SECTION 22 63 00
GAS SYSTEMS FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Central Laboratory and Healthcare Gas Systems: Consisting of oxygen, nitrous oxide, nitrogen, and compressed air services; complete, ready for operation, including all necessary piping, fittings, valves, cabinets, station outlets, rough-ins, ceiling services, gages, alarms including low voltage wiring, nitrogen control panels, cylinder manifolds, filters, pressure regulators and all necessary parts, accessories, connections and equipment. Match existing station outlet and inlet terminal connections.

B. Nitrous Oxide and Nitrogen Systems: Ready for connection to cylinders, but not including cylinders.

C. Laboratory and healthcare gas system alarm wiring from equipment to alarm panels.

1.2 RELATED WORK

A. Sealing around pipe penetrations to maintain the integrity of time rated construction: Section 07 84 00, FIRESTOPPING.

B. Sealing around pipe penetrations through the floor to prevent moisture migration: Section 07 92 00, JOINT SEALANTS.

C. General requirements and items common to more than one section of Division 22. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

D. Alarm interface with ECC. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

E. Conduit: Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS.

F. Control wiring: Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER

CONDUCTORS AND CABLES (600 VOLTS AND BELOW).

G. Electrical wiring and accessories: Section 26 27 26, WIRING DEVICES.

H. Electric motors: Section 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT.

I. Motor starters: Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.

J. Prefabricated bedside patient units: Section 10 25 13, PATIENT BED SERVICE WALLS.

K. Vacuum Piping and Equipment: SECTION 22 62 00, VACUUM SYSTEMS FOR LABORATORY AND HEALTHCARE FACILITIES

L. SECTION 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

Requirements for commissioning, systems readiness checklist, and training.

1.3 QUALITY ASSURANCE

A. Materials and Installation: In accordance with NFPA 99, (2005) and as specified.

B. Equipment Installer: Show technical qualifications and previous experience in installing laboratory and healthcare equipment on three similar projects. Submit names and addresses of referenced projects. Installers shall meet the qualifications of ANSI/ASSE Standard 6010.

C. Equipment Supplier: Show evidence of equivalent product installed at three installations similar to this project that has been in satisfactory and efficient operation for three years. Submit names and addresses where the product is installed.

D. Laboratory and healthcare System Testing Organization: The testing shall be conducted by a party technically competent and experienced in the field of laboratory and healthcare pipeline testing. Testing and systems verification shall be performed by personnel meeting the qualifications of ANSI/ASSE Standard 6030. Such testing shall be performed by a party other than the installing contractor.

E. Provide names of three projects where testing of medical or laboratory gases systems has been performed by the testing agency. Include the name of the project, names of such persons at that project who supervised the work for the project owner, or who accepted the report for the project owner, and a written statement that the projects listed required work of similar scope to that set forth in this specification.

F. Submit the testing agency's detailed procedure which will be followed in the testing of this project. Include details of the testing sequence,

procedures for cross connection tests, outlet function tests, alarm tests, purity tests, etc., as required by this specification. For purity test procedures, include data on test methods, types of equipment to be used, calibration sources and method references.

G. Certification: Provide documentation prior to submitting request for final inspection to include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and a certification that all results of tests were within limits allowed by this specification.

H. Installing contractor shall maintain as-built drawings of each completed phases for verification; and, shall provide the complete set at the time of final systems certification testing, for certification by the Third Party Testing Company. As-built drawings shall be provided on prints and in digital format. The digital format shall be in the native CAD system required for the project design. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the ‘third party testing company’ requirement.

I. “Hot taps” are not permitted for operating medical oxygen systems. Methods for connection and extension of active and pressurized medical gas systems without subsequent medical gas testing and verification are not allowed.

1.4 SUBMITTALS

A. Submit as one package in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Manufacturer's Literature and Data:

1. Piping.

2. Valves.

3. Inlet and outlet cocks

4. Valve cabinets.

5. Gages.

6. Station outlets and rough-in assemblies.

7. Ceiling services.

8. Alarm controls and panels.

9. Pressure Switches.

10. Nitrogen control panels.

11. Manifolds.

C. Station Outlets: Submit letter from manufacturer stating that outlets are designed and manufactured to comply with NFPA 99. Outlet shall bear label of approval as an assembly, of Underwriters Laboratories, Inc., or Associated Factory Mutual Research Corporation. In lieu of above labels, certificate may be submitted by a nationally recognized independent testing laboratory, satisfactory to the Contracting Officer, certifying that materials, appliances and assemblies conform to published standards, including methods of tests, of above organizations.

D. Certification: The completed systems have been installed, tested, purged, analyzed and verified in accordance with the requirements of this specification.

E. Completed System Readiness Checklist provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

1.5 TRAINING

A. Furnish the services of a competent instructor for not less than two four-hour periods for instructing personnel in the operation and maintenance of the laboratory and healthcare gas systems, on the dates requested by COTR.

B. Coordinate with other requirements specified in Section 01 00 00, GENERAL REQUIREMENTS.

1.6 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the test by the basic designation only.

B. American Society for Testing and Materials (ASTM):

B819-(R2006).....Seamless Copper Tube for Medical Gas Systems

C. American Society of Mechanical Engineers (ASME):

A13.1-07.....Scheme for Identification of Piping Systems

B16.22-01(R2005).....Wrought Copper and Bronze Solder-Joint Pressure Fittings

B40.100 (2005) .....Pressure Gauges and Gauge Attachments Boiler and Pressure Vessel Code -

Section VIII-07.....Pressure Vessels, Division I

Section IX-07.....Welding and Brazing Qualifications

D. American Welding Society (AWS):

AWS A5.8-04.....Brazing Filler Metal

AWS B2.2-91.....Standard for Brazing Procedure and Performance Qualification (Modified per NFPA 99)

E. Compressed Gas Association (CGA):

C-9-04.....Standard Color Marking of Compressed Gas Cylinders

G-4.1 (2009).....Cleaning Equipment for Oxygen Service

G-10.1(2008) .....Nitrogen, Commodity

P-9-01.....Inert Gases Argon, Nitrogen and Helium

V-1-05.....Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections

F. National Electrical Manufacturers Association (NEMA):

ICS-6-93(R2006).....Industrial Controls and Systems Enclosures

G. National Fire Protection Association (NFPA):

99-05.....Health Care Facilities

H. United States Pharmacopoeia XXI/National Formulary XVI (USP/NF)

I. Manufacturing Standardization Society (MSS):

MSS-SP-72-99.....Ball Valves With Flanged or Butt Welding For General Purpose

MSS-SP-110-96.....Ball Valve Threaded, Socket Welding, Solder Joint, Grooved and Flared Ends

MSS-SP-73-03.....Brazing Joints for Copper and Copper Alloy Solder Pressure Fittings

PART 2 - PRODUCTS

2.1 PIPING AND FITTINGS

A. Copper Tubing: Type "K", ASTM B819, seamless copper tube, hard drawn temper, with wrought copper fittings conforming to ASME B16.22 or brazing fittings complying with MSS SP-73. Size designated reflecting nominal inside diameter. All tubing and fittings shall be labeled "ACR/OXY", "OXY", "OXY/MED", "ACR/MED", or "MED".

B. Brazing Alloy: AWS A5.8, Classification BCuP, greater than 537 °C (1000 °F) melting temperature. Flux is strictly prohibited for copper-to-copper connections.

C. Screw Joints: Polytetrafluoroethylene (teflon) tape.

D. Memory metal couplings: Temperature and pressure rating shall not be less than that of a brazed joint.

E. Apply piping identification labels at the time of installation in accordance with current NFPA. Apply supplementary color identification in accordance with CGA Pamphlet C-9.

F. Special Fittings: The following special fittings shall be permitted to be used in lieu of brazed joints:

1. Memory-metal couplings having temperature and pressure ratings joints not less than that of a brazed joint.

2. Listed or approved metallic gas tube fittings that, when made up, provide a permanent joint having the mechanical, thermal, and sealing integrity of a brazed joint.

3. Dielectric fittings where required by the manufacturer of special medical equipment to electrically isolate the equipment from the piping distribution system.

4. Axially swaged, elastic strain preload fittings providing metal to metal seal having pressure and temperature ratings not less than that of a brazed joint and when complete are permanent and non-separable.

2.2 EXPOSED LABORATORY AND HEALTHCARE GASES PIPING

A. Finished Room: Use full iron pipe size chrome plated brass piping for exposed laboratory and healthcare gas piping connecting fixtures, casework, cabinets, equipment and reagent racks when not concealed by apron including those furnished by the Government or specified in other sections.

1. Pipe: Fed. Spec. WW-P-351, standard weight.

2. Fittings: ASME B16.15 cast bronze threaded fittings with chrome finish, (125 and 250 PS1 Classes).

3. Nipples: ASTM B 687, Chromium-plated.

4. Unions: Mss SP-72, SP-110, Brass or Bronze with chrome finish. Unions 65 mm (2-1/2 inches) and larger shall be flange type with approved gaskets.

5. Valves: Mss SP-72, SP-110, Brass or bronze with chrome finish.

2.3 VALVES

A. Ball: In-line, other than zone valves in cabinets:

1. Seventy five millimeter (2 1/2 inches) and smaller: Bronze/ brass body, Fed. Spec. MSS SP72 & SP 110 , Type II, Class 150, Style 1, with tubing extensions for brazed connections, full port, three-piece or double union end connections, teflon seat seals, full flow, 4125 kPa (600 psi) WOG minimum working pressure, with locking type handle, cleaned for oxygen use and labeled for intended service

2. Eighty to one hundred millimeter (3-4 inches): Bronze/ brass body, Fed. Spec. MSS SP72 & SP 110, Type II, Class 150, Style 1 with tubing extensions brazed to flanges, full port~~ed~~, three piece, double seal, teflon seals, full flow, 4125 kPa (600 psi) WOG minimum working

pressure, with locking type handle, cleaned for oxygen use and labeled for intended service.

B. Check:

1. Eighty millimeter (3 inches) and smaller: Bronze/brass body, straight through design for minimum pressure drop, spring loaded, self aligning with teflon cone seat, vibration free, silent operation, supplied NPT female threads at each end with flow direction arrow permanently cast into, cleaned for oxygen use and labeled for intended service, 2750 kPa (400 psi) WOG minimum working pressure.

2. One hundred millimeter (4 inches) and larger: Iron body, bronze trim, swing type, vertical or horizontal installation, flange connection, with flow direction arrow permanently cast into, cleaned for oxygen use and labeled for intended service, 1025 kPa (150 psi) WSP.

C. Zone Valve in Cabinet: Ball valve, bronze/ brass body, double seal, three piece or double union end connections, replaceable teflon seat seals, teflon stem seal, 4125 kPa (600 psi) WOG, cold, non-shock gas working pressure service to 100 kPa (29 inch Hg), cleaned for oxygen use and labeled for intended service, blowout proof stem, one quarter turn of handle to completely open or close. Provide tubing extensions factory brazed, and pressure tested. Provide 3 mm (1/8 inch) NPT gauge port for a 50mm (2 inch) diameter monitoring gauge downstream of the shut off valve. Zone valves shall be securely attached to the cabinet and provided with type-K copper tube extensions for making connection to system piping outside the cabinet. Zone valves shall be products of one manufacturer, and uniform throughout in pattern, overall size and appearance. Trim with color coded plastic inserts or color coded stick-on labels. Install valves in cabinets such that cover window cannot be in place when any valve is in the closed position. Color coding for identification plates and labels is as follows:

SERVICE LABEL	**IDENTIFICATION COLORS**	**MFG. STD. CLR.**
OXYGEN	White letters on green background	GREEN
NITROUS OXIDE	White letters on blue background	BLUE

SERVICE LABEL	IDENTIFICATION COLORS	MFG. STD. CLR.
NITROGEN	White letters on black background	BLACK
MEDICAL AIR	Black or white letters on yellow background	YELLOW

2.4 VALVE CABINETS

A. Flush mounted commercially available item for use with laboratory and healthcare services, not lighter than 1.3 mm (18 gage) steel or 1.9 mm (14 gage) extruded aluminum, rigidly assembled, of adequate size to accommodate valve(s) and fittings. Punch or drill sides to receive tubing. Provide anchors to secure cabinet to wall construction. Seal openings in cabinet to be dust tight. Locate bottom of cabinet 1375 mm (4 foot 6 inches) above floor.

B. Mount engraved rigid plastic identification plate on wall above or adjacent to cabinet. Color code identification plate to match gas identification colors as indicated above. Identification plate must be clearly visible at all times. Provide inscriptions on plate to read in substance: "VALVE CONTROL SUPPLY TO ROOMS."

C. Cover plate: Fabricate from 1.3 mm (18 gage) sheet metal with satin chromed finish, extruded anodized aluminum, or .85 mm (22 gage) stainless steel. Provide cover window of replaceable plastic, with a corrosion resistant device or lever secured to window for emergency window removal. Permanently paint or stencil on window: CAUTION-CLOSE ONLY IN EMERGENCY, SHUT-OFF VALVES FOR PIPED GASES", or equivalent wording. Configure such that it is not possible to install window with any valve in the closed position. Each valve shall have gauge upstream of valve inside valve box.

D. Cabinets and isolation valves shall be located and piped as shown, and at a minimum, so as to allow the isolation of each smoke compartment separately. No cabinet shall serve more than one smoke compartment.

2.5 GAGES

A. Pressure Gages: Includes gages temporarily supplied for testing purposes.

1. For line pressure use adjacent to source equipment: ASME B40.1, pressure gage, single, size 115 mm (4-1/2 inches), for compressed air, nitrogen and oxygen, accurate to within two percent, with metal case. Range shall be two times operating pressure. Dial graduations and figures shall be black on a white background, or white on a black background. Gage shall be cleaned for oxygen use, labeled for appropriate service, and marked "USE NO OIL". Install with gage cock.

2. For all services downstream of main shutoff valve: Manufactured for oxygen use, labeled for the appropriate service and marked "USE NO OIL", 40 mm (1-1/2 inch) diameter gage with dial range 1-690 kPa (1-100 psi) for air service.

2.6 STATION OUTLETS

A. For all services except ceiling hose drops and nitrogen system: For designated service, consisting of a quick coupler and inlet supply tube. Provide coupler that is non-interchangeable with other services, and leak proof under three times the normal working pressure. Equip each station outlet with an automatic valve and a secondary check valve to conform with NFPA 99. Equip each station inlet with an automatic valve to conform with NFPA 99. Place valves in the assembly to provide easy access after installation for servicing and replacement, and to facilitate line blow-out, purging, and testing. Fasten each outlet and inlet securely to rough-in to prevent floating and provide each with a capped stub length of 6 mm (1/4-inch) (10 mm outside diameter) (3/8-inch outside diameter) tubing for connection to supply. Identification of each gas service shall be permanently cast into the back plate and shall be visible through a transparent plastic guard. Label stub tubing for appropriate service. Rough-in kits and test plugs for Prefabricated Bedside Patient Units (PBPU) are furnished under this specification but installed by manufacturer of PBPUs before initial test specified herein. Install completion kits (valve body and face plate) for the remainder of required tests.

B. For Ceiling Hose Drops and Nitrogen Service: Brass, stainless steel or chromed metal non-interchangeable DISS connections for appropriate service to conform with CGA V-5. Equip each station outlet with an automatic valve and a secondary check valve to conform with NFPA 99. Equip each station inlet with an automatic valve to conform with NFPA 99. Place valves in the assembly to provide easy access after

installation, for servicing and replacement, and to facilitate line blow-out, purging, and testing. Fasten each outlet and inlet securely to rough-in to prevent floating, and provide each with a capped stub length of 6 mm (1/4-inch) (10 mm (3/8-inch) outside diameter) tubing for connection to supply. Label stub tubing for appropriate service. Adjust to compensate for variations in plaster or cover thickness.

2.7 STATION OUTLET ROUGH-IN

A. Flush mounted, protected against corrosion. Anchor rough-in securely to unit or wall construction.

B. Modular Cover Plate: Die cast back plate, two-piece .85 mm (22 gage) stainless steel or 1.6 mm (16 gage) chromium plated metal, with mounting flanges on all four sides, secured to rough-in with stainless steel or chromium plated countersunk screws.

C. Cover Plate for Prefabricated Bedside Patient Units (PBPU): One-piece with construction and material as indicated for modular cover plate.

D. Provide permanent, metal or plastic, identification plates securely fastened at each outlet and inlet opening, with inscription for appropriate service using color coded letters and background. Metal plates shall have letters embossed on baked-on enamel background. Color coding for identification plates is as follows:

SERVICE LABEL	IDENTIFICATION PLATE COLORS
OXYGEN	White letters on green background
NITROUS OXIDE	White letters on blue background
NITROGEN	White letters on black background
MEDICAL AIR	Black or white letters on yellow

2.8 ALARMS

A. Provide all low voltage control wiring, except for wiring from alarm relay interface control cabinet to ECC, required for complete, proper functioning system, in conformance with Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW). Run wiring in conduit, in conformance with Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS.

B. Local Alarm Functions: Provide individual local air compressor malfunction alarms at each compressor system main control panel.

1. Vacuum Pump Malfunction Alarm: Pump system receives the following individual signals and sends a single consolidated pump malfunction alarm signal to master alarm.

a. High Temperature Shut down Alarm: Functions when exhaust air temperature exceeds 104 °C (220 °F), shutting down affected pump.

b. Lead Pump Fails to Start Alarm: Functions when lead pump fails to start when actuated causing lag pump to start.

c. Lag Pump In Use Alarm: Functions when the primary or lead vacuum pump in incapable of satisfying the demand. When three or more vacuum pumps are part of the system, the lag pump in use alarm shall energize when the last vacuum pump has been signaled to start.

C. Nitrogen Alarms:

a. Reserve switchover alarm: Functions when, or just before, secondary or reserve nitrogen supply goes in operation.

b. Pressure alarms: Functions when system pressure downstream of main shutoff valve drops below 1310 kPa (190 psi), plus/minus 14 kPa (2 psi) or increases above 1510 kPa (220 psi), plus/minus 14 kPa (2 psi) set points; operated by pressure switches or transmitters.

c. Cylinder reserve pressure low: Functions when the content of a cylinder reserve header is reduced below one day’s average supply.

3. Compressed Air Alarms:

a. Medical air dew point high alarm: Functions when the line pressure dew point rises above 2 °C (35 °F) at 380 kPa (55 psi).

b. Pressure Abnormal Alarm: Functions when system pressure downstream of main shutoff valve drops below 550 kPa (80 psi) (plus/minus gage or increases above 830 kPa (120 psi) (plus/minus 14 kPa (2 psi) set points; operated by pressure switch.

c. Compressor Malfunction Alarm: Functions when compressor system control panel signals compressor thermal malfunction alarm, lead compressor fails to start alarm or high water level in receiver or separator (if so required) receives signal from system control panel.

d. Low Lubricant Shutdown: For rotary screw compressors. Functions when lubricant level drops to a low point. Receives signal from compressor control panel.

e. Instrument air dew point high alarm: Functions when the line pressure dew point rises above -30 °C (-22 °F) at 380 kPa (55 psi).

D. Alarm Functions:

1. Oxygen, nitrous oxide, and compressed air alarms: Pressure alarms: Functions when pressure in branch drops below 275 kPa (40 psi), plus/minus 14 kPa (2 psi) or increases above 414 kPa (60 psi), plus/minus 14 kPa (2 psi) set points; operated by pressure switches or transmitters.

2. Nitrogen alarms: Pressure alarms: Functions when pressure in branch drops below 1310 kPa (190 psi), plus/minus 14 kPa (2 psi) or increases above 1500 kPa (220 psi), plus/minus 14 kPa (2 psi) set points; operated by pressure switches or transmitters.

3. Vacuum alarms: Low vacuum alarm: Functions when vacuum in branch drops below 40 kPa (12-inches Hg); operated by vacuum switch.

a. Reserve switchover alarm: Functions when secondary or reserve manifold supply goes in operation.

b. Pressure alarms: Function when system pressure downstream of main shutoff valve drops below set points, operated by pressure switches or transmitters.

4. Vacuum alarms:

a. Low vacuum alarm: Function when system vacuum upstream of main shutoff valve drops below 40 kPa (12 inches Hg); operated by vacuum switch.

b. Filter differential pressure/back pressure alarm: Functions when discharge oil filter differential rises to set level, or when back pressure is sensed; receives signal from pump control panel.

c. Laboratory vacuum pump malfunction.

E. Alarm Panels:

1. General: Modular design, easily serviced and maintained; alarms operate on alternative current low voltage control circuit; provide required number of transformers for efficient functioning of complete system. Alarm panels shall be integral units, reporting compressed air and vacuum services, as required.

2. Box: Flush mounted, sectional or one piece, corrosion protected. Size to accommodate required number of service functions for each location, and for one audible signal in each box. Anchor box securely. Provide spare capacity to accommodate 50% of the number of provided alarm points.

3. Cover plate: Designed to accommodate required number of signals, visual and audible, for each location, and containing adequate operating instructions within the operator's view. Bezel shall be extruded aluminum, chromium plated metal, or plastic. Secure to the box with chromium plated or stainless steel countersunk screws.

4. Service indicator lights: Red translucent plastic or LED with proper service identification inscribed thereon. Number of lights and service instruction shall be as required for each location. Provide each panel with a green test button of the same material, inscribed with "PUSH TO TEST" or similar message.

5. Audible signal: Provide one in each alarm panel and connect electrically with all service indicator light functions.

6. Controls:

a. Visual signal: When the condition occurs which any individual service indicator light is to report, button for particular service shall give a lighted visual signal which cannot be canceled until such condition is corrected.

b. Audible signal: Alarm shall give an audible signal upon circuit energization of any visual signal. Audible signal shall be continuous until silenced by pushing a button. This shall cancel and reset audible only, and not affect the visual signal. After silencing, subsequent alarms shall reactivate the audible alarm.

c. Signal tester: Test button or separate normal light shall be continuously lighted to indicate electrical circuit serving each individual alarm is energized. Pushing test button shall temporarily activate all visual signals and sound audible signal, thereby providing desired indications of status of system.

F. Alarm Relay Interface Control Cabinet: Design cabinet to transfer the closed circuit alarm signals through relays to a set of terminals for monitoring signals at the ECC without interrupting the closed circuit system. Construct of 1.9 mm (14 gage) steel, conforming with NEMA ICS-6, Type 1, enclosures. Provide both normally open and normally closed contacts for output signals, with number of circuits required for full alarm capability at the ECC. Refer to Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC for compatibility.

G. Alarm Network Communication: Network communications board shall be installed in local alarm and connected to the facility’s Ethernet. Local alarm modules shall send information to the master alarm and the data can be downloaded thru the computer connected to the facility’s Ethernet. Master alarm displays the message, sound its alarm and saves the information in an event log. This event log shall be downloaded to a computer file for tracking data and troubleshooting.

2.9 PRESSURE SWITCHES

General purpose, contact or mercury type, allowing both high and low pressure set points, with contact type provided with a protective dust cover; adjustable range set by inside or outside adjustment; switches activate when indicated by alarm requirements. Use one orifice nipple (or DISS demand check valve) for each sensor or pressure switch.

2.10 NITROGEN CONTROL PANEL (NCP)

A. General: For nitrogen service, consisting of a line pressure control regulator, outlet line pressure gage, DISS service outlet, and supply valve, assembled and rigidly mounted in a roughing-in assembly, and provided with a metal cover plate. Panel shall be designed to deliver 10

L/s (20 SCFM) at 1535 kpa (223 psi). Unit may be recessed wall mounted or integral with the articulating arm or column with individual regulators for each outlet.

B. Manifold Assembly: Mounted to a steel support bracket, factory assembled and tested, ready for installation in the roughing-in assembly.

1. Supply valve, bronze bodied, double seal, full flow, ball type, designed for working pressure in excess of 1700 kPa (300) psi, with chrome plated brass ball which seals in both directions, requiring only a quarter turn of the knob from open to closed position.

2. Line pressure control regulator, self-relieving, diaphragm type, with high-flow precision adjustment and working pressure in excess of 1700 kPa (250 psi).

3. Line pressure gage, to monitor the gas outlet line pressure, calibrated from 0 to 2000 kPa (300 psi) in increments of 100 kPa (10 psi).

4. Nitrogen service outlet, DISS type as specified under Article, STATION OUTLETS, with a self-sealing dust plug, having a working pressure of 1700 kPa (250 psi) maximum.

5. Two 146 mm (5-3/4 inch) lengths of 10 mm (3/8-inch) outside diameter type "K" copper tubing for connection to gas service supply line and to remote outlet line.

C. Roughing-In Assembly: Designed for recessed installation, consisting of a prime painted steel fabricated back box with mounting flanges on all four sides, with provisions to securely anchor the back box to wall construction. Equip with a crossover "U" tube to facilitate testing of the nitrogen system prior to the manifold installation, and a plaster shield to prevent dust or other foreign matter from contaminating internal parts prior to final assembly.

D. Cover plate Assembly: Chromed cast metal or NAAMM Number 4 satin finished stainless steel panel with provisions for line pressure gage(s), nitrogen outlet, regulator and supply valve knobs, attaching directly to the roughing-in assembly by means of four Number 6 - 32 by 40 mm (1-1/2 inch) long mounting screws, with plaster adjustments up to 20 mm (3/4 inch).

2.11 CYLINDER GAS SUPPLY MANIFOLDS

A. Non-ferrous metal manifold and fittings, valves, parts and connections, suitable for a regular working pressure of 21 MPa (3000 psi). Gas cylinders at manifold shall be individually chained to wall or floor with adequate support.

B. Duplex arrangement, each bank having number of cylinder connections as required, high pressure copper cylinder connection pigtails with brazed fittings. Shutting of either bank shall not interrupt supply to system.

C. Provide manifold with two (one for each bank) two-stage pressure regulators with gages and built-in safety valves, manifold header valves and check valves, service line connection valves, relief valves, tank connecting coils and handles, and all required equipment for a complete assembly. Enclose manifold controls in sheet metal cabinet.

D. Switch-over to full reserve bank shall be automatic when one cylinder bank becomes exhausted, with no fluctuation in pressure, and not require resetting of regulators. After replacement of empty tank, resetting of controls shall be automatic or by single lever. Reserve switch-over shall be actuated by pressure switch; alarm shall be part of manifold control.

2.12 PRESSURE REGULATORS:

A. For 690 kPa (100 psi) regulator, provide duplex in parallel, valve for maintenance shut-down without service interruption. For additional pressures, locate regulators remote from compressor near point of use, and provide with isolation valves and valve bypass.

1. For systems 5 L/s (10 scfm) and below: Brass or bronze body and trim, reduced pressure range 170 – 850 kPa (25 – 125 psi) adjustable, spring type, diaphragm operated diaphragm operated, relieving. Delivered pressure shall vary not more than one kPa (0.15psi) for each 10 kPa (1.5psi) variation in inlet pressure.

2.13 EMERGENCY LOW PRESSURE OXYGEN INLET

A. The Low Pressure Emergency Oxygen Inlet provides an inlet for connecting a temporary auxiliary source of oxygen to the oxygen pipeline system for emergency or maintenance situations per NFPA 99.

B. The inlet consist of a 1" (25 mm) ball valve, pressure gauge and a 1/2"/1" NPTF connection housed in a weather tight enclosure. The

enclosure is labeled "Emergency Low Pressure Gaseous Oxygen Inlet", and includes a padlock staple to prevent tampering or unauthorized access. The enclosure is suitable for recess mounting on the exterior of the building being served. The enclosure is 14 gauge, cold rolled steel with a primer coat of paint. The Emergency Oxygen Inlet is connected at a point downstream of the main supply line shutoff valve.

C. Check valves are provided for installation in the emergency supply line and ~~i~~in the main supply line between the main line shutoff valve and the emergency supply line connection per by NFPA 99. Check valves have a cast bronze body and straight through design for minimum pressure drop.

D. The check valves for sizes under 3" (76 mm) are soft seated, bubble tight, self aligning, and spring loaded, and ball type check valves. Three inch (76 mm) check valves are hard seated, spring loaded, self aligning ball type checks with cone seats (3" valves may not be "bubble tight"). Check valves are fast acting.

E. A relief valve is provided for installation in the emergency supply line per NFPA 99. The relief valve has a brass body, single seat design, and is cleaned for oxygen use. It automatically reseats to provide a "bubble tight" seal after discharging excess gas. Pre-set at 75 psi.

PART 3 - EXECUTION

3.1 INSTALLATION

A. In accordance with current NFPA. Run buried oxygen piping in PVC protective pipe for entire length including enclosure of fittings and changes of direction.

B. Install cast escutcheon with set screw at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.

C. Keep open ends of tube capped or plugged at all times or otherwise sealed until final assembly.

D. Cut piping square and accurately with a tube cutter (sawing not permitted) to measurements determined at place of installation. Ream tube to remove burrs, being careful not to expand tube, and so no chips of copper remain in the tube. Work into place without springing or forcing. Bottom tube in socket so there are no gaps between tube and fitting. Exercise care in handling equipment and tools used in cutting

or reaming of tube to prevent oil or grease being introduced into tubing. Where contamination has occurred, material is no longer suitable for oxygen service.

E. Spacing of hangers: Current NFPA.

F. Rigidly support valves and other equipment to prevent strain on tube or joints.

G. While being brazed, joints shall be continuously purged with *oil* free nitrogen. The flow of purged gas shall be maintained until joint is cool to touch.

H. Do not bend tubing. Use fittings.

I. Support ceiling column assembly from heavy sub-mounting castings furnished with the unit as part of roughing-in. Anchor with 15 mm (1/2-inch) diameter bolts attached to angle iron frame supported from structural ceiling, unless otherwise indicated.

J. Provide two 25 mm (1 inch) minimum conduits from ceiling column assembly to adjacent corridor, one for mass spectrometer tubing and wiring and one for monitor wiring, for connection to signal cabling network.

K. Install pressure switches, transmitter and gauges to be easily accessed, and provide access panel where installed above plaster ceiling. Install pressure switch and sensors with orifice nipple between the pipe line and switches/sensors.

L. Apply pipe labeling during installation process and not after installation is completed. Size of legend letters shall be in accordance with ANSI A13.1.

M. Pipe compressor intake to a source of clean ambient air as indicated in current NFPA.

N. After initial leakage testing is completed, allow piping to remain pressurized with testing gas until testing agency performs final tests.

O. Penetrations:

1. Fire Stopping: Where pipes pass through fire partitions, fire walls, smoked partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases as

specified in Section 07 84 00, FIRESTOPPING, with intumescent materials only. Completely fill and seal clearances between raceways and openings with the fire stopping material.

2. Waterproofing: At floor penetrations, completely seal clearances around the pipe and make watertight with sealant as specified in Section 07 92 00, JOINT SEALANTS.

P. Provide 40mm (1 1/2 inch) diameter line pressure gage downstream of zone valve in cabinets.

Q. Provide zone valves in cabinets where indicated and outside each Operating Room and a minimum one zone valve assembly for each 18 outlet set.

3.2 TESTS

A. Initial Tests: Blow down, and high and low pressure leakage tests as required by current NFPA with documentation.

B. Laboratory and healthcare testing agency shall perform the following:

1. Perform and document all cross connection tests, labeling verification, supply system operation, and valve and alarm operation tests as required by, and in accordance with, current NFPA and the procedures set forth in pre-qualification documentation.

2. Verify that the systems, as installed, meet or exceed the requirements of current NFPA, this specification, and that the systems operate as required.

3. Piping purge test: For each positive pressure gas system, verify cleanliness of piping system. Filter a minimum of 35 cubic feet (1000 liters) of gas through a clean white 0.45 micron filter at a minimum velocity of 3.5 scfm (100 Lpm). Filter shall show no discoloration, and shall accrue no more than 0.1 mg of matter. Test each zone at the outlet most remote from the source. Perform test with the use of an inert gas as described in CGA P-9.

4. Piping purity test: For each positive pressure system, verify purity of piping system. Test each zone at the most remote outlet for dew point, carbon monoxide, total hydrocarbons (as methane), and halogenated hydrocarbons, and compare with source gas. The two tests

must in no case exceed variation as specified in Paragraph, Maximum Allowable Variation. Perform test with the use of an inert gas as described in CGA P-9.

5. Outlet and inlet flow test:

   a. Test all outlets for flow. Perform test with the use of an inert gas as described in CGA P-9.

   b. Oxygen, nitrous oxide and air outlets must deliver 100 Lpm (3.5 scfm) with a pressure drop of no more than 35 kPa (5 psi), and static pressure of 350 kPa (50 psi).

   c. Nitrogen outlets must deliver 565 Lpm (20 scfm) with a pressure drop of no more than 35 kPa (5 psi), and static pressure of 1445 kPa (210 psi).

   d. Needle valve air outlets must deliver 1.5 scfm with a pressure drop of no more than five psi, and static pressure of 350 kPa (50 psi).

6. Source Contamination Test: Analyze each pressure gas source for concentration of contaminants, by volume. Take samples for air system test at the intake and at a point immediately downstream of the final filter outlet. The compared tests must in no case exceed variation as specified in Paragraph, Maximum Allowable Variation. Allowable concentrations are below the following:

Dew point, air	4 degrees C (39 degrees F) pressure dew point at 690 kPa (100 psi)
Carbon monoxide, air	10 mg/L (ppm)
Carbon dioxide, air	500 mg/L (ppm)
Gaseous hydrocarbons as methane, air	25 mg/L (ppm)
Halogenated hydrocarbons, air	2 mg/L (ppm)

7. Analysis Test:

a. Analyze each pressure gas source and outlet for concentration of gas, by volume.

b. Make analysis with instruments designed to measure the specific gas dispensed.

c. Allowable concentrations are within the following:

1) Laboratory air 19.5 percent to 23.5 percent oxygen.

Oxygen	>=97 plus percent oxygen
Nitrous oxide	>=99 plus percent nitrous oxide
Nitrogen	>=99 plus percent nitrogen
Medical air	19.5 percent to 23.5 percent oxygen
Carbon Dioxide	99 plus percent carbon dioxide

8. Maximum Allowable Variation: Between comparative test results required are as follows:

Dew point	2 degrees C (36 degrees F)
Carbon monoxide	2 mg/L (ppm)
Total hydrocarbons as methane	1 mg/L (ppm)
Halogenated hydrocarbons	2 mg/L (ppm)

C. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the Project Engineer and Commissioning Agent. Provide a minimum of 7 days prior to notice.

3.3 CONNECTION TO EXISTING LABORATORY GAS SYSTEM:

A. Contactor shall test the existing system for hydrocarbons, dew point, etc. If problems are present, the Project Engineer (RE) would notify the facility of the results. The facility would then make the necessary repairs and/ or maintenance.

B. Install shut-off valve at the connection of new line to existing line.

C. Coordinate time for shut-down of the existing laboratory and healthcare system with the VA medical center.

D. Shut off all oxygen zone valves and gas riser valves if the section to be connected to cannot be totally isolated from the remainder of the system.

E. Prior to any work being done, check the new pipeline for particulate or other forms of contamination.

F. Insure that the correct type of pipe tubing and fittings are being used.

G. Make a spot check of the existing pipelines in the facility to determine the level of cleanness present.

H. Reduce the pressure to zero and make the tie-in as quickly as possible. A nitrogen purge is not required since this would require another opening in the pipe.

I. After the tie-in is made and allowed to cool, slowly bleed the source gas back into the pipeline. Test the work area for leaks with soapy water and repair any leaks.

J. After all leaks, if any, are repaired and the line is fully recharged, perform blow down and testing. Open the zone that is closest to the main to the system, access the closest outlet to the work, and blow the main through the outlet. After the outlet blows clear into a white cloth, make an additional check at a zone most distant from the work. Perform all required current NFPA tests after connection.

3.4 COMMISSIONING

A. Provide commissioning documentation accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS for all inspection, startup, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.

B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS and related sections for contractor responsibilities for system commissioning.

3.5 DEMONSTRATION AND TRAINING

A. Provide services of manufacturer’s technical representative for four hours to instruct VA Personnel in operation and maintenance of units.

B. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

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