SECTION 226000

MEDICAL GAS AND VACUUM SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Medical oxygen gas system.

B. Medical compressed air system.

C. Medical vacuum system.

1.2 RELATED SECTIONS

A. Section 22 07 00 - Piping Insulation.

B. Section 23 05 48 - Vibration Isolation.

C. Section 23 05 53 - Mechanical Identification.

D. Section 26 05 05 - Equipment Wiring Systems: Electrical characteristics and wiring connections.

E. Section 26 27 26 - Wiring Devices.

F. Division 01- Summary of Work: Execution requirements for Owner supplied liquid oxygen bulk storage.

1.3 ALLOWANCES

A. Division 01 - Allowances: Testing allowances affecting this section.

B. Allowance includes purchase and delivery of bottled gases. Installation is included in this section and is part of the Contract Sum/Price.

C. Allowance includes cost of testing and certifying systems in accordance with cross connection tests.

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.

E. ASTM A167 - Stainless and Heat-Resisting Chromium - Nickel Steel Plate.

F. ASTM A269 - Stainless and Welded Austenitic Stainless Steel Tubing for General Service.

G. ASTM A403 - Wrought Austenitic Stainless Steel Piping Fittings.

H. ASTM B32 - Solder Metal.

I. ASTM B88 - Seamless Copper Water Tube.

J. ASTM B280 - Seamless Copper Tube for Air Conditioning and Refrigeration field Service.

K. AWS A5.8 - Filler Metal for Brazing and Braze Welding.

L. CGA P-2.1 - Medical-Surgical Vacuum Systems in Health Care Facilities.

M. CGA V-5 - Diameter Index Safety System (Non- Interchangeable Low Pressure Connections for Medical Gas Applications).

N. FM - Factory Mutual System - Approval Guide.

O. FS WW-V-35 - Valve, Ball.

P. FS WW-V-54 - Valve, Gate, Bronze (125, 150 and 200 Pound, Screwed, Flanged, Solder End, For Land Use).

Q. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture.

R. MSS SP-69 - Pipe Hangers and Supports - Selection and Application.

S. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves.

T. MSS SP-88 - Diaphragm Type Valves.

U. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

V. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

W. NFPA 50 - Bulk Oxygen Systems at Consumer Sites.

X. NFPA 70 - National Electrical Code.

Y. NFPA 99 - Standard for Health Care Facilities.

1.5 SUBMITTALS

A. Division 01 - Submittals: Procedures for submittals.

B. Product Data: Provide manufacturers literature and illustrations for all components indicating size, dimensions and configuration.

C. Shop Drawings: Indicate general assembly of components, mounting and installation details, and general layout of control and alarm panels. Submit detailed medical wall assembly drawings.

D. Independent Testing Agency Reports: Indicate systems are complete, zone valves installed, alarm systems functional, and pressure and cross connections tests performed. Document tests.

E. Manufacturer's Instructions: Indicate installation requirements for equipment and systems.

F. Manufacturer's Field Reports: Indicate systems are complete; zone valves installed, and alarm systems functional.

1.6 SUBMITTALS AT PROJECT CLOSEOUT

A. Division 01 - Contract Closeout: Procedures for submittals.

B. Project Record Documents: Record actual locations of piping, valving, and outlets.

C. Operation Data: Include installation instructions, assembly views, lubrication instructions, and assembly views.

D. Maintenance Data: Include maintenance and inspection data, replacement part numbers and availability, and service depot location and telephone.

1.7 QUALITY ASSURANCE

A. Perform Work in accordance with NFPA 99. Maintain one copy copies on site.

B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with a minimum of three (3) years' documented experience.

C. Installer Qualifications: Company specializing in performing the work of this section with a minimum of three (3) years' experience approved by manufacturer.

D. Testing Laboratory: Company specializing in performing the testing of this Section with a minimum of three (3) years' experience.

1.8 REGULATORY REQUIREMENTS

A. Conform to applicable code for medical gas systems.

B. Provide certificate of compliance from authority having jurisdiction indicating approval of systems.

C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.9 DELIVERY, STORAGE, AND PROTECTION

A. Deliver, store, protect, and handle products to site under provisions of Section 22 05 00.

B. Accept material on site in factory containers and packing. Inspect for damage.

C. Protect from damage and contamination by maintaining factory packaging and caps in place until installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. BeaconMedaes.

B. Chemtron.

C. Puritan Group.

D. Amico.

2.2 PIPE AND FITTINGS

A. Factory Preparation: Wash inside of copper pipe and copper fitting with hot solution of sodium carbonate or trisodium phosphate mixed 1 lb. to 3 gal of water; rinse with water, and blow dry with oil-free dry nitrogen or compressed air.

B. Oxygen, Compressed Air, Aboveground:
   1. Copper Tube: ASTM B88, Type L, hard drawn or ASTM B280, Type ACR-Oxy. Cleaned and bagged for oxygen use.
   2. Fittings: ANSI B16.18, cast copper alloy or ANSI B16.22, wrought copper.
   3. Joints: AWS A5.8 Classification BCuP-3 or BCuP-4 silver braze. Purge per NFPA 99 requirements.

C. Oxygen, Compressed Air, Buried:
   1. Copper Tube: ASTM B88, Type K, annealed.
   2. Fittings: ANSI B16.18, cast copper alloy or ANSI B16.22, wrought copper.
   3. Joints: AWS A5.8 Classification BCuP-3 or BCuP-4 silver braze. Purge per NFPA 99 requirements.

D. Vacuum, Aboveground:
   1. Copper Tube: ASTM B88, Type L, hard drawn or ASTM B280, Type ACR-Oxy.
   2. Fittings: ANSI B16.18, cast copper alloy or ANSI B16.22, wrought copper.
   3. Joints: AWS A5.8 Classification BCuP-3 or BCuP-4 silver braze or ASTM B32, solder, Grade 95TA. Purge per NFPA 99 requirements.

2.3 VALVES

A. Factory Preparation for Oxygen Service: Disassemble, clean, degrease, seal, and pack for shipping.

B. Ball Valves:
   1. FS WW-V-35 Type II, Class A, Style 1; MSS SP-110; bronze body, three piece, double-seal ball valves with replaceable neoprene or Teflon seat and stem seals, for minimum 600 psi cold working pressure, flange or union mounting, labeled for intended service.

C. Diaphragm Valves (Oxygen):
   1. MSS SP-88, brass-bodied, packless, diaphragm type with regrinding or renewable seats and disks, for minimum 300 psi working pressure.

D. Gate Valves (Vacuum):
   1. FS WW-V-54, Type II, Class B; MSS SP-80; Class 150 bronze body, bronze trim, rising stem, handwheel, inside screw, solid wedge disc, solder or threaded ends.

2.4 PIPING ACCESSORIES

A. Hangers and Supports: MSS SP-58 with types as required by MSS SP-69.

B. Pressure Gages:
   1. ANSI B40.1, white dials and black lettering with restrictor.
   2. Oxygen systems: Manufactured and labeled expressly for intended service; UL labeled.
   3. BeaconMedaes Model 841.

C. Vacuum Bottle Brackets: Stainless steel, chrome-plated metal, or aluminum with finish matching adjacent outlet.

D. Flexible Connectors: Corrugated flexible, single ply, seamless or seam-welded tubing of stainless steel or bronze or reinforced Teflon bellows or hose.

E. 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 construction.
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 chrome plated valves and tubing extensions.
5. Gages: Provide where indicated and in areas downstream of isolating valves.
6. BeaconMedaes Model 6802-9020.

F. Piping Identification: Pressure sensitive adhesive tape and decals, color and labeling to conform to Section 23 05 53.

2.5 OUTLETS

A. Outlet Units:
1. CGA V-5, Diameter Index Safety System (DISS), NFPA 99 non-interchangeable connectors, automatic valves, secondary check valves (except vacuum and evacuation outlets), and capped 3/8 inch tubing stubs for supply connections, color coded and labeled for intended service.

B. Faceplates:
1. Flush Outlets: Mount in galvanized steel boxes with stainless steel faceplate with Lexan cover, color coded with embossed labeling.
2. Surface Outlets: Surface mount with color coded plastic cover and stainless steel faceplate with Lexan cover, color coded with embossed labeling.

C. Electrical Convenience Receptacles: Refer to Section 26 27 26.

2.6 COMPRESSED AIR MANIFOLD

A. Duplex Compressed Air Manifold: Consist of wall mounted control cabinet and necessary header connection and pigtails for number of cylinders indicated. Arrange controls to have half of cylinders in service and half in reserve.

B. Manifold Delivery: Maximum 30 cfh compressed air continuously at 55 psi. Provide automatic changeover from primary to secondary bank and allow replacing depleted cylinders with no change in line pressure. Provide bank regulators to reduce cylinder pressure for line regulator set at 50 psi delivery pressure. Provide manifold relief valve set at 150 psi.

C. By-Pass System: Between regulators to service regulator or switch over system without interrupting supply of gas. Bleed valves allow adjustment of pressure reducing regulators.

D. Cabinet: House components in lockable cabinet with baked enamel finish.
1. Three front mounted gages indicate bank and hospital line pressures.
2. Green indicator light indicates service bank in use.
3. Red indicator light indicates reserve bank in use.
4. Provide terminal block connections for remote alarm.

E. BeaconMedaes Model 6804-9040-012.

2.7 MEDICAL VACUUM SYSTEM

A. Duplex Vacuum Pump:
   1. Duplex Oil-less Claw Medical Vacuum Pump Package: Tank mounted, each equipped with check valve, inlet flexible connector, water separator, strainer, compound gage, solenoid valve and metering valve for service liquid, exhaust muffler, motor coupling with guard.

B. Electrical Controls: Pre-wired in NEMA 250 Type 12 enclosure, with fusible disconnects, magnetic motor starters, overload protection with manual reset, control circuit transformers, automatic alternators, vacuum control switches, hand-off automatic switches in cabinet cover, and safety disconnect door.

C. Receiver: Welded steel ASME SEC 8 receiver, prime coated with vinyl lining, with gage, safety relief valve, and automatic tank drain.

2.8 LIQUID OXYGEN STORAGE TANK

A. Coordinate with Owner selected gas (oxygen) supplier.

B. Provide underground service main from bulk oxygen site.

2.9 ALARM SYSTEM

A. High-Low Pressure Alarm Panels: Closed circuit, self-monitoring type, to monitor oxygen, vacuum, compressed air, nitrous oxide, and nitrogen.
   1. Green light for systems normal.
   2. High or low pressure warning:
      a) Green light extinguishes.
      b) Audible warning device sounds.
      c) Red light energizes.
   3. Gage indicates pressure or vacuum.
   4. Switch silences warning device.
   5. Test switch to test light bulbs and audible warning device.
   6. Provide system with internal switches, gages, control unit, and transformer.

B. Master Alarm Panel:
   1. Closed circuit, self-monitoring type, to monitor oxygen, vacuum, compressed air, piping systems pressure or liquid level.
   2. Green light for systems normal.
   3. For abnormal condition:
      a) Green light extinguishes.
      b) Audible warning device sounds.
      c) Red light energizes.
   4. Switch silences warning device.
   5. Test switch to test light bulbs and audible warning device.
   6. Design system such that one, two or more monitors may be connected to a single pressure switch.
   7. Provide alarm points as indicated in NFPA 99 Table A.5.1.9.2 and as detailed on drawings.
   8. High-low pressure switch: Dual circuit with two single pole, double throw, snap action switches, tested at 180 psi with adjustable range of 4 psi, preset at 40 psi and 60 psi.
   9. Vacuum switch.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with NFPA 99.

B. Pre-Installation Cleaning: Disassemble positive pressure gas systems pipe, fittings, valves, and components, except those supplied cleaned and prepared for intended service, and thoroughly wash in hot solution of sodium carbonate or trisodium phosphate mixed 1 lb. to 3 gal. of water. After washing, rinse with water, dry and cap until installation.

C. Braze joints in pipe and tubing. Avoid leaving excess flux inside of pipe and fittings. During brazing of pipe connections, purge interior of pipe continuously with nitrogen.

D. Effect changes in size with reducing fittings. Make changes in direction of required turns or offsets with fittings or tubing shaped by bending tools. Make bends free of flattening, buckling or thinning of tube wall.

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. Encase buried oxygen piping in cast-iron pipe. Provide with FM listed heat trace with fixed temperature regulation, set for 80 degrees F maximum, and terminating at junction box, mounted near main oxygen supply shut-off valve. Insulate buried oxygen lines and heat trace with insulation as specified in Section 22 07 00.

H. Grade piping down in direction of flow.

I. Provide pipe sleeves where pipes and tubing pass through walls, floors, roofs, and partitions. Finish flush at both ends. Extend 2 inches (50 mm) above finished floors. Pack space between pipe or tubing and sleeve, and caulk.

J. Identify piping with tape and decals. Provide piping identification code and schematic. Refer to Section 22 05 53. Install labeling on pipe at intervals of not more than 20 feet (6 meters) and at least once in each room and each story traversed by pipeline.

K. Excavate and backfill pipe trenches as specified in Division 02. Coordinate provision of utility warning and identification tape with backfill operation. Provide above all buried lines at a depth of 8 to 12 inches below finish grade.

L. Support gas piping with pipe hooks or hangers suitable for size of pipe, spaced:
   1. ½ inch pipe or tubing: 72 inches.
   2. 3/4 inch or one inch pipe or tubing: 96 inches.
   3. 1-1/4 inches or larger (horizontal): 120 inches.
   4. 1-1/4 inches or larger (vertical): Every floor level.

M. Install underground piping in trench minimum 42 inches deep adequately protected against physical damage and corrosion, or in ducts and tunnels which are not occupied by fuel oil lines and are vented.

N. Except where indicated or in flush wall mounted cabinets, install manual shut off valves with stem vertical and accessible for operation and maintenance.

O. Install strainers on inlet side of pressure reducing valves. Provide main gas valves (pressure reducing or flow control) with by-passes and isolation valves to permit maintenance without interruption of gas.

P. Provide a valved by-pass around receivers.

Q. Vibration and Noise Isolation: Refer to Section 23 05 48.

R. Install bulk liquid oxygen system to NFPA 50 and under supervision of manufacturer. Provide bulk liquid oxygen systems with shut-off valve and connection point with valve for portable emergency oxygen supply. Install bulk oxygen to inlet side of oxygen manifold.

S. Provide electric motor drive equipment with electrical equipment and wiring. Refer to Section 26 05 05.

3.2 PIPING SYSTEMS CLEANING AND PRESSURE TESTING

A. After erection of pipe and tubing but prior to installation of service outlet valves, blow systems clear of free moisture and foreign matter with nitrogen gas.

B. Perform and document the following tests in strict accordance with NFPA 99 prior to performing the system verification test required by NFPA 99 5.1. 12.3.

System verification tests:
1. Initial Pressure Test.
2. Initial Cross Connection Test.
3. Initial Piping Purge Test.
4. Standing Pressure Test for Positive Pressure Medical Gas Piping.
5. Standing Vacuum Test for Vacuum Piping.

3.3 FIELD QUALITY CONTROL

A. Independent testing agency to certify system is complete, zone valves installed, alarm systems functional, and tests performed. Document tests and submit.

B. Reduce pressure in piping systems other than system under investigation to atmospheric.

C. Test system with dry nitrogen with test pressure in piping system at 50 psi.

D. Check each station outlet of every piping system to determine test gas is dispensed only from outlet of system under investigation. Measure pressure with gage attached to specific adaptor. Do not use universal adaptors.

E. Disconnect test gas and connect proper gas to each system. Purge entire system to remove test gas. Check with analyzer suitable for gas installed.

F. System verification testing shall be done in strict accordance with NFPA 99 5.1. 12.3 and shall include the following:
   1. Standing Pressure Test.
   2. Cross Connection Test.
   3. Value Test.
   4. Alarm Test.
   5. Piping Purge Test.
   6. Piping Particulate Test.
   7. Piping Purity Test.
   8. Final Tie in Test.
   9. Operational Pressure Test.
   10. Medical Gas Concentration Test.
   11. Source Equipment Verification.

END OF SECTION