SECTION 15480 – MEDICAL PLUMBING SYSTEMS

PART 1 – GENERAL

1.1 WORK INCLUDED

A. The work shall include labor, materials, tools, equipment, transportation, insurance, temporary protection, supervision and incidental items essential for proper installation and operation, even though not specifically mentioned or indicated on the drawings but which are usually provided or are essential for proper installation of systems related to this Section, as indicated on the drawings and specified herein.

B. The specifications and drawings describe the minimum requirements that must be met for the installation of all work as shown on the drawings and as specified hereinunder.

C. Shop drawings.

D. Field acceptance testing.

1.2 RELATED SECTIONS

A. Examine drawings and criteria sheets and other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1. Section 15050: Basic Mechanical Materials and Methods
2. Section 15055: Through-Penetration Firestop Systems
3. Section 15060: Hangers and Supports
4. Section 15075: Mechanical Identification
5. Section 15241: Mechanical Vibration controls and Seismic Restraints
6. Section 15410 – Plumbing Valves
7. Section 15420 – Plumbing Distribution Piping
8. Section 15430 – Drainage and Vent Piping
9. Section 15440 – Plumbing Specialties
10. Section 15450 – Plumbing Fixtures
11. Section 15460 – Plumbing Equipment

1.3 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as following:

1. ANSI American National Standards Institute
2. ASME American Society of Mechanical Engineers
3. ASTM American Society of Testing Materials ASTM B88-78: Wrought Copper Fittings
4. AWS American Welding Society
5. CS Commercial Standards, U.S. Department of Commerce
6. FM Factory Mutual
7. FS Federal Specification, U.S. Government
8. MSS Manufacturer's Standardization Society of the Valve and Fittings Industry
9. UL Underwriters Laboratories, Inc.
10. OSHA Occupational Safety and Health Act
11. ASPE American Society of Plumbing Engineers
12. NFPA National Fire Protection Association
13. ASSE American Society of Sanitary Engineers

1.4 ALTERNATES

A. Refer to Section 01230 – ALTERNATES.

1.5 SUBMITTALS

A. Refer to Section 01330 – SUBMITTAL PROCEDURES.

B. Prepare and submit shop drawings in accordance with the requirements of the General Conditions and Supplementary General Conditions and in the manner described herein, modified as note hereinafter.

C. Submittals: The following documents shall be provided;

1. Medical vacuum system.
2. Manifold gas system.
3. Medical gas pipe materials and valves.
4. Medical compressed air system.
5. Waste anesthetic gas disposal system (WAGD)
6. Instrument compressed air system
7. Medical gas outlets/inlets
8. Medical gas alarms

D. Installer Certification: The following installer qualifications shall be submitted for review and approval:

1. State Certification of ASSE 6000 Compliance.

1.6 QUALITY ASSURANCE

A. Refer to Section 01400 – QUALITY REQUIREMENTS.

B. Qualifications

1. Manufacturer: Company specializing in manufacturing the type of products specified in this section, with minimum ten (10) years of documented experience.

1.7 EXTENT OF WORK

A. This section pertains to all other labor, equipment and services necessary for and incidental to the oxygen, medical air, medical vacuum, nitrogen, nitrous oxide, WAGD and carbon dioxide systems as shown on the drawings and specified herein.

B. Provide source equipment, alarms, valves, outlets and inlets, piping and fittings and all associated components and materials required for complete systems as shown on the drawings, specifications and manufacturer's instructions as listed herein.

1. The bulk oxygen system shall be supplied and installed under separate contract. This Contractor shall be responsible for all medical gas work from the bulk system point of connection to the facility and the low voltage electrical connections from the bulk oxygen alarm pressure switches to the facilities new master alarm panels.

C. Contractor shall make all necessary connections to Owner furnished equipment.

D. Install all piping as shown on drawings, as described herein and as described in NFPA 99, Latest Edition, ASSE 6010 and Section 15050, BASIC MECHANICAL MATERIALS AND METHODS, using methods of fabrication, grading, testing, repairing, cleaning and other procedures as described.

E. High voltage (>115VAC) electrical wiring for ceiling columns, alarms, vacuum pump, air compressor, manifolds and modular accessories associated with the system(s) shall be part of the electrical contract. Any equipment supplied by Mechanical/Plumbing Contractor that requires additional electrical services other than the specified products shall be the responsibility of the Mechanical/Plumbing Contractor to supply these services.

F. Retain a qualified installer (ASSE 6010 Qualified) as specified and per NFPA 99, Latest Edition. The installing company shall be pre-approved by the Owner.

G. Retain a qualified third party verifier (MGPHO Credentialed and ASSE 6030 qualified) as specified herein and per NFPA 99, Latest Edition. The verifier shall be acceptable to the Engineer and Owner to perform and attest to final verification of the system. If items or areas of non-conformance are noted, the installer or manufacturer shall make corrections as required and the verifier shall periodically check with the Contractor during installation of the pipeline systems equipment and perform additional testing if necessary to attain acceptable certification.

H. Finished medical gas and vacuum systems shall be complete, compliant with NFPA 99, Latest Edition in every material respect and ready to be put into operation. All materials used shall be new and comply with NFPA 99, Latest Edition requirements for materials and workmanship shall be first class in every respect. Contractor shall be responsible for compliance with all Local, State or Federal codes.

I. This Contractor shall retain the services of an on-site factory trained Engineer or authorized representative to inspect, adjust and place in operating condition the medical plumbing systems. Refer to 15050, 1.24 for additional requirements.

PART 2 – PRODUCTS

2.1 PIPING, FITTINGS AND JOINTS

A. Medical Gas and Vacuum Pipe and Fittings

1. All pipe and fittings shall be specially cleaned and prepared for medical oxygen service by the manufacturer or by a cleaning service company and received sealed on the job. Each length of tube shall be permanently labeled and delivered plugged and capped. Fittings shall be sealed and marked. The Contractor shall furnish documentation certifying that all piping materials comply with the requirements of this paragraph.
2. Medical gas (air, oxygen, nitrous oxide, dental air, carbon dioxide) piping and medical vacuum (patient, medical, surgical, dental, WAGD) piping shall be ASTM B819 Type "L" hard drawn seamless copper tube.
3. Nitrogen piping shall be ASTM B819, Type "K" hard drawn seamless copper tube.
4. Medical gas and medical vacuum pneumatic alarm connections (3/8" O.D. tubing) shall be ASTM B819 type "L" hard drawn seamless copper tube.
5. Medical air system intakes, medical vacuum exhausts and manifold relief vents shall be ASTM B88, B280 or B819 Type "L" hard drawn copper tube.
6. Fittings: for copper tubing shall be wrought copper fittings, deep socket, designed expressly for brazing at temperature greater than 1000°F and comply with ANSI B16.22. Cast flare or compression fittings shall not be used for brazed joints. Bent tubing shall not be used in place of fittings.
7. Brazing Alloy: for assembling braze-joint fittings shall be Copper-Phosphorus or Copper-Phosphorous-Silver Brazing (BCuP series) filler metals and comply with ANSI/AWS A5.8. Flux shall not be used.

2.2 VALVES

A. Medical Gas Valves

1. Zone or Section Valves

a. All valves and tubing shall be specially prepared for oxygen service and shall conform in all particulars to NFPA 99, Latest Edition.

b. All valves shall be 3-piece ball type with teflon "O" ring stem seal, rated at not less than 300 psig actuated from full "ON" to full "OFF" for 90° turn of valve handle.
c. Valves shall be provided with Type-K copper tube extensions with 1/8" NPT gauge port.
d. Color-coded gas identification labels shall be provided with each valve. Pressure/vacuum gauges shall be located immediately adjacent to each shut-off on the patient side.
e. Valves shall be packaged in polyethylene bag.
f. Shut-off valves shall be labeled to identify the medical gas/vacuum service, rooms or areas served and a caution not to close (or open) except in an emergency.
g. All main, riser, isolation and sectional valves shall include lockable handles and shall be locked open unless noted otherwise.

2. Main, Riser, Isolation and Section Valves

a. ½" through 2" shall be Beacon Medaes 6-211XXX-00, or approved equal, full port (3) piece ball valve, lockable handles, extensions and gauge port.
b. 2½" through 4" shall be Beacon Medaes 6-230XXX-00, or approved equal, full port (3) piece ball valve, lockable handles and extensions.
c. All main, riser, isolation and sectional valves shall be locked open unless noted otherwise.

3. Medical Gas Zone Valve Boxes (ZVB)

a. Valve boxes shall be constructed of 18-gauge sheet steel white epoxy finish and provided with two galvanized steel brackets that anchor the box to the wall.
b. Anchor brackets shall be designed to permit box assemblies to be ganged together in a vertical stack.
c. Factory installed tubing shall extend at least 3" beyond the box and the valve body shall be swung out of line of heat transfer, permitting joint to be brazed without obstruction or heat damage to valve. Open ends of tubing shall be capped to avoid pre-installation contamination.
d. The zone valve box shall be provided with an anodized aluminum trim capable of adjusting to variations in wall thickness up to 1" below flush.
e. The zone valve box assembly shall have a sliding, opaque door with pull ring and clear gauge window. The door shall be capable of sliding to the right or left to facilitate installation requirements. In an emergency, the door shall SNAP-OUT by pulling the pull ring forward without exposing sharp edges.
f. The window shall conceal exposed piping and valves within the box and shall be labeled "Caution – Medical Gas Shutoff Valves – Close Only in Emergency".
g. Clear gauge window shall be to display the gas service and the area controlled by the valve. Placement of the valve handle within the box shall be such that the plastic pull out window cannot be replaced with the valve handle in the off position.
h. The zone valve box assembly shall be supplied with color-coded gas identification labels. All boxes shall be labeled for rooms served by valves.

i. Medical Gas Zone Valve Boxes (ZVB) shall be Beacon Medaes Model 6-150XXX-00, Allied or Squire Cogswell.
j. Refer to documents for orientation and location.

4. Purge Valves

a. Shall be 1/4" (3) piece ball valve with threaded connections.

5. Gauges

a. Main line pneumatic gauges shall be Beacon Medaes or Allied, Bourdon Tube Gauge, cleaned for oxygen use and installed with gauge cock. Gauge face shall read 0-100 PSI for all pressure gases except Nitrogen and vacuum. Nitrogen gauge face shall read 0-400 PSI, vacuum gauge face shall read 0-30" Hg.

2.3 MEDICAL AIR COMPRESSOR SYSTEM

A. Furnish and install per plans and specifications one (1) Beacon Medaes Medical Products Model LPS-70-5080, Medical Compressed Air System, comprised of two (2) 15 HP scroll compressor modules, each driven by a 15 HP motor, each rated for 25.2 SCFM @ 100 psig. The system shall be of a single point connection, base mounted design consisting of two (2) stack mounted compressor modules. The complete package must be fully compliant with the latest edition of NFPA 99 and shall be pre-wired, pre-piped, and assembled to include one common base with single point connections for electrical, intake air, and discharge air.

B. The compressors shall be a continuous duty rated scroll type with sealed bearings. The design shall be single-stage, air-cooled, consisting of one fixed and one orbiting scroll sealed with PTFE tip seals between the scroll halves and rated for 120 psig discharge pressure. The scrolls shall be protected from dust or contamination with a two part face seal. Orbiting bearings shall be grease filled and permanently sealed type requiring no lubrication at any time. The drive bearings shall be grease filled and lip sealed with a maintenance interval of not less than 10,000 hours. The scroll case shall be constructed of diecast aluminum. Maximum heat dissipation shall be achieved through an integral cooling fan and air ducting. The compressor shall be v-belt driven and protected by an OSHA approved totally enclosed belt guard. A sliding motor mounting base that is fully adjustable with one adjusting screw shall achieve belt tensioning. The motor shall be a NEMA rated, ODP, 3600 RPM, with a 1.15 service factory suitable for 460V electrical service. Each compressor shall have a piped intake manifold with one inline inlet air filter with isolation valve. Each compressor shall be equipped with an integral air-cooled aftercooler designed for a maximum approach temperature of 15 deg. F, complete with automatic solenoid drain valve. Each compressor must be equipped with a wired high discharge air temperature shutdown switch. The compressor discharge line shall include a flex connector, safety relief valve, isolation valve and check valve. The discharge piping of each compressor shall incorporate an integral valve to provide load-less starting and rapid air evacuation between the check valve and scroll discharge at shutdown to produce less than 1/4 revolution of reverse rotation of the scroll. The discharge air piping shall be of ASTM B-819 copper tubing, brass, and/or stainless steel. The discharge flex connector shall be braided 304 SS, brass, or bronze.

C. The compressor module shall be fully isolated from the system base by means of a four-point, heavy duty isolation system for a minimum of 95% isolation efficiency. Seismically restrained isolators shall be provided.

D. The vertical air receiver shall be corrosion resistant, ASME Coded, National Board Certified, rated for a minimum 150 PSIG design pressure and include a liquid level gauge glass, safety relief valve, manual drain valve, and a timed automatic solenoid drain valve.

E. The Duplex Dryer System shall be a Beacon Medaes Medical Products Model No. LLD-20D-RK, or Allied, comprised of two (2) twin tower desiccant dryers, pre-filters, afterfilters, regulators, safety relief valves, and integral purge saving control system within a four-valve bypass arrangement. Each desiccant dryer must be individually sized for peak calculated demand and capable of producing a - 12 deg. C (10 deg. F) pressure dew point at 100 psig. Dryer purge flow shall be minimized through an integral demand based purge saving control system that shall include a 441 transfer valve utilizing 2 ceramic slide plates that is covered by a 10-year factory warranty. The inlet to each dryer shall include a mounted pre-filter rated for 0.01 micron with automatic drain and element change indicator. Fully duplexed final line filters rated for 0.01 micron with element change indicators and duplexed final line regulators and duplexed safety relief valves shall be factory mounted and piped.

F. The Duplex mounted and wired control system shall be NEMA 12 and UL labeled. This control system shall provide automatic lead/lag sequencing with circuit breaker disconnects for each compressor module with external operators, full voltage motor starters with overload protection, 120V control circuit transformers for each motor circuit, phase reversal protection, visual and audible reserve unit alarm with isolated contacts for remote alarm, hand-off-auto lighted selector switches, pressure gauge and run time hourmeters for each compressor. Automatic alternation of the compressors based on a first-on/first-off principle with provisions for simultaneous operation if required, automatic activation of reserve unit if required, visual and audible alarm indicator high discharge air temperature shutdown with isolated contacts for remote alarm shall be included.

G. The dryer shall incorporate a dew point hygrometer that is mounted, prepiped wired and includes remote alarm contacts. The hygrometer sensor shall be a ceramic type. Aluminum oxide sensors are not acceptable. Dewpoint alarm shall be factory set at 39 deg. F (4 deg. C) per NFPA 99. High dew point condition shall be indicated with visual and audible alarm.

H. Also furnished pre-piped, mounted and wired will be a CO monitor to include remote alarm contacts. The CO sensor shall be a chemical type with system accuracy of +/- 2 PPM. The CO Alarm shall be factory set at 10 PPM per NFPA 99.

I. The Medical Compressed Air System shall be warranted against defects in material and workmanship under normal use for a period of not to exceed thirty (30) months from date of shipment, or, twenty-four (24) months from date of start-up.

2.4 MEDICAL VACUUM PUMP SYSTEM

A. Provide a Duplex medical vacuum system complying with latest edition of NFPA 99 and as manufactured by Beacon Medaes, Squire Cogswell or Allied.

B. The package consists of two (2), oil-less rotary claw vacuum pumps, a control panel, and a receiver sized for appropriate demand all mounted on a common base frame. The receiver is ASME coded and has a three-valve bypass system to allow for draining of the receiver without interrupting the vacuum service. A manual drain is provided on the receiver. Each pump and the receiver is connected to a common intake manifold. A single point of connection to the intake of the system is provided. A single point of connection to the electrical panel of the system is also provided. The package shall be completely testing prior to shipment.

C. Each pump is direct driven, non-contacting claw type, capable of operating at 22.5" HgV (sea level) continuous duty. The pumping chamber is oil free. The pump is completely air-cooled with no water requirements. The pump has an inlet air filter and is equipped with a vacuum relief valve, check valve to prevent backflow through off-cycle units, flexible connector, isolation valve, high discharge temperature switch, high inlet vacuum switch, and exhaust muffler at each pump location. The only preventative maintenance requirements are periodic inlet air filter change-out.

D. The pump is direct driven. Torque is transmitted from the motor to the pump through a shaft coupling. The claws are synchronized by heavy-duty precision timing gears.

E. The motor is a continuous duty, NEMA rated, C-face, TEFC 3600 RPM, with 1.15 service factor suitable for 460Vm 60 hertz, 3 phase electrical service.

F. Each vacuum pump has a factory piped intake with integral flex connector, isolation valve, and check valve. Interconnecting piping shall consist of black iron pipe and fittings.

G. The vacuum receiver is ASME Code stamped, and rated for a minimum 150 PSIG design pressure.

H. The system manufacturer shall provide startup supervision by a qualified technician.

I. System Specifics

1.	Beacon Medeas Model No. LVS–10D–N240	
2.	Hp each pump	10
3.	System HP	20 (Total plant including lag pump)
4.	Capacity at 19" Hg, each pump	55 scfm
5.	System, per NFPA	55 scfm (not including lag)

2.5 MANIFOLD GAS SYSTEMS

A. Furnish and install one (1) Beacon Medical Products *LifeLine*, Squire Cogswell or Allied automatic switchover medical gas manifold Model 6-107011-6 for nitrous oxide, manifold 6-

107014-10 for nitrogen. The manifold will accommodate 12 cylinders of nitrous oxide, and 12 cylinders of nitrogen equally divided into two banks. The cylinder banks are arranged in a staggered configuration and provide an uninterrupted supply of gas. The manifold is cleaned, tested, and prepared for the indicated gas service and constructed in accordance with requirements of the latest edition of NFPA 99 and CGA.

B. A bank regulator (one for each cylinder bank) is used to initially reduce the cylinder pressure to the two line regulators which control the final line pressure. Both line pressure regulators are in service at all times to maximize flow rates. The manifold automatically changes from the depleted primary supply bank to the secondary supply bank without fluctuation in line pressure utilizing dome-bias loading and unloading of the bank regulators. After replacement of the depleted cylinders, the manifold automatically indicates the cylinder bank recently replaced as the secondary supply. Manual resetting of the control panel is NOT necessary. The manifold includes a line pressure gauge, two cylinder bank pressure gauges (left-bank and right-bank), and color-coded indicator LED visual indicators for “IN USE” (green), “READY” (yellow), and “EMPTY” (red) for each cylinder bank. The manifold has intermediate and line pressure relief valves that are internally connected to a common vent port, terminating into a ½” FNPT O-ring sealed “zero clearance” union. Master shutoff valves (one for each cylinder bank) are located within the manifold cabinet and both valves are fabricated with metallic seating surfaces. The cabinet enclosure is easily removable by releasing draw latches for component accessibility and the enclosure may be secured from unauthorized access by locking the draw latches (locks provided by others).

C. The manifold includes high-pressure modular header assemblies with gas specific pigtail-to-header check valves to permit changing of cylinders without gas leakage. Stainless steel flexible pigtails are provided for each cylinder gas connection. A separate power supply is furnished with the manifold to convert 120 VAC to 24 VAC output power and includes dry contacts for (2) separate, electrically isolated, remote alarm connections. The power supply is housed in a NEMA 3R enclosure with electrical requirements of (1) amp at 120 VAC, 60 HZ, single phase. The manifold is supplied with a 3/4” FNPT O-Ring sealed “zero clearance” union outlet. The system also includes a 3/4” full port, three piece, ball-type source shut-off valve with a 1/8” FNPT port. The source valve has a 3/4” NPT attachment to the union outlet and a 3/4” nominal copper (type K) tube for brazing to main supply line.

D. Manifolds are to be installed in accordance with requirements stated by NFPA 99, CGA, and all applicable local codes.

2.6 MEDICAL GAS OUTLETS AND CONNECTIONS

A. Medical gas station outlets/inlets shall be UL listed, and compliant with NFPA 99, Latest Edition, recessed, non-interchangeable interlocking stainless steel faceplate, complete with rough-in box, washed and capped Type "K" copper pigtail, and secondary check valve. Provide vacuum slide at each vacuum system. All outlets shall be as scheduled and oriented in accordance with the schedule on the documents and in accordance with the architectural headwall elevations.

1. Quick Connect: Beacon Medaes

a.	Oxygen:	6-121020-00
b.	Nitrous Oxide:	6-121021-00
c.	Air:	6-121022-00
d.	Vacuum:	6-121023-00
e.	WAGD:	6-121029-00
f.	Slide Bracket:	6-120978-00

2. DISS Connection: Beacon Medaes

a.	Oxygen:	6-121100-00
b.	Nitrous Oxide:	6-121101-00
c.	Air:	6-121102-00
d.	Vacuum:	6-121103-00
e.	CO_2:	6-121110-00
f.	Nitrogen:	6-121104-00
g.	WAGD:	6-121109-00
h.	Slide Bracket:	6-120978-00

B. Emergency Oxygen Connection

1. The connection shall be a recessed, watertight enclosure with padlock staple, complete with line size check valves installed on both main and emergency supply lines, shutoff at inlet and relief valve piped to the exterior and pressure gauge. Emergency low pressure oxygen inlet equal to Beacon Medaes Model 6-140340-00, Squire Cogswell or Allied.
2. The components shall be cleaned for oxygen service, capped and factory assembled.

C. Nitrogen or Medical Support Gas Control Panel and Outlet

1. Nitrogen or Medical Support Gas control panels shall be designed to deliver variable pressures to power pneumatic surgical tools.
2. Located immediately upstream of this gauge shall be a supply line shut-off valve, rated at not less than 300 psig. A quarter turn of the valve handle shall be required to obtain a fully “open” or “closed” position.
3. An adjustable self-relieving type pressure regulator, with an operating range of 12 to 250 psig shall provide required pressure to the service outlet.
4. The control panel shall be pre-piped internally requiring only external supply line connections. Additional outlets in the same room may be connected to the remote outlet pigtail furnished in the control panel. Remote outlets shall be regulated by the adjustable pressure regulator within the panel and shall match the nitrogen control panel outlet.
5. The control panel shall be available in horizontal or vertical orientation.
6. Beacon Medaes Model 6-120276-01, Squire Cogswell or Allied, with DISS outlet, inlet and outlet pressure gauges, ¼-turn shutoff valve and pressure regulator mounted in a rough-in assembly complete with cover plate.

2.7 MEDICAL GAS AND MEDICAL VACUUM ALARMS

A. Medical Gas (Air, Oxygen, Nitrous Oxide, Nitrogen, Carbon Dioxide) and Medical Vacuum (Patient, Medical, Surgical, WAGD) shall be alarmed. The electrical contractor shall provide necessary 120 volt wiring from the life safety branch of the emergency power system and conduit for the operation of all medical gas alarm panels. Control and interlocking wiring and conduit shall be furnished and installed by this Subcontractor, including wiring of pressure switches, gas manifolds, tanks farms and equipment to master alarm panels and wiring of pulse sensors/transducers to area alarm panels.

1. The medical gas alarm system shall be Beacon Medaes TotalAlert™ Alarm Network System, Series 6819, Allied or Squire Cogswell and shall comply with NFPA 99 Latest Edition.
2. The Alarm Network shall be a fully electronic monitoring system. It monitors and displays the status of all piped gas and vacuum systems that are in a typical healthcare facility by using Master Alarms, Area Alarms, and Local Alarms that monitor the following:

    a. Medical gas and vacuum supplies; Mainline pressure and vacuum; Area zone pressure and vacuum, selected compressor operating conditions, selected vacuum pump operating conditions, selected manifold operating conditions, and other source equipment conditions per the drawings.

3. The Alarm Network shall provide the capability to browse, download, configure, and troubleshoot Master Alarms and Area Alarms using the facility's terminals and/or a personal computer that is connected to the facility's Ethernet. The alarm's Web pages are built-in; no additional software or setup is required.
4. The alarm system shall be capable of, when any alarms or events occur on the network, display the message, sound its alarm, and save the information in an event log. This event log can be downloaded to a computer file for tracking data and troubleshooting.
5. The alarm system shall be capable of, when there is an alarm condition, sending up to five electronic messages (page, e-mails, etc.) to notify the appropriate personnel whenever an alarm occurs.

B. Master Alarms

1. Shall be capable of continuously monitoring either 30 or 60 input signals, being supervised for open circuits.
2. Shall be capable of interfacing with conventional building automation equipment by using dry-contact, normally open or normally closed relay contacts. Alarm shall include Building Automation System N2 mapping.
3. Power requirements shall be 120 VAC, 60 Hz, critical branch.
4. Accessory Components: Appropriate signals (required by NFPA 99) shall be provided.
5. Alarm system shall be complete with the needed remote sensing switches and gauges. DISS Demand Checks are required for both switches and main line gauges.
6. The master alarms shall be configurable (3) ways: via the front panel of the alarm; with a computer directly connected to the alarm; or through the facility's Ethernet system.

7. Signal cabling requirements are: maximum distance – 10,000 feet; signal cable-stranded, 22-gauge, shielded, twisted-pair; signal power – 20 V DC. 20 mA maximum.
8. Master Alarm Points

ALARM		SENSING DEVICE	DEVICE LOCATION
Nitrous Oxide	High Line Pressure Main	High & Low Switch	Outlet Side Source Valve
Nitrous Oxide	Low Line Pressure Main	High & Low Switch	Outlet Side Source Valve
Nitrous Oxide	Changeover	Contacts	Manifold
Nitrogen	High Line Pressure Main	High and Low Switch	Outlet Side Source Valve
Nitrogen	Low Line Pressure Main	Low and Low Switch	Outlet Side Source Valve
Nitrogen	Changeover	Contacts	Manifold
Air	Low Line Pressure Main	Contacts	Outlet Side Source Valve
Air	High Line Pressure Main	Contacts	Outlet Side Source Valve
Air	Dewpoint High	Contacts	Control Panel
Air	Carbon Monoxide High	Contacts	Control Panel
Air	Lag Compressor in Use	Contacts	Control Panel
Air	Air Temperature High	Contacts	Control Panel
Air	High Water Level (Receiver)	Contacts	Control Panel
Oxygen	High Line Pressure	High & Low Switch	Outlet Side Main Valve
Oxygen	Low Line Pressure	High & Low Switch	Outlet Side Main Valve
Oxygen	Main Tank Low Liquid	Contacts	Tank Farm
Oxygen	Reserve Liquid Low	Contacts	Tank Farm
Oxygen	Reserve Low Pressure	Contacts	Tank Farm
Vacuum	Low Vacuum Main	Vacuum Switch	Inlet Side Main Valve
Vacuum	Lag Pump in Use	Contacts	Control Panel
Vacuum	Inlet Temperature High	Contacts	Control Panel
(b) Non-Liquid Ring Compressor			

C. Area Alarms (MGAP)

1. The Area Alarm shall continuously display the actual pressure or vacuum of the type of gas being monitored, unless there is an alarm error. In that case, the error code displays.
2. The alarm shall provide separate Normal, High and Low LED indicators on each module: a green LED is used for Normal Conditions and red LED's are used for High and Low alarm conditions. An audible alarm is mounted on the P.C. Board inside the front panel.
3. During normal operation, the Test Key on each module starts a self-diagnostic routine of the seven segment displays, the LEDs, and the audible alarm.
4. Gas-specific transducers remotely monitor pressure and vacuum lines. The transducers are provided with the Area Alarm, are gas specific and include DISS gas specific demand valve installed at the factory.
5. Transducers shall transmit a digital signal to their respective gas-specific Area Alarm Modules at a distance up to 4500'. Signal cable shall be stranded, 22-gauge, shielded, twisted-pair. Transducers shall receive their power from their respective Area Alarm Modules.
6. Transducers shall be housed in a transparent enclosure and have an LED inside the housing used to indicate proper function.
7. Transducers not connected to the appropriate gas-specific Area Alarm Module shall transmit an error message to the Area Alarm Module display.
8. Transducers not performing properly shall transmit an error message to its respective Area Alarm Module display.
9. The alarm shall be configured to the NFPA-99 standard values at the factory, but are field adjustable for high and set-points. Pressing the increment/decrement keys displays the pressure set-points.
10. The Area Alarm has as an optional network communications board that interfaces with the facility's Ethernet via switch or hub. This allows a user to browse and configure the Area Alarm by using a local terminal or personal computer that is logged onto the facility's Ethernet. Area alarm can also be configured from face of unit without the use of a computer.
11. The Area Alarm can be an independent or an integral component of the TotalAlert™ Alarm Network.

D. Combination Alarm: The combination alarm shall be as specified for Master and Area Alarms above, provided in one common housing for both systems.

E. Local Alarm

1. The Local Alarm shall provide connections for monitoring up to 16 signals from source equipment. There shall be individual alarm indicators for each signal. When an alarm condition occurs, the Local Alarm shall provide both an audible and visual indication.
2. The front panel shall have a Test key and a Silence key. Pressing the Test key shall test the LED indicators and audible alarm. Pressing the Silence key shall silence the audible alarm. The LED indicator shall remain lit until the alarm condition is eliminated.
3. Signal cable shall be stranded, 22-gauge, shielded, twisted-pair.
4. The Local Alarm is a stand-alone component of the alarm network.

F. Pressure Switches

1. Pressure medical gas mains shall be equipped with UL listed high/low switch, Beacon Medaes, Squire Cogswell or Allied, and shall be controlled by a copper diaphragm type pressure capsule and gas specific check valve.
2. Vacuum mains shall be equipped with a UL listed vacuum switch, Beacon Medaes, Squire Cogswell or Allied. The switch shall be a single pole, double throw, snap action type wired to signal either increasing or decreasing vacuum levels and controlled by a copper bellows vacuum sensing element.
3. Nitrogen mains shall be equipped with a UL listed switch, Beacon Medaes, Squire Cogswell or Allied with an adjustable range of 0 to 250 psig, adjustable differential of 3 to 30 psi and a maximum pressure rating of 900 psig.
4. Switches and gages shall be fully accessible. Provide access panel where installed above hard ceilings.
5. Provide gas specific demand check valves between pipeline and switch, sensor or gage.

PART 3 – EXECUTION

3.1 EXAMINATION / PREPARATION

A. Inspect existing site conditions in areas where piping and equipment will be installed and verify existing systems and the impact of the proposed modifications before fabricating systems to be installed.

B. Notify the Architect immediately regarding any substantially different conditions than those shown in the Contract Documents.

3.2 CORE DRILLING

A. All core drilling required for the installation of the plumbing system is to be done by the Plumbing Subcontractor. This contractor shall carry all costs for core drilling. The General Contractor will not be responsible for any circular penetrations required for the proper installation of the plumbing system. Locate all required openings prior to coring, coordinate the opening with the General Contractor and all other trades. Do not disturb the existing systems. Thoroughly investigate the existing conditions in the vicinity of the required opening prior to coring. This Subcontractor shall be responsible for damages to the building and its systems from the coring operations. Disturbances from coring shall be kept to a minimum.

3.3 MEDICAL GAS PIPING SYSTEMS INSTALLATION

A. The entire medical gas and medical vacuum system shall be installed in accordance with NFPA 99-latest edition and ASSE 6000 except where amended by these specifications.

B. The installation of equipment and individual components shall be made in accordance with the instructions of the manufacturer. These instructions shall be submitted to the owner and made part of the operation and maintenance manuals.

C. All piping, valves, fittings and components for medical gas and medical vacuum use shall be supplied cleaned, capped or bagged and prepared and certified for medical oxygen service by the manufacturer and be received sealed on the job.

D. Piping

1. Pipe shall be cut square with a tubing cutter with sharp cutting wheels. All burred ends of all piping and tubing shall be reamed to full bore of the pipe or tube and all chips shall be removed. Piping shall not be bent. Provide fittings for all changes in direction. Tools used in cutting and reaming shall be kept free from oil, grease or other lubricants not suitable for medical oxygen service. All cuts shall be cleaned and restored to original pipe dimensions. Where contamination has occurred, the items affected shall be recleaned in accordance with NFPA 99. Joints shall be brazed within one hour of being cleaned. Two or more medical gas or vacuum systems shall not be interconnected at any time during installation or testing.
2. All brazing shall be performed according to ANSI/AWS C3.4 and by installers certified under ASSE 6010. Brazed joints shall be considered Class B brazed joints. While brazing, all joints shall be continuously purged with nitrogen N.F. Flux shall not be used. Final connections of new piping to existing (in-use) piping shall be made without a nitrogen purge.
3. During and after installation, openings in the piping shall be kept capped by an external cap, except that during brazing, a discharge hole (holes) shall be provided to allow the discharge of purge gas. During brazing, the purge gas flow rate shall be maintained at a level that will not produce excessive positive pressures in the piping system. The flow of purge gas shall be maintained until the joint is cool to the touch. After brazing, the discharge hole (holes) shall be sealed with a nitrogen atmosphere maintained.
4. All joints in the piping shall be made with silver bearing copper-phosphorus (BCuP) brazing alloy (melting point at least 1000 degrees F). The use of flux is prohibited. The outside of the tube and fittings shall be cleaned by washing with hot water and a stainless steel brush after brazing.
5. Each brazed joint shall be visually examined after cleaning. The following conditions shall be considered unacceptable:

    a. Flux or flux residue.
    b. Excessive oxidation.
    c. Presence of unmelted filter 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 component.
    f. Cracks in the braze filler metal.
    g. Failure to hold the test pressure.

6. Defective brazed joints shall be repaired or replaced in accordance with NFPA 99. No joint shall be repaired more than twice. Cracked joints or joints exhibiting excessive oxidation shall be replaced.
7. Threaded joints shall be kept to a minimum. Liquid sealants are prohibited.
8. Identify and permanently mark all piping as it is installed with pre-approved labels and direction arrows. Labeling shall be applied at intervals of not more than 20 feet, at least once in each room and at each story traversed by the pipe. All labels must be positioned to be easily seen and read.
9. Piping shall be supported from the building structure in accordance with MSS Standard Practice SP-69, Piping Hangers and Supports - Selection and Application. Hangers and supports shall comply with MSS Standard Practice SP-58, Piping Hangers and Supports - Materials, Design and Manufacture. Portions of hangers in contact with copper tube shall have a copper finish or other protection against galvanic corrosion. Maximum support spacing shall be as follows:

a.	3/8 in. nominal	5 ft. (Alarm/gage tubing only)
b.	1/2 in. nominal	5 ft.
c.	3.4 in. nominal	5 ft.
d.	1 in. nominal	5 ft.
e.	1-1/4 in. nominal	6 ft.
f.	1-1/2 in. nominal and larger	10 ft.

   g. Where a single pipe is to be supported, an adjustable steel clevis hanger (MSS Type-1) shall be used.
   h. Where pipe is to be supported on racks, a U-bolt (MSS Type-24) shall be used.

10. After installation of the piping, but before installation of the outlet valves, the lines shall be blown down (purged) by means of dry nitrogen. NOTE: Large lines should be purged before small lines are attached.
11. Changes of direction in medical vacuum piping shall be made with T-fitting and cleanout plug. The cleanout shall be made with a cast brass street female adapter with brass plug. The cleanout shall be accessible for rodding. Medical vacuum piping changes of direction (½" & ¾") from vertical to horizontal shall be made with long sweep 90° bends.
12. Manifold relief vents shall be vented to atmosphere.
13. Buried piping from bulk tanks shall be protected from freezing, corrosion and damage. Minimum depth of bury is 36". Provide continuous tape or marker at approximately 1/2 the depth of bury.
14. Piping shall not be installed in kitchens or electric rooms.
15. Drops to individual outlets or inlets shall not be less than 1/2" for medical gases and 3/4" for vacuum and WAGD.
16. Branch take-offs and run-outs from horizontal piping shall be taken off the centerline of the main or branch pipe and rise vertically or at an angle of not less than 45 degrees from vertical.

E. Valves and Gauges

1. Furnish and install any and all valves including purge valves, required to isolate sections of the piping systems extending into areas for construction at a later date. Provide all

valves to properly test each system with respect to the construction phasing and as essentially indicated on the drawings. Provide all required adapters, valves and interconnecting tubing required to perform the medical gas testing as required by the Hospital. Identify all isolation and phasing valves as such and indicate on tag or plastic sign that valve is to remain open and that anesthesia department is to be notified if closed.

2. Install isolation valves on laterals adjacent to risers.
3. Lock in open position all main, section, and riser valves.
4. Zone valves services shall be in the following top to bottom sequence: air, oxygen, carbon dioxide, nitrous oxide, nitrogen, WAGD and medical vacuum. This sequence shall be maintained where two zone valve boxes are required for a given location.

F. Pre-Testing

1. Before any existing medical gas piping is breached, the contractor shall perform a purge (particulate) and concentration test on the existing systems shown being connected to. The test procedure shall be as outlined in these specifications with the exception that the purge test shall be performed with the gas of system designation. Test results shall be recorded and submitted as outlined in these specifications.

3.4 MEDICAL GAS TESTING

A. Scope

1. This Contractor shall provide performance testing of the complete installation of all medical gases of new pipe line and connections in accordance with NFPA 99, latest edition.

    a. This Contractor shall provide purge valves and isolation valves at all dead ends and points of connections to piping systems or at all phasing break points for the proper execution of the testing, blowing out, purging and certification. Purge valves to consist of 3/8" ball valves with a threaded end capped adapter. This subcontractor shall be responsible for supplying the bottled gas, gauges, adapters, analyzer and all other necessary equipment to conduct the testing and certification.
    b. All tests shall be observed by a representative of the Hospital and Medical Gas Equipment Supplier. This Contractor shall be responsible for supplying the bottled gas, gauges, adapters and all other necessary equipment to conduct these tests.
    c. Testing shall be performed in the following manner and sequence and shall be completed prior to use of the system for patient care:

        1) Installation Tests

            a) Initial Blow DownTest
            b) Initial Pressure Test
            c) Final Pressure Test
            d) Cross Connection Test

2) Verification Tests

a) Operational (Standing) Pressure Test
b) Cross Connection Test
c) Valve Test
d) Master and Area Alarm Test
e) Purge Test
f) Purity Test
g) Gas Source Test
h) Outlet Test
i) Final Tie In Test
j) Concentration Test

2. All installation tests shall be performed by the installer or representative prior to the verification tests. Test gas shall be nitrogen N.F.
3. All verification tests shall be performed and certified by an independent (not the installation contractor) medical gas testing contractor/laboratory. The testing (verification) Contractor shall have a minimum of 5 years experience in the testing of medical gases and shall meet the requirements of ASSE Standard 6030. The testing laboratory used shall be state certified. The choice of testing (verification) Contractor shall be pre-approved by the Owner. The testing contractor shall submit a shutdown management plan before any work is begun. Test gas, up to and including the purity test, shall be nitrogen N.F. The balance of verification tests shall be with the gas of system designation.
4. This subcontractor shall submit installation test reports and results to the architect/engineer or his representative for review. Installation test reports shall note date, time and pressure readings for tests sections as well as results of blow down, purge and cross-connection tests for tested sections, valves, alarms and outlets. Verification test reports, certified by the independent laboratory, shall note date and time of tests on a room-by-room, outlet-by-outlet, valve-by-valve, alarm-by-alarm format.
5. Installation Tests

a. Initial Blow Down Test

1) After installation of the piping, but before installation of the outlet/inlet, alarm panels and gauges, the line for each installed gas system shall be blown clear of particulate contamination by means of nitrogen N.F. at 200 psi.

b. Initial Pressure Test

1) Before attachment of system components such as pressure actuating switches for alarms, pressure gauges, etc., but after installation of the station outlets/inlets, with test caps in place, and before closing of the walls and ceilings, each piping system shall be subjected to a minimum test pressure of 1.5 times the working pressure with nitrogen N.F. After the piping system is filled with the test gas, the supply valve and all outlets/inlets shall be closed and the source of test gas disconnected, the piping system shall

remain leak-free for 24 hours. Each joint shall be examined for leakage by means of soapy water or other equally effective means of leak detection safe for use with oxygen.

2) Leaks, if any, shall be located, repaired and the section retested.
3) The source shut-off valve shall remain closed during these tests.

c. Final (Standing) Pressure Test

1) After testing of each individual system as specified above, the assembled station outlet valves and all other system components such as pressure actuating switches for alarms and pressure gauges shall be installed and all medical gas piping systems shall be subjected to a 24 hour standing pressure test at 20% above normal line pressure. System shall remain pressurized during drywall installation/repair to monitor system integrity. Check system at beginning and end of each work day.
2) Leaks, if any, shall be located and repaired or replaced and the section retested.

d. Cross Connection Test

1) Once labeling is in place, prior to closing walls, each system shall be separately tested to determine that no cross connections of piped system exists.
2) Each piping system shall be reduced to atmospheric pressure.
3) Source of testing gas shall be disconnected from all piping systems except for the one being tested.
4) System to be tested shall be charged with 50 psi nitrogen N.F. Individual outlets/inlets shall be checked to determine if test gas is being dispended.
5) Each outlet shall be purged with an intermittent high volume flow of test gas.

6. Verification Tests

a. Operational (Standing) Pressure Test

1) Each medical gas system shall be tested at operational pressure for 10 minutes, with all system hardware installed to verify there are no leaks within the systems. Test shall be conducted on a by-zone basis. Results of this test shall be reported in terms of LPM leakage to the nearest 0.02 lpm.

b. Cross Connection Testing

1) Once the system is complete, the systems shall be tested to ensure that there is no cross connection of gas and vacuum systems. Each system shall be separately pressurized with nitrogen and the outlet type verified.

a) All system labeling shall be verified.

c. Valve Test

1) Certify that system valves are operating properly and identified according to the suite/rooms.

d. Alarm System

1) All medical gas alarm systems shall be tested to verify operation within the limits required.

e. Labeling

1) All gas outlets, gauges, alarms and zone valves shall be verified to incorporate proper labeling for gas service, function and room or area control.

f. Piping Purge/Particulate Test

1) Each positive pressure medical gas system shall be purged to eliminate the solid particulate contaminants that may be present in the systems.
2) Each positive pressure terminal outlet shall be tested using a 0.45 micron filter for evidence of solid particulate contamination. A minimum flow of 3.5 scfm, minimum volume of 35 cu.ft. with no discoloration, and no more than 0.1 mg of matter at the most remote outlet from the source at each supply branch. Each outlet shall be tested with the outlet most remote from the zone valve to be the last outlet tested.

g. Piping Purity Test

1) Samples of the source gases for each positive pressure system intended for patient application shall be tested for contaminants. Samples shall be taken from a location as close to the source as possible without creating a disruption of the gas services. Medical air samples shall be taken downstream of the medical air dryer and filters. Test parameters shall be for the following:

a) Total Hydrocarbons
b) Halogenated Hydrocarbons
c) Carbon Monoxide
d) Dewpoint
e) Particulates

h. Final Tie-In Test

1) Prior to the final connection being made to any existing system, the following tests shall be conducted:

a) Operational Pressure Test
b) Cross Connection Test
c) Valve Test
d) Alarm Test
e) Purge Test
f) Piping Purity Test

2) After connection to the existing system and before use of the new system for patients, the following tests shall be conducted:

a) Operational Room Test
b) Concentration Test
c) Gas Source Analysis

i. Operational Pressure Test

1) The applicable gas for each system shall be introduced into the respective piping systems. Each installed outlet shall be purged to remove any of the nitrogen N.F. test gas present during previous testing and any remaining particulate contamination:

a) Oxygen and Air: 3.5 scfm at 50 psig
b) Vacuum: 3.5 scfm at 12" Hg

2) Each piping system shall be tested to confirm the supply sources are set to deliver gas at the pressure levels as defined by NFPA 99:

a) The testing (verification) agency shall provide testing of the complete installation of all new or modified medical gas systems as documented in NFPA 99C, 4.5.1.3 and as follows:

(1) Final Tie-In Test
(2) Cross Connection Test
(3) Piping Purge/Particulate Test
(4) Valve Test
(5) Flow Test
(6) Piping Purity Test
(7) Operational Pressure Test
(8) Concentration Test
(9) Alarm Testing
(10) Identification and Labeling
(11) Gas Source Analysis Test for establishing baseline values of source systems

j. Concentration Test

1) After completion of the above, each positive pressure outlet shall be analyzed to confirm the delivery of the proper gas at the proper concentration level. Minimum allowable concentration levels are defined by the United States Pharmacopoeia and Compressed Gas Assn. Gas Commodity Specifications and as follows:

a)	Oxygen:	99%
b)	Air:	19.5 to 23.5% Oxygen
c)	Nitrous Oxide:	99%
d)	Nitrogen:	99%
e)	Other Gases:	As specified by label

k. Medical Air Purity Test

1) Medical air outlets shall be tested for concentration of contaminants. The basis for comparison for allowable concentrations shall be as follows:

a)	Dewpoint:	39°F @ 50 psig
b)	Carbon Monoxide:	10 ppm
c)	Carbon Dioxide:	500 ppm
d)	Gaseous Hydrocarbons as Methane:	25 ppm
e)	Halogenated Hydrocarbons:	2 ppm

2) The installed points of use shall be compared with source and any discrepancies noted in the report and brought to the attention of the Owner and Engineer. The Contractor's installation shall not adversely affect the quality of the existing systems.

B. Installer Tests, Manufacturer's Start-up Tests and Verifiers Test

1. Documentation shall be provided upon completion of all testing to include test results, names of individuals performing work on this project, detailed procedures followed for tests and a certification that all results of tests were within limits specified.
2. The inspection and testing reports from the installer, manufacturer and verifier shall be submitted directly to the party that contracted for the testing, who shall submit the report to the Owner's Representative.
3. The Medical Gas Installer will perform the Installer Performance Test of the Medical Gas and Vacuum System.
4. The manufacturer will provide factory authorized representatives to review installation and perform initial start-up of the Medical Gas and Vacuum Systems.
5. The MGPHO Credentialed Medical Gas Verifier shall submit a final verification report that indicates the completed systems and components as indicated on the drawings and specifications herein are tested and verified to NFPA 99, Latest Edition and this specification. The report shall include a verification of the integrity of the medical gas

and vacuum delivery system, quality of delivered gases and the proper operation of peripheral devices of the central supply systems.

3.5 CONNECTIONS TO EXISTING SYSTEMS

A. Medical Gas System

1. Field verify the existing systems affected by the renovation and isolate those systems by closing the closest upstream system valve. Test the system valve by opening a downstream port to atmospheric pressure. Install a gauge at downstream location and monitor pressure for (2) hours to verify that the system valve is not leaking.
2. Continuously purge with nitrogen N.F. through the new connection while brazing.
3. Connection to the existing system shall be made after the 200 psi blowdown test has been conducted after the new piping system has been roughed, prior to outlet installation.
4. All gas outlets affected by the shutdown and tie-in of the new piping systems shall be tested and recertified as outlined in "Medical Gas Testing" Section.

3.6 CONNECTIONS TO EQUIPMENT

A. Furnish and install waste and vents, traps, cold water, hot water, non-domestic cold and hot water, medical gases, piping, shutoffs, backflow preventers, pressure reducing valves, vacuum breakers, shock absorbers, regulators and flexible tubing for all final connections to kitchen, medical and laboratory equipment, headwalls, casework and sinks provided under other Sections. Roughing for this equipment shall be as indicated on the drawings.

B. Obtain exact roughing in dimensions from manufacturers of all service locations before connecting to or roughing for equipment. Provide shutoff valves at each piece of equipment.

C. Owner provided equipment shall be furnished and set under other Sections. Roughing for and final connections to including piping shall be provided by this Contractor. Equipment included shall be:

1. Kitchen equipment (dishwasher, ice maker)
2. Prefabricated medical gas headwalls
3. Preformed sink tops
4. Scrub stations
5. Sterilizers

3.7 IDENTIFICATION OF SYSTEMS

A. Provide clip-on color coded piping identification markers on piping systems installed under this Section. Provide matching flow arrows to indicate direction of flow. Markers shall be Seton Nameplate Co., W.H. Brady, Westline Products or approved equal.

B. Color coding shall comply with the American Hospital Association or ANSI A13.1 Standards as directed by the Owner.

C. Install markers on each side of wall penetrations, at each valve, at tee fittings and base of risers. Spacing of markers shall not exceed 20’-0" and shall include at least one marker in each room. Letters shall not be less than 1 1/2" in height. Arrows shall not be less than 9' long.

D. Install markers on cleaned or painted piping only after piping is complete and has been accepted by the Architect. Install marker adjacent to access panels where piping is concealed.

E. Stencil equipment, such as pumps, compressors, water heaters, and tanks with the name of the equipment and equipment number. Stencils shall be at least 6" high and of a color to provide a contrast with the equipment finish.

END OF SECTION