducing or flow control) with bypasses and shut-off valves to permit maintenance without interruption of gas.
- R. Provide a valved bypass around all receivers.
- S. Manufacturer shall inspect the installation and assist in startup of equipment. Manufacturer shall submit report certifying the equipment is operating properly.

3.2 SYSTEMS CLEANING, TESTS, AND ANALYSIS OF EXISTING AND NEW PIPING SYSTEMS

- A. Document all tests and submit to Owner, Engineer, and Authority Having Jurisdiction.
- B. Prior to the installation of station outlets, pressure switches, gauges, manifolds, or relief valves, blow down the piping system with oil-free dry nitrogen to clear piping of any moisture or foreign material.
- C. In system additions or remodel installations, test all new piping prior to connection to existing system. Test all existing piping from new connections to isolation valve or zone valve in the system.
- D. Perform the following Installer Performance Tests in accordance with the 2005 edition of NFPA 99:
 - 1. Initial Pressure Test:
 - a. Prior to the installation of pressure switches, gauges, manifolds, and relief valves, before closing of walls, but after the installation of station outlets, test all piping or piping sections with oil-free dry nitrogen at 1.5 times system working pressure, 150 psig minimum.
 - b. Maintain test pressure and examine each joint for leakage using soapy water or equally safe detection method.
 - c. Locate and repair all leaks. Repeat test and repairs until no leaks are evident.
 - 2. Standing Pressure Test:
 - a. Upon passing the Initial Pressure Test and installation of the remaining system components (pressure switches, gauges, manifolds, relief valves), test all piping systems with oil-free dry nitrogen for 24 hours at 20% above the normal operating system pressure. Vacuum system piping shall be tested at a pressure not less than 60 psig.
 - b. The piping system shall remain leak free for 24 hours. Only system pressure fluctuations due to ambient temperature variations are allowed. Vacuum system pressure must be within 5 psig of the original test pressure.
 - c. Locate and repair all leaks. Repeat test and repairs until no leaks are evident.
 - 3. Piping Purge Test:
 - a. A high-flow purge of oil-free dry nitrogen shall be performed on each outlet utilizing the appropriate adapter to remove particulate matter from the pipelines.
 - b. Allow each outlet to flow fully until no discoloration is evident on a white cloth.

4. Cross-Connection Test:
 - a. Reduce pressure to atmospheric in piping systems other than system under investigation. Verify the medical vacuum systems are in operation.
 - b. Pressurize system under investigation with 50 psig oil-free dry nitrogen.
 - c. Check each station outlet of every piping system to determine test gas is dispensed only from outlet of system under investigation. Measure pressure with gauge attached to specific adaptor. Do not use universal adapters.
 - d. Test medical vacuum outlets at the same time the medical gas systems are tested.
 - e. Repeat test for each gas.
 - f. Verify the presence and correctness of all system component (outlets, valves, panels) labeling.
 - g. Include Waste Anesthetic Gas Disposal systems in cross-connect and flow tests as required by NFPA 99.

- E. Enlist an independent testing agency specializing in the testing and certification of medical gas systems with minimum five years documented experience. Agency is to certify the system is complete, zone valves installed, alarm systems functional, all manufactured assemblies have been installed, and to verify that all Installer Performance Tests have been performed. Agency is to perform the following System Verification and Tests in accordance with the 2005 edition of NFPA-99.
 1. Cross-Connection Test. (Including Waste Anesthetic Gas Disposal System)
 2. Vacuum Test.
 3. Valve Test.
 4. Outlet Flow Test.
 5. Alarm Test.
 6. Piping Purge Test.
 7. Piping Purity Test.
 8. Final Tie-in Test (for additions and remodels).
 9. Operational Pressure Test.
 10. Medical Gas Concentration Test.
 11. Medical Air Purity Test.
 12. Labeling.
 13. Source Equipment Verification.
 - a. Gas Supply Source.
 - b. Medical Air Compressor.
 - c. Medical Vacuum Pump.

END OF SECTION