

MEDICAL GAS SYSTEMS 22 63 13

1 GENERAL

1.1 Scope

- .1 Provide medical gas piping system with pipes, fittings, valves, valve boxes, medical gas terminal units, and alarms, both central and local with sensing devices, including:
 - .1 manifolds, control panels, and accessories for these systems.
 - .2 medical vacuum system with vacuum producers, motors, motor starters, and accessories,
 - .3 medical air system with compressors, motors, motor starters, dryers, filtration, quality control release, and accessories.
 - .4 AGSS (anaesthetic gas scavenging system) with scavenging producers, motors, motor starters, and accessories,
 - .5 compressor system for instrument air (for MDR and ancillary equipment only) with compressors, motors, motor starters, dryers, filters and accessories.
 - .6 connections to Owner's medical gas systems and sources of supply.
 - .7 electrical wiring incidental to alarm, control, and monitoring functions within medical gas system.
- .2 Applicable systems:
 - .1 gases or medical gas mixtures, intended for patient care, including
 - (a) oxygen USP;
 - (b) medical air USP;
 - (c) nitrous oxide USP;
 - (d) carbon dioxide USP;
 - (e) Oxygen 93 percent USP remove unless including a concentrator Oxygen supply system in master spec.
 - (f) helium USP;
 - (g) oxygen USP/nitrous oxide USP mixtures; and
 - (h) helium USP/oxygen USP mixtures;
 - .2 gases for powering devices unrelated to human respiration:
 - (a) instrument air
 - (b) nitrogen NF; and
 - .3 medical vacuum.
 - .4 AGSS

1.2 Definitions

- .1 Inspection body: an organization accredited to the requirements of ISO/IEC 17020 and qualified to inspect and test medical gas systems (In Canada, inspection bodies are accredited by the Standards Council of Canada).
- .2 *Anaesthetizing location*: any room in a health care facility in which:

- .1 the induction and maintenance of general anaesthesia are routinely carried out in the course of the examination or treatment of patients; or
- .2 both nitrous oxide and oxygen are supplied by pipeline.
- .3 *Instrument air*: a medical support gas intended for powering of devices unrelated to human respiration (e.g., surgical tools, ceiling arms).
- .4 *Terminal unit*: an outlet assembly (inlet or Vacuum or AGSS) in a medical gas pipeline system at which the operator makes connections and disconnections.
- .5 *Diameter index safety system (DISS)*: threaded connections that comply with the requirements of CGA V-5.
- .6 *Zone alarm*: a system used to monitor the pressure of a medical gas or vacuum downstream of the zone valve. *Local Emergency Alarm* has the same meaning.
- .7 *Supply System Alarm (Source of supply or master alarm have the same meaning)*: a warning system that monitors:
 - .1 the operation and condition of the supply systems in a medical gas pipeline system; and
 - .2 the pressures in the main lines of each medical gas and vacuum service.
- .8 *Installer*: a qualified person or company responsible for the installation of medical gas pipeline systems or components within a system.
- .9 *Qualified Person*: a person with professional training or extensive knowledge and experience in the subject field who is capable of analyzing performance and specifications in the subject work, project, or product.
- .10 *Medical Supply Unit*: prefabricated equipment of Class I, Type B, that supplies medical gases, either singly or in combination with other services, at the point of patient care.
- .11 *NF* : National Formulary
- .12 *USP*: United States Pharmacopeia.

1.3 **Applicable Standards**

- .1 Except where a specific edition is identified, the referenced document is the most current published version.
- .2 Comply with;
 - .1 CSA Z7396.1-17 Medical gas pipeline systems - Part 1: Pipelines for medical gases, medical vacuum, medical support gases, and anaesthetic gas scavenging systems
 - .2 CSA-Z9170-1 Terminal Units for Medical Gas Pipeline Systems. Part1: Terminal Units for Use with Compressed Medical Gas and Vacuum.
 - .3 CSA B51 Boiler, Pressure Vessels and Pressure Piping Code.
 - .4 AWS A5.8 Brazing Filler Metal.

- .5 ASTM B819 Standard Specification for Seamless Copper Tube for Medical Gas Systems.
- .6 Compressed Gas Association (CGA) G-4.1 *Cleaning Equipment for Oxygen Service*.
- .7 CGA V-1 Compressed Gas Cylinder Valve Outlet and Inlet Connections.
- .8 CGA V-5 Diameter Index Safety System.
- .9 CGA – P2.1 Standard for Medical/Surgical Vacuum Systems in Hospitals,
- .10 CGA M-1-2013 Standard for Medical Gas Supply Systems at Health Care Facilities
- .11 CAN/CSA-Z5359 Low-pressure hose assemblies for use with medical gases
- .12 CAN/CSA-Z10524-02 Pressure regulators and pressure regulators with flow-metering devices for medical gas systems
- .13 CAN/CGSB-24.2-M86 Identification of Medical Gas Containers, Pipelines and Valves
- .14 CAN/CSA-Z305.8-03 Medical supply units
- .15 CAN/CSA-Z10083-08 Oxygen concentrator supply systems for use with medical gas pipeline systems
- .16 British Columbia Safety Authority (BCSA) requirements,
- .17 NPFA 55 Storage, Use, and Handling of Compressed and Liquefied Gases in Portable Containers
- .18 NFPA 56F Non-flammable Medical Gas System,

1.4 Pressure Piping Registration

- .1 Make application and pay costs for registration and inspection of pressure piping systems with the provincial pressure piping Authority Having Jurisdiction, for medical gases operating at pressures in excess of 103 kPa (15 psig).
 - .1 Submit three sets of drawings and one copy of specification to Authority Having Jurisdiction for approval.
 - .2 Collect and record Canadian Registration Numbers (CRN) for components and fittings, and obtain and coordinate equipment CRN or field registration of composite equipment.
- .2 Install registered pressure piping to:
 - .1 British Columbia: Ministry of Community, Aboriginal and women's service
 - .2 British Columbia: Boiler and Pressure Vessel Safety Program
 - .3 CSA B51 Pressure Piping Code
 - .4 Add in other provincial bodies and testing groups such as ABSA and TSSA.
- .3 All products subject to pressure piping registration to have Canadian Registration Numbers in accordance with CSA B51 Pressure Piping Code.

1.5 Workmanship

- .1 An installer as defined in Z7396.1 shall meet the requirements of the CSA Medical Gas Piping & Systems Installation Personnel Certification Program or equivalent.
- .2 Prior to installation (with the exception of stationary liquid supply systems), installers shall submit evidence of qualification to install medical gas systems to the health care facility for inclusion in its permanent records. In Canada, evidence of qualification to install medical gas systems consists of a valid medical gas license meeting the requirements of the CSA Medical Gas Piping & Systems Installation Personnel Certification Program or equivalent.
- .3 Where applicable, prior to installation, installers shall submit evidence of qualification (e.g., a valid brazing licence, as issued by an authority having jurisdiction in accordance with CSA B51) to the health care facility for inclusion in its permanent records.
- .4 Make arrangements and pay for services of medical gas equipment supplier to advise on installation of valves, terminal units, source units, alarms, and associated equipment.

1.6 Shop drawings and product data sheets

- .1 Submit product data sheets for;
 - .1 tubing,
 - .2 fittings
 - .3 valves,
 - .4 alarm panels,
 - .5 terminal units,
 - .6 zone valve boxes,
 - .7 filters,
 - .8 pressure reducing and pressure relief valves, and
 - .9 local gas regulation control panel for nitrogen and / or instrument air.
 - .10 Medical Air systems and Quality Control
 - .11 Medical Vacuum systems
 - .12 AGSS systems
 - .13 Manifolds
- .2 Submit shop drawings for;
 - .1 Alarm wiring
 - .2 Pressure regulating stations
 - .3 Medical gas specialties (Vacuum traps, pressure transducers, gauges, emergency inlets, etc)

1.7 Brazing Sample Quality Control

- .1 Demonstrate brazing penetration and freedom from internal oxidation by cutting out brazed joints selected by Testing Agency using quality control sample selection technique. Not less than 2% of brazed joints to be cut out and examined throughout entire length of medical gas piping system.
- .2 If a significant proportion of joints contain unacceptable imperfections, examination will be extended to 10% of joints and continued at that level until satisfactory joints are found in 10 successive samples.

1.8 Certification and testing

- .1 Installation will be certified by an inspection body, hired directly by Owner, to confirm that installation is in accordance with CSA-Z7396.1.
- .2 Include labour, superintendence and costs associated with coordination and attendance during testing and certification of medical gas systems.

1.9 Maintenance data

- .1 Submit maintenance data to include;
 - .1 Equipment list identifying components used in each system.
 - .2 Equipment manufacturer's names and addresses.
 - .3 Wiring diagrams of alarms and electrical components.
 - .4 Detailed drawings of equipment and components.
 - .5 Manufacturers service manuals, including warranty for equipment.
 - .6 Valve schedule listing valves in system with location.
 - .7 Completed certification report forms.
 - .8 As-built drawings as reviewed by Engineer.
 - .9 Canadian Registration Numbers (CRN) for components and fittings.

2 PRODUCTS

2.1 Tubing

- .1 Type 'L' copper to ASTM B819,
 - .1 Factory OXYGEN cleaned and marked with classification symbols,
 - .2 shipped sealed with plastic end caps,
 - .3 hard drawn for distribution piping with purge ports on piping either side of service isolation valves,
 - .4 soft annealed for NPS 3/8 sensing lines to pressure sensors/switches and zone alarm panels.. -

2.2 Fittings

- .1 Wrought copper suitable for silver soldering.

- .2 For pipe sizes 12.5 mm (1/2 in) or less, fittings that are not made especially for soldered or brazed connections may be used, provided that the fitting as installed is visible in the room or is readily accessible for maintenance. All medical gas Fittings must be cleaned for Oxygen service.
- .3 Dielectric fittings may be used where required by the manufacturer of special medical equipment to electrically isolate the equipment from the pipeline distribution system.
- .4 Axially swaged, elastic strain preload fittings providing metal-to-metal seal may be used provided that the fittings have pressure and temperature ratings not less than that of a brazed joint and, when complete, are permanent and non-separable.
Standard of Acceptance
 - TW Metals
 - LOKRING Technology

2.3 Jointing Materials

- .1 Silver brazing alloy AWS Classification BCUP-5 conforming to AWS A5.8.
Standard of Acceptance
 - Handy Harmon "SIL-FOS"
 - All-State Welding Alloys "SILFLO 15"

2.4 Pipe Hangers and Supports

- .1 To section 20 05 29 except as specified herein.
- .2 Trapeze Hangers:
 - .1 12 ga galvanized steel channel frames, solid backs.
Standard of Acceptance
 - Taylor Figure TS
 - Unistrut
- .3 Pipe/Tubing Clamps:
 - .1 Two piece, epoxy coated clamp, with thermoplastic liner to separate piping from clamp.
Standard of Acceptance
 - Taylor Figure 8500 Strut-Clamp
 - Unistrut
- .4 Spacers:
 - .1 U-shape splice plates used as spacer control between adjacent piping clips.
Standard of Acceptance
 - Taylor UF series
 - Unistrut

2.5 Valves

- .1 Zone Valves, up to NPS 3:
 - .1 ball valves, quarter turn from open to closed, lever valve handle with locking device,

- .2 forged brass, 3 piece bolted pattern, chrome plated finish,
- .3 stainless steel, brass, or chrome plated bronze ball, with teflon seat and viton seals,
- .4 blow-out resistant stem with viton seal,
- .5 design pressure: 4137 kPa (600 psi),
- .6 factory assembled with type "K" copper tube extensions, complete with 1/8" FNPT inlet and outlet purge / gauge ports,
- .7 identification bracket bolted over valve body for application of medical gas identification label,
- .8 cleaned for oxygen service with extension ends sealed with plastic caps and shipped in sealed plastic bag,
- .9 fitted with line pressure gauges;
 - (a) 0-700 kPa (0-100 psig) for gases except nitrogen, vacuum and AGSS;
 - (b) 0-2000 kPa (0-300 psig) for Nitrogen; and
 - (c) 0-100 kPa (0-30 in Hg) for Vacuum.
 - (d) 0-100 kPa (0-30 in Hg) for AGSS

.10 ULC and CRN Listed.

- (a) locks will be supplied by Owner.

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.2 Service Isolation valves up to NPS 3:

- .1 ball valves, quarter turn from open to closed, lever valve handle with locking device,
- .2 forged brass, 3 piece bolted pattern,
- .3 stainless steel, brass, or chrome plated bronze ball, with teflon seat and viton seals,
- .4 blow-out resistant stem with viton seal,
- .5 design pressure: 4137 kPa (600 psi),
- .6 factory assembled with type K" copper tube extensions, complete with 1/8" FNPT inlet and outlet purge / gauge ports,
- .7 cleaned for oxygen service with extension ends sealed with plastic caps and shipped in sealed plastic bag,
- .8 ULC and CRN Listed, and

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.3 Service Isolation valves, NPS 3 and over:

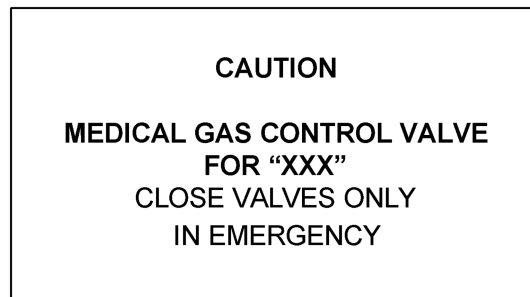
- .1 butterfly lug style type, in-line serviceable and bi-directional differential pressure rating of 200 PSI with flanges, pipe extensions & bolts
- .2 ductile iron body, lever handle, aluminum bronze disc, stainless steel stem with top and bottom bushing of dissimilar materials with
- .3 positive stem retention mechanism, 2" extended neck to allow for insulation, and bonded or cartridge style seat of BUNA-N (NBR) rubber.
- .4 factory pressure tested, cleaned and shipped in sealed plastic bag.
- .5 valve handle locking device; Locks by Owner.

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2.6 Zone Valve Boxes

- .1 Recessed steel valve box sized to house single or multiple shut-off Zone valves:
 - .1 panel back box constructed of 18 gauge steel with baked enamel or powder coat finish,
 - .2 field adjustable steel brackets for mounting to structural support.,
 - .3 panel door frame assembly screwed to back box assembly,
 - .4 removable front window with pull-out ring mounted in centre of window for access to zone shut-off valves
 - .5 Window shall be coated with antimicrobial instaCure guardian.
 - .6 window capable of reinstallation without use of tools only after valve handles have been returned to open position,
 - .7 window marked with following silk-screen label:



where XXX is identifier for Room or Area Controlled (this information may be added by lamacoid on frame)

- .2 Valves:
 - .1 as specified above for Zone Valves, of size and gas type as shown.

2.7 Zone Alarm Panel:

- .1 Digital Area Alarm, CSA approved, ethernet compatible, capable of monitoring up to 8 medical gas lines, requiring no field calibration.
- .2 Alarm to include alarm module, 120/240V, 50/60Hz power supply in an enclosure separate from valve box, 90 dBA audible alarm, digital display of gas pressures, LED trend display, and dry contact for a general alarm for remote monitoring to BMS system
- .3 Alarm to be pre configured to add user defined alarm specific instructions
- .4 Alarm shall have ethernet connection to facilitate connection to Web Server and BACnet capable to connect to BMS
- .5 Pressure Sensors may be mounted inside the alarm or associated zone valve box

- .6 Digital gas sensor/transducer includes a "heartbeat" flashing green LED light to designate the sensor functioning correctly.
- .7 Alarms to be programmable to allow monitoring of any third party 4-20mA output device.

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1.2 Nitrogen & Instrument air control panel:

.1 UL listed

- .1 supplied with an integral 3447 kPa (500 psig) shut-off valve requiring quarter turn from fully open position to fully closed position,
- .2 0-2000 kPa (0-300 psig) inlet pressure gauge mounted ahead of shut-off valve,
- .3 adjustable, self-relieving, pressure regulator with "push/pull" safety lock, operating range of 0-1724 kPa (0-250 psig) positioned on "outlet" side of control valve,
- .4 0-2000 kPa (0-300 psig) pressure gauge mounted on low-pressure side of regulator,
- .5 DISS nitrogen/instrument air outlet for connection to pneumatic tools,
- .6 components assembled in 1.5 mm (0.060 in) steel back box with supports to secure unit within wall or partition and anodised aluminum fascia,
- .7 two type "K" washed and degreased copper inlet/outlet connections for direct connection to main distribution and for remotely located nitrogen outlets,
- .8 packaged to prevent contamination prior to installation.

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1.3 Supply System Central Alarm Panel

- .1 Supply System Alarm Panel to monitor source of supply and main pipeline pressures of each medical gas, medical vacuum, medical support gas and AGSS.
 - .1 CSA approved, ethernet compatible for wireless or remote communication,
 - .2 housed in 1.33mm (18 ga) steel back box with hinged front panel,
 - .3 integral 120/240V, 50/60Hz switching transformer, adjustable 90 dBa audible alarm, and minimum of 10 signal alarm modules, or integrated programmable alarm points
 - .4 Alarms to be programmable to allow monitoring of any third party 4-20mA output device.
 - .5 modules to include continuous green LED indicators for each normal condition, continuous red LED indicators for each abnormal condition, and an information display window for programming and site configuration,
 - .6 alarm features to include:
 - Alarm History Recall
 - dry contacts for each signal to permit monitoring by BMS or other remote devices
 - pre configured to add user defined alarm specific instructions
- .2 Multiple Supply System Alarm Panels are to function independently of each other and to be connected in parallel only.

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.3 Provide alarms in source of supply system for;

.1 Oxygen stationary cryogenic liquid system (bulk) with cryogenic liquid secondary source:

- (a) high line pressure,
- (b) low line pressure,
- (c) primary source liquid level low,
- (d) secondary source in use
- (e) secondary source liquid level low,
- (f) secondary source low head pressure
- (g) reserve in use

.2 Oxygen high pressure cylinder system (reserve to cryogenic liquid primary and secondary source):

- (a) high line pressure,
- (b) low line pressure,
- (c) secondary source in use

.3 Nitrous Oxide high pressure cylinder system with high pressure cylinder reserve:

- (a) high line pressure,
- (b) low line pressure,
- (c) reserve in use

.4 Nitrogen high pressure cylinder system with high pressure cylinder reserve:

- (a) high line pressure,
- (b) low line pressure,
- (c) reserve in use

.5 Carbon Dioxide high pressure cylinder system with high pressure cylinder reserve:

- (a) high line pressure,
- (b) low line pressure,
- (c) reserve in use

.6 Medical Air with oil-less type compressor system

- (a) high line pressure,
- (b) low line pressure,
- (c) lag compressor in use,
- (d) reserve in use
- (e) reserve low pressure,
- (f) high dew point,
- (g) high CO level,
- (h) high CO2 level,
- (i) General Quality Control Breach,
- (j) high discharge temperature,
- (k) desiccant dryer tower switching failure,
- (l) primary transformer failure,

(m) motor overload,

.7 Medical Vacuum with oil-less claw type vacuum pump system

- (a) vacuum line low,
- (b) lag pump in use,
- (c) high discharge temperature,
- (d) primary transformer failure,
- (e) motor overload,

.8 AGSS with oil-less claw type vacuum pump system

- (a) vacuum line low,
- (b) lag pump in use,
- (c) high discharge temperature,
- (d) primary transformer failure,
- (e) motor overload,

.9 Instrument Air with oil-less type compressor system:

- (a) high line pressure,
- (b) low line pressure,
- (c) lag compressor in use,
- (d) reserve in use
- (e) reserve low pressure,
- (f) high dew point,
- (g) high discharge temperature,
- (h) desiccant dryer tower switching failure,
- (i) primary transformer failure,
- (j) motor overload

.4 Alarm system initiates an alarm if there is an open sensor circuit.

.5 Alarms to be programmable to allow monitoring of any third party 4-20mA output device.

.6 Building Automation System Interface:

.1 Output from a dry contact relay or BACnet or webserver

1.4 Zone Alarms

.1 Type:

- .1 microprocessor based with individual microprocessors on each display and sensor board.
- .2 modular construction and field expandable with addition of extra modules. Up to eight (8) services to be accommodated in standard box.
- .3 continuously monitored by microprocessor based sensor for each specific service, and pressure or vacuum to be displayed by red digital LED. For pressure services readout to be 0-1724 kPa (0-250 psig). For vacuum and AGSS, service readout to be -100-0 kPa (0-30 in Hg).
- .4 Dry contacts or BACnet for each gas for remote monitoring to BMS system.

.2 Construction:

- .1 18 gauge (1.3 mm) steel back box with mounting brackets adjustable for up to 13 mm (½ in) variation in wall thickness and 6.4 mm (¼ in) ID type "K" copper tubing for connection to gas service line.
- .2 modules mounted on hinged frame.
- .3 digital readout providing constant indication of each service being measured with bar graph trend indicator for each service displaying green "NORMAL", yellow "CAUTION" and red "HIGH" or "LOW" alarm condition. Under normal operations bar graph display to move up and down in "GREEN" range depending on service usage. If deviation exceeds ±20% from factory pre-set normal condition, "RED" alarm light flashes and audible buzzer in excess of 95 decibels will sound. "ALARM SILENCE" button to cancel audible buzzer, but unit to remain in alarm condition until problem is rectified.
- .4 repeat alarm function, when enabled, turns on buzzer after preset time interval if alarm condition has not been cleared.
- .5 field adjustable parameters; High/Low set points, Imperial/Metric units and Repeat alarm Enable (1 to 60 minutes)/Disable function. These parameters to be accessed through microprocessor calibration mode function and set points to be adjustable through two on-board push buttons.
- .6 Pre configured to add user defined alarm specific instructions
- .7 self-diagnostics with error message display.
- .8 labels with ISO colour code, and alarm signals visible from distance of 12 m (40 ft) when other lights in room are on and off.
- .9 alarm to be BACnet compatible for ethernet communication via embedded webpage
- .10 CSA certified and UL listed.
- .11 green "power on" light to indicate that alarm is energized and "push to test" button.

.3 Sensors:

- .1 Digital Gas Sensors shall include a "heartbeat" flashing green LED light to designate the sensor is functioning correctly.
- .2 sensors suitable for mounting within alarm box or remote mounting, using twisted pair wiring up to 1524 m (5000 ft). Each sensor and display unit to be gas specific; i.e. gas specific sensor with DISS nut & nipple, and display module with an error message display for incorrect sensor/display connection. Location of remote sensors to be labeled inside backbox.

.4 Manufacturers:

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.5 Provide local alarms as shown for;

- .1 Oxygen,
- .2 Nitrous Oxide,
- .3 Nitrogen

- .4 Instrument air
- .5 Medical air
- .6 Medical vacuum,
- .7 Carbon dioxide, and
- .8 Anaesthetic Gas Scavenging System (AGSS)
- .9 Programmable for user defined monitoring of any third party 4-20mA output device.

1.5 Line pressure alarm sensors

.1 Type:

- .1 connected to main through 9 mm (3/8 in) copper tube sensor lines and DISS gas specific body with check valve installed in pipeline with DISS nut and nipple
- .2 installed in a CSA C22.2 No. 94.1 Type 4 enclosure.
- .3 adjustable range of 0-552 kPa (0-80 psig), proof pressure of 1103 kPa (160 psig).
- .4 dual control with two single pole, double-throw snap action switches rated at 10 amps, 125 volts AC suitable for normally open or normally closed alarm circuit.
- .5 UL listed, CSA approved, and cleaned for oxygen service. Settings:
- .6 pre-set to alarm at 276 kPa (40 psig) decreasing pressure and at 414 kPa (60 psig) increasing pressure for oxygen, nitrous oxide, medical air, and carbon dioxide.
- .7 Digital gas sensors include a "heartbeat" flashing green LED light to designate that sensor is functioning correctly.

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1.6 Dual line pressure regulators

- .1 Capable of supplying specified gas quantities at 350 kPa (50 psig) with pressure variation less than 15 kPa (2 psi) from full flow to no flow when supplied with 380 kPa (55 psig) inlet pressure,
- .2 Direct acting, not pilot operated,
- .3 A sample port shall be provided downstream of the dual line pressure regulator assembly and upstream of the supply shut-off valve.

1.7 Medical gas terminal units – DISS

- .1 Diameter Index Safety System (DISS) recessed wall terminal units designed for various installation methods including:
 - .1 recessed wall mount for concealed piping,
 - .2 surface wall mount for exposed piping,
 - .3 recessed console mount for console installation,
 - .4 recessed ceiling mount for ceiling installation,
 - .5 ceiling column mount for ceiling column installation,
 - .6 medical supply unit mount for medical supply unit installation,

- .7 MRI compatible for installation in MRI Rooms.
- .2 Colour coded front plate with English or French language printed service identification and indexing pins for safety keying gas specific cover plate to appropriate steel rough-in mounting plate.
- .3 One piece fascia plate covering wall terminal unit with back box rough in mounted so that terminal unit can be adjusted for 10 mm (3/8 in) to 32 mm (1-1/4 in) variation in wall thickness,
- .4 Rough-in box consisting of type "K", 6.4 mm (1/4 in) inside diameter copper inlet pipe stub, silver brazed to terminal unit body of 32 mm (1-1/4 in) diameter one-piece brass construction. For positive pressure gas services, terminal units to be equipped with primary and secondary check valves rated at minimum 1379 kPa (200 psig),
- .5 Modular design and include gas specific 1.6 mm (16 ga) steel mounting plate designed to permit on-site ganging of multiple terminal units, in any order, on 127 mm (5 in) spacing.
- .6 Latch/valve assembly of DISS type that only accepts corresponding DISS type gas specific adapter.
- .7 Integrated Outlet/Flowmeter Option: The latch valve shall have an integral 0-15 lpm pressure compensated thorpe tube style flowmeter with DISS 1240 male outlet and a DISS (or quick connect) gas specific 50 psi terminal unit. Double (Y) outlets with a detachable flowmeter shall not be considered equivalent.
- .8 Each outlet trim plate shall incorporate a retractable hook with a 15 pound load rating and be finished with a coating inclusive of Biomaster additive to inhibit bacterial growth.
- .9 Manufacturers:
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1.8 Headwall Units, Ceiling Service Columns, Ceiling Articulating Arms, Patient Service Strips and Medical Supply Unit

- .1 Headwall Units, Ceiling Service Columns, Ceiling Articulating Arms, Patient Service Strips and Medical Supply Unit ("Service Units") are provided under [Division 26][Division 11] including internal wiring and internal piping, but excluding terminal outlet units.
- .2 Supply medical gas outlets to the vendor supplying the Service Units for factory installation.

1.9 Manifolds

- .1 Type:
 - .1 Two high-pressure header bar assemblies to facilitate connection of primary and secondary cylinder supplies,
 - .2 UL listed,
 - .3 header bars provided with high pressure shut off valves, CGA gas-specific cylinder pigtail connections incorporating check valve at header connection and designed to allow additional cylinder connections,
 - .4 fully automatic changeover from primary to secondary supply and alternation of primary supply,

.5 compatible in design and materials with the intended gas service.

.2 Control panel:

- .1 control equipment housed in NEMA 4 enclosure.,
- .2 capable of automatic, mechanically controlled, change over from primary bank of cylinders to secondary bank of cylinders without interruption or fluctuation in delivery pressure,
- .3 control logic to give indication when manifold switches from one bank of cylinders to another
- .4 gauges, visible through enclosure door, showing left bank pressure, right bank pressure, intermediate pressure in series arrangements, and delivery pressure.
- .5 control panel incorporating six LED's, three for Left Bank and three for Right Bank. Green for Bank in use, Green for Bank ready and Red for Bank empty. Pressure switches, micro switches, and lights within panel to be pre-wired to an internal terminal strip for field wiring.
- .6 internal electric heaters shall not be required for Nitrous Oxide and Carbon Dioxide service.
- .7 Capable of ethernet connectivity via Total Alert Embedded (TAE)webpage

.3 Pressure regulation:

- .1 control equipment made up of series of regulators to reduce cylinder pressure to line delivery pressure.
- .2 Dome Bias piston regulators shall be housed in a single brass forging that minimizes threaded connections and associated potential for leaks.
- .3 SAE o-rings connections shall be used on line regulators
- .4 pressure safety valve after line regulator, and intermediate pressure safety valves between high-pressure regulators and line delivery regulators.

.4 Performance:

- .1 Provided in accordance with following manifold schedule:

MEDICAL GAS MANIFOLD SCHEDULE			
GAS NAME	No of CYLINDERS per SIDE	NOMINAL CONTE NT OF EACH CYLIN DER	STORAGE PRESS URE
		m ³	kPa
OXYGEN	XX	6.77	15168
NITROUS OXIDE	XX	15.35	5136
MEDICAL AIR (Reserve)	XX	5.87	15168

NITROGEN	XX	6.77	15168
CARBON DIOXIDE	XX	22.7	5700
INSTRUMENT AIR	XX	6.77	15168

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1.10 Medical Air - Compressor Based Supply System

.1 System:

.1 Factory assembled and tested system including:

- (a) compressors,
- (b) receivers,
- (c) duplex drying and purification units with combination humidity/CO₂ dryer purge controls,
- (d) CO₂ Monitor
- (e) CO Monitor
- (f) Prevent and Purge Assembly
- (g) high-pressure cylinder reserve with check assembly,
- (h) dual pressure regulating station,
- (i) control panel c/w alarms and controls
- (j) pre-filters,
- (k) after-filters,
- (l) bacteria retention filters,
- (m) filter/pressure regulator,
- (n) control panel c/w motor starters, controls and alarms,
- (o) epoxy finished structural steel base frame and shipping hardpoints,
- (p) Quality Control Release function

.2 System redundancy:

- (a) quadplex arrangement with four compressors, requiring two compressors to run to meet load and two compressors on standby,

.3 Performance:

Parameter	Rating	Units
Air delivery per compressor		Actual Litres/min @ delivered pressure kPa
Air delivery per compressor		Standard Litres/min @ 101.3 kPa, 20°C DB, 36% RH inlet conditions
Delivered pressure		kPa
Power input per compressor		kW
Receiver capacity		Litres

Dryer flow rate per tower		°C @ 350 kPa
Dryer Dew point temperature		°C @ 350 kPa

.2 Medical Air Compressors, Rotary Scroll:

- .1 air cooled, oil-less rotary scroll,
- .2 electric driven compressors equipped with 10 micron intake filter assembly rated for 2.5 times the flow of the compressor and CRN registered discharge water separator sized for the flow capacity of the compressor with constant liquid removal efficiency when operating between 25 and 100% of the rated flow. Liquid separators with internal moving parts shall not be acceptable,
- .3 fitted with discharge temperature sensors mounted at the discharge of the compression chamber of each compressor and wired to shut down compressor and initiate high discharge temperature alarm if head temperature rises above normal,
- .4 discharge port of each compressor head shall be interconnected to the intake filter using braided stainless steel flex connector,
- .5 self-lubricating tip seals,
- .6 Field regreaseable bearings,
- .7 integral air-to-air aftercooler,
- .8 safety relief valve,
- .9 braided stainless steel discharge flex connector,
- .10 discharge check valve,
- .11 discharge isolation ball valve
- .12 assembly configuration - stack mounted/tank mounted/base mounted
- .13 air to air intercooler and discharge air water separator with water drain trap on each compressor.

Standard of Acceptance

- ° AirLiquide Healthcare
- °

.3 Air receiver;

- .1 capacity: 450 L (120 usgal),
- .2 construction: galvanized inside and outside carbon steel as an unfired pressure vessel to CSA B51,
- .3 design pressure: 1030 kPa (150 psig),
- .4 cylindrical tank with dished ends and supporting legs for vertical mounting/horizontal mounting,
- .5 provided with;
 - (a) inlet air connection,
 - (b) outlet air connection,
 - (c) bottom drain with automatic drain valve.

- (d) pressure safety valve,
- (e) pressure gauge, and
- (f) site glass.

.4 Air dryer system - Desiccant Type:

.1 Type:

- (a) Factory assembled and tested, skid mounted package.
- (b) two column heatless regeneration type with automatic switching between beds,
- (c) columns, heads and casings of dryer body manufactured from stainless steel, carbon steel, or aluminum
- (d) design pressure: 1030 kPa (150 psig) pressure rating,
- (e) ball valves at inlet and outlet of dryer,
- (f) pre-filters, after-filters and bacteria retention filters in duplex arrangement with ball valves for shut-off on inlet and outlet of each filter housing,
- (g) equipped with Scott Freedom 5000 CO Monitor with sensing range of 0-50 ppm, accuracy of +-2%, integrated digital display, and 4-20mA output..
- (h) equipped with a Vaisala Carbocap (r) series GMT220 infrared CO₂ monitor with 0-1000 ppm range and 4-20mA output
- (i) equipped with a Vaisala DRYCAP® dewpoint monitor with auto-calibration technology, 4-20mA output, and compatible with Vaisala DRYCAP® Hand-Held Dewpoint Meter DM70,,
- (j) the dewpoint and CO₂ measured values shall be displayed on the main control panel touch screen interface,
- (k) controls designed to initiate dryer tower purge if either measured humidity (dewpoint) or CO₂ levels surpass a user definable limit.
- (l) The dryer outlet piping arrangement shall include two one-way actuated valves (or a single two-way actuated valve) and one purge muffler. In the event of a quality alarm (moisture, CO, or CO₂), the valves shall actuate thus preventing compressed air flow into the distribution pipeline and initiation of a timed purge to cleanse the impurity out of the medical air intake piping, compressors and receiver. If all monitored quality points return to specification within the timed purge, the valves shall reverse thus returning on-site production to the distribution pipeline.

.2 Performance:

Parameter	Rating	Units
Desiccant per bed, minimum	!	kg
Flowrate	!	litres/min
Inlet pressure	350	kPa
Dewpoint temperature	-40	°C

.3 Control panel:

- (a) 120 volt/1 phase/60 Hz control panel,
- (b) panel face mounted pressure gauges, pre-wired alarm and operating sensors, relays, switches, pilot lights and terminal strip for external alarm connections.
- (c) pressure gauge and pressure sensor with DISS, check valve, and nipple on outlet piping from dryer package, on downstream side of after-filters and bacteria retention filters, to detect "Dryer Pressure Drop High" alarm,

- (d) moisture sensors, timers and switching valves and solenoid valves to control switching and regeneration,
- (e) internal self diagnostic circuitry and alarm contacts for "Dryer Switching Failure" alarm,
- (f) pressure gauges between prefilter and dryer inlet, between dryer outlet and after-filters and between after-filters and final filters.

Standard of Acceptance

- Air Liquide Healthcare / Busch

.5 Line Pressure Regulator System:

.1 dual line pressure regulating assembly consisting of:

- (a) two pressure regulators,
- (b) outlet pressure gauges,
- (c) inlet and outlet isolation ball valves,
- (d) pressure safety valves,
- (e) arranged so that isolation of one regulator will not affect operation of second regulator.

Standard of Acceptance

- Air Liquide Healthcare

.6 Pre-filters:

- .1 high efficiency coalescing type, rated 0.01 micron filtration with an efficiency exceeding 99.9999% D.O.P.,
- .2 initial (dry and clean) pressure drop of not more than 6 Kpa (0.9 psig) (1030 Kpa (150 psig) pressure rating,
- .3 epoxy coated glass fibre media,
- .4 NPT 1 connections, and
- .5 external automatic drain

Standard of Acceptance

- Air Liquide Healthcare / Busch

.7 Prefilter automatic drain:

- .1 demand cycled drain,
- .2 liquid sensor,
- .3 direct acting, normally closed solenoid valve rated at 1030 kPa (150 psig),
- .4 NPT 1/4 or 1/2 connections, and
- .5 EMAC 4 construction with adapter for 13 mm (1/2 in) conduit.

Standard of Acceptance

- Air Liquide Healthcare / Busch

.8 After-filters:

- .1 "absolute" particulate removal type (0.9 um),
- .2 rated 0.01 micron filtration with an efficiency exceeding 99.9999% D.O.P.,
- .3 initial (dry and clean) pressure drop of not more than 2 kPa (0.3 psig) (1030 kPa (150 psig) pressure rating,
- .4 cellulose media,
- .5 stainless steel housing, and

- .6 NPT 1 connections.
- Standard of Acceptance*
- ° Air Liquide Healthcare / Busch

.9 Air intakes:

- .1 filters to be mounted on each pump or compressor inlet.
- .2 Intake filter housing to have quick release fasteners and to be rated for air flow capacity of pump or compressor with efficiency greater than 98% when challenged with 6 micron particles.

.10 Medical Air Control System:

- .1 mounted in NEM1 enclosure,
- .2 programmable logic module,
- .3 main disconnect switch,
- .4 magnetic motor starters with circuit protection for each compressor,
- .5 manual-auto-off selector switches for each compressor,
- .6 control transformers with primary and secondary circuit protection.
- .7 two dryer auto/off selector switches,
- .8 one continuous/controlled dryer purge selector switch,
- .9 internal pressure sensors and pressure switches for controlling stop/start operation of compressors,
- .10 multi-unit compressor package control through Siemens S7-1200 Programmable logic controller with alternating strategy to equalize compressor run time, and coordinate automatic back-up from stand-by units.
- .11 visual and audible alarms for;

Signal	Medical Air with oil-less type compressor system
High line pressure	•
Low line pressure	•
Lag compressor in use	•
Reserve in use	•
Reserve low pressure	•
High dew point	•
High CO level	•
High CO2 level	•
Quality Breach	•

High discharge temperature	•
Desiccant dryer tower switching failure	•
Primary transformer failure	•
Motor overload	•

.12 Automatic controls sequences;

- (a) start lead compressors when pressure falls to 621 kPa (90 psig)
- (b) stops lead compressor when pressure reaches 759 kPa (110 psig)
- (c) start lag 1 compressor when system pressure falls to 586 kPa (85 psig)
- (d) stops lag 1 compressor when pressure reaches 724 kPa (105 psig)]
- (e) start lag 2 compressor when system pressure falls to 551 kPa (80 psig)
- (f) stops lag 2 compressor when system pressure reaches 724 kPa (105 psig)
- (g) start lag 3 compressor when system pressure falls to 531 kPa (77 psig)
- (h) stops lag 3 compressor when system pressure reaches 724 kPa (105 psig)
- (i) if lag 1 compressor is not available, start lag 2,
- (j) alternates lag compressor designation on shut-down,
- (k) alternate assignment of compressors between lead, lag 1, lag 2 and lag 3
- (l) adjustable minimum run timer on each compressor,
- (m) "Compressor(s) Disabled, Reserve in Use" alarm contacts

.13 Medical Air quality control monitoring system (aerALin™) to ensure compliance with Z7396.1-17, Clause 5.5.2.1.4;

- (a) Pre-paid five (5) year quality control service,
- (b) quality control module designed to monitor and record the following medical air USP formula constituents: oxygen, carbon monoxide, carbon dioxide, nitric oxide, nitrogen dioxide, sulphur dioxide, and water vapour.
- (c) quality control module shall monitor all parameters on a full time real time basis with recording at the minute interval, and the module shall be designed to prevent off-spec product from entering the pipeline by way of automatic valve actuation in the event of any one more constituent measurements exceed the USP specified limit.
- (d) quality control module shall include valving and control logic to facilitate trend based remediation
- (e) supplier shall maintain ownership of the quality control module throughout the term, and shall provide on-site performance verification and sensors calibration a minimum of three times per year.
- (f) supplier shall provide the client with a GMP quality control compliance report following each calibration, complete with a digital copy of the recorded data set for client's records retention.

.14 Network Communications:

- (a) Ethernet IP based network protocol compatible with medical gas Supply System Alarm Panel, or over BACnet IP, BACnet MSTP or MODBUS RTU.

1.11 Medical vacuum systems

.1 System:

- .1 Factory assembled and tested system including:

- (a) vacuum pumps,.
- (b) receivers (if provided),
- (c) control panel c/w alarms and controls
- (d) epoxy finished structural steel base frame and shipping hardpoints.

.2 System redundancy:

- .1 triplex arrangement with three pumps, requiring one pump to run to meet load and two pumps on standby,

.3 Performance:

Parameter	Vacuum Rating	Flow Rate Units
Capacity	!	L/s @ 47 kPa abs
	!	L/s @ 34 kPa abs
	!	L/s @ 27 kPa abs
Input Power	!	kW
Receiver capacity	!	Liters

.4 Vacuum pumps, Rotary Lobe type

- .1 factory packaged and tested prior to shipment,
- .2 dry-running, oil-free, rotary lobe vacuum pumps,
- .3 direct-driven through shaft coupling by 3 phase induction motor, or
- .4 direct-driven through shaft coupling by C-face, foot mounted, 3 phase induction motor,
- .5 lubricant required for gears only
- .6 equipped with oil drain valve,
- .7 built-in anti-suck-back valve mounted at pump inlet,
- .8 factory assembled and tested by vacuum pump manufacturer,
- .9 mounted on vibration isolators and supplied with threaded exhaust adapter piped with stainless steel flexible connector,

Standard of Acceptance

- AirLiquide Healthcare/Busch
-

.5 Vacuum receiver (if provided):

- .1 connected to vacuum producers by common manifold,
- .2 hot dipped galvanized steel (inside and out) to CSA B51, suitable for 1035 kPa (150 psi) working pressure,
- .3 for vertical mounting/horizontal mounting,
- .4 provided with:

- (a) vacuum gauge,.

- (b) drain valve,
- (c) vent valve,
- (d) vacuum relief valve,
- (e) sight glass assembly, and
- (f) three valve receiver by-pass with ball valves

.6 Vacuum producer control panel:

- .1 mounted in NEM1 enclosure,
- .2 programmable logic module,
- .3 main disconnect switch,
- .4 magnetic motor starters with circuit protection for each vacuum producer,
- .5 manual-auto-off selector switches for each vacuum producer,
- .6 control transformers with primary and secondary circuit protection.
- .7 internal pressure sensors and pressure switches for controlling stop/start operation of vacuum producers,
- .8 multi-unit vacuum producer package control through Siemens S7-1200 Programmable logic controller with alternating strategy to equalize vacuum producer run time, and coordinate automatic back-up from stand-by unit.
- .9 visual and audible alarms for;
- .10 fail-safe operation of vacuum pumps with no power to PLC

Signal	Medical Vacuum with oil-less claw type vacuum pump system
Vacuum line low	●
Lag pump in use	●
High discharge temperature	●
Primary transformer failure	●
Motor overload	●

.11 Automatic controls sequences;

- (a) start lead vacuum producers when vacuum rises to -68 kPa relative (-20 in Hg vacuum)
- (b) stops lead vacuum producer when vacuum reaches -77 kPa relative (-23 in Hg vacuum)
- (c) start lag 1 vacuum producer when system vacuum rises to -60 kPa relative (-18 in Hg vacuum)
- (d) shuts down lag 1 vacuum producer when pressure reaches -74 kPa relative (-22 in Hg vacuum)
- (e) start lag 2 vacuum producer when system vacuum rises to -57 kPa relative (-17 in Hg vacuum)
- (f) shuts down lag 2 vacuum producer when pressure reaches -74 kPa relative (-22 in Hg vacuum)
- (g) if lag 1 vacuum producer is not available, start lag 2 vacuum producer,
- (h) alternate assignment of vacuum producers between lead, lag 1 and lag 2,

- (i) adjustable minimum run timer on each vacuum producer
- (j) "Vacuum producer(s) Disabled" alarm contacts
- .12 Network Communications:
 - (a) Ethernet IP based network protocol compatible with medical gas Supply System Alarm Panel, or over BACnet IP, BACnet MSTP or MODBUS RTU.

1.12 Medical Vacuum - ModuleVide for Critical Care Areas (Optional)

- .1 Critical Care back up medical vacuum pump installed into centrally piped medical vacuum piping network to provide medical vacuum to critical zone(s) during cases of central system shut-down, unexpected or planned maintenance. The vacuum pump shall be installed with a check valve arrangement designed to ensure the emergency vacuum pump serves only the intended zone, and not the entire central pipeline.

1.13 Medical Vacuum in-line filter trap (Optional)

- .1 Type:
 - .1 plexiglas body,
 - .2 stainless steel connection nipples and couplings,
 - .3 removable [40][80] mesh screen
 - .4 100mm (4 inch) size
 - .5 gasketed cover held in place with stainless steel studs and wing nuts.
 - .6 integral debris sensor with 1 set of NC contacts to close automatic valve in vacuum line serving trap and 1 set NO contacts to operate local alarm.
 - .7 drain valve tapping in filter body
- Standard of Acceptance*
 - Air Liquide Healthcare / Busch Clear-Vu Model P-1
 -

1.14 AGSS (Anaesthetic Gas Scavenging System)

- .1 System:
 - .1 Factory assembled and tested system including:
 - (a) vacuum pumps Oxygen Assured,.
 - (b) receivers (if provided),
 - (c) control panel c/w alarms and controls
 - (d) epoxy finished structural steel base frame and shipping hardpoints.
- .2 System redundancy:
 - .1 duplex arrangement with two (2) pumps, requiring one pump to run to meet load and one pump on standby in accordance with Z7396.1-12, Clause 5.10.1.3,
- .3 Performance:

Parameter	Vacuum	Flow Rate
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	Rating	Units
Capacity	!	L/s @ 47 kPa abs
	!	L/s @ 34 kPa abs
	!	L/s @ 27 kPa abs
Input Power	!	kW
Receiver capacity	!	Liters

.4 Vacuum pumps, Rotary Lobe type:

- .1 factory packaged and tested prior to shipment,
- .2 dry-running, oil-free, rotary lobe vacuum pumps,
- .3 direct-driven through shaft coupling by 3 phase induction motor, or
- .4 direct-driven through shaft coupling by C-face, foot mounted, 3 phase induction motor,
- .5 lubrication only required for gears equipped with oil drain valve,
- .6 built-in anti-suck-back valve mounted at pump inlet,
- .7 factory assembled and tested by vacuum pump manufacturer,
- .8 mounted on vibration isolators and supplied with threaded exhaust adapter piped with flexible stainless steel connector,

Standard of Acceptance

- AirLiquide Healthcare
-

.5 Vacuum receiver (if provided):

- .1 connected to vacuum producers by common manifold,
- .2 hot dipped galvanized steel (inside and out) to CSA B51, suitable for 1035 kPa (150 psi) working pressure,
- .3 for vertical mounting/horizontal mounting,
- .4 provided with:
 - (a) vacuum gauge,.
 - (b) drain valve,
 - (c) vent valve,
 - (d) vacuum relief valve,
 - (e) sight glass assembly, and
 - (f) three valve receiver by-pass with ball valves

.6 Vacuum producer control panel:

- .1 mounted in NEM1 enclosure,
- .2 programmable logic module,
- .3 main disconnect switch,
- .4 magnetic motor starters with circuit protection for each vacuum producer,
- .5 manual-auto-off selector switches for each vacuum producer,
- .6 control transformers with primary and secondary circuit protection.

- .7 internal pressure sensors and pressure switches for controlling stop/start operation of vacuum producers,
- .8 multi-unit vacuum producer package control through Siemens S7-1200 Programmable logic controller with alternating strategy to equalize vacuum producer run time, and coordinate automatic back-up from stand-by unit.
- .9 visual and audible alarms for;

Signal	AGSS Medical Vacuum with oil-less claw type vacuum pump system
AGSS Vacuum line low	•
Lag pump in use	•
High discharge temperature	•
Primary transformer failure	•
Motor overload	•

- .10 Automatic controls sequences;
 - (a) start lead vacuum producer when vacuum rises to -68 kPa relative (-20 in Hg vacuum)
 - (b) stops lead vacuum producer when vacuum reaches -77 kPa relative (-23 in Hg vacuum)
 - (c) start lag vacuum producer when system vacuum rises to -60 kPa relative (-18 in Hg vacuum)
 - (d) shuts down lag vacuum producer when pressure reaches -74 kPa relative (-22 in Hg vacuum)
 - (e) alternate assignment of vacuum producers between lead and lag,
 - (f) adjustable minimum run timer on each vacuum producer
 - (g) "Vacuum producer(s) Disabled" alarm contacts
- .11 Network Communications:
 - (a) Ethernet IP based network protocol compatible with medical gas Supply System Alarm Panel, or over BACnet IP, BACnet MSTP or MODBUS RTU.

1.15 Instrument Air - Compressor Based Supply System

- .1 System:
 - .1 Factory assembled and tested system including:
 - (a) compressors,
 - (b) receivers,
 - (c) duplex drying and purification units,
 - (d) high-pressure cylinder reserve with check assembly,
 - (e) dual pressure regulating station,
 - (f) control panel c/w alarms and controls
 - (g) pre-filters,
 - (h) after-filters,
 - (i) bacteria retention filters,
 - (j) filter/pressure regulator,
 - (k) control panel c/w motor starters, controls and alarms,

- (l) epoxy finished structural steel base frame and shipping hardpoints.
 - .2 System redundancy:
 - (a) duplex arrangement with two compressors, requiring one compressor to run to meet load and one compressor on standby,
 - .3 Performance:

Parameter	Rating	Units
Air delivery per compressor		Actual Litres/min @ delivered pressure kPa
Air delivery per compressor		Standard Litres/min @ 101.3 kPa, 20C DB, 36% RH inlet conditions
Delivered pressure		kPa
Power input per compressor		kW
Receiver capacity		Litres
Dryer flow rate per tower		°C @ 350 kPa
Dryer Dew point temperature		°C @ 350 kPa

.2 Instrument Air Compressors, Rotary Scroll:

- .1 air cooled, oil-less rotary scroll,
- .2 electric driven compressors equipped with 10 micron intake filter assembly rated for 2.5 times the flow of the compressor and CRN registered discharge water separator sized for the flow capacity of the compressor with constant liquid removal efficiency when operating between 25 and 100% of the rated flow. Liquid separators with internal moving parts shall not be acceptable,
- .3 fitted with discharge temperature sensors mounted at the discharge of the compression chamber of each compressor and wired to shut down compressor and initiate high discharge temperature alarm if head temperature rises above normal,
- .4 discharge port of each compressor head shall be interconnected to the intake filter using braided stainless steel flex connector,
- .5 self-lubricating tip seals,
- .6 field regreaseable bearings,
- .7 integral air-to-air aftercooler,
- .8 safety relief valve,
- .9 braided stainless steel discharge flex connector,
- .10 discharge check valve,
- .11 discharge isolation ball valve

- .12 assembly configuration - stack mounted
- .13 air to air intercooler and discharge air water separator with water drain trap on each compressor.
- .14

Standard of Acceptance

- AirLiquide Healthcare/Busch

.3 Air receiver;

- .1 capacity: 302 L (80 usgal),
- .2 construction: galvanized (inside and out) carbon steel as an unfired pressure vessel to CSA B51,
- .3 design pressure: 1030 kPa (150 psig),
- .4 cylindrical tank with dished ends and supporting legs for vertical mounting/horizontal mounting,
- .5 provided with;
 - (a) inlet air connection,
 - (b) outlet air connection,
 - (c) bottom drain with automatic drain valve.
 - (d) pressure safety valve,
 - (e) pressure gauge, and
 - (f) site glass.

.4 Air dryer system - Desiccant Type:

- .1 Type:
 - (a) Factory assembled and tested, skid mounted package.
 - (b) two column heatless regeneration type with automatic switching between beds,
 - (c) columns, heads and casings of dryer body manufactured from stainless steel, carbon steel, or aluminum
 - (d) design pressure: 1030 kPa (150 psig) pressure rating,
 - (e) ball valves at inlet and outlet of dryer,
 - (f) pre-filters, after-filters and bacteria retention filters in duplex arrangement with ball valves for shut-off on inlet and outlet of each filter housing.

.2 Performance:

Parameter	Rating	Units
Desiccant per bed, minimum	!	kg
Flowrate	!	litres/min
Inlet pressure	350	kPa
Dewpoint temperature	-40	°C

.3 Control panel:

- (a) 120 volt/1 phase/60 Hz control panel,

- (b) panel face mounted pressure gauges, pre-wired alarm and operating sensors, relays, switches, pilot lights and terminal strip for external alarm connections.
- (c) moisture sensors, timers and switching valves and solenoid valves to control switching and regeneration,
- (d) internal self diagnostic circuitry and alarm contacts for "Dryer Switching Failure" alarm,
- (e) pressure gauges between prefilter and dryer inlet, between dryer outlet and after-filters and between after-filters and bacteria retention filters.

Standard of Acceptance

- Air Liquide Healthcare/Busch

.5 Line Pressure Regulator System:

.1 dual line pressure regulating assembly consisting of:

- (a) two pressure regulators,
- (b) outlet pressure gauges,
- (c) inlet and outlet isolation ball valves,
- (d) pressure safety valves,
- (e) arranged so that isolation of one regulator will not affect operation of second regulator.

Standard of Acceptance

- Air Liquide Healthcare

.6 Pre-filters:

- .1 high efficiency coalescing type, rated 0.01 micron filtration with an efficiency exceeding 99.9999% D.O.P.,
- .2 initial (dry and clean) pressure drop of not more than 6 Kpa (0.9 psig) (1030 Kpa (150 psig) pressure rating),
- .3 epoxy coated glass fibre media,
- .4 NPT 1 connections, and
- .5 external automatic drain

Standard of Acceptance

- Air Liquide Healthcare / Busch

.7 Prefilter automatic drain:

- .1 demand cycled drain,
- .2 liquid sensor,
- .3 direct acting, normally closed solenoid valve rated at 1030 kPa (150 psig),
- .4 NPT 1/4 or 1/2 connections, and
- .5 EMAC 4 construction with adapter for 13 mm (1/2 in) conduit.

Standard of Acceptance

- Air Liquide Healthcare / Busch

.8 After-filters:

- .1 "absolute" particulate removal type (0.9 um),
- .2 rated 0.01 micron filtration with an efficiency exceeding 99.9999% D.O.P.,
- .3 initial (dry and clean) pressure drop of not more than 2 kPa (0.3 psig) (1030 kPa (150 psig) pressure rating),
- .4 cellulose media,

- .5 stainless steel housing, and
- .6 NPT 1 connections.

Standard of Acceptance

- Air Liquide Healthcare / Busch

.9 Air intakes:

- .1 filters to be mounted on each pump or compressor inlet.
- .2 Intake filter housing to have quick release fasteners and to be rated for air flow capacity of pump or compressor with efficiency greater than 98% when challenged with 6 micron particles.

.10 Instrument Air Control System:

- .1 mounted in NEM1 enclosure,
- .2 programmable logic module,
- .3 main disconnect switch,
- .4 magnetic motor starters with circuit protection for each compressor,
- .5 manual-auto-off selector switches for each compressor,
- .6 control transformers with primary and secondary circuit protection.
- .7 two dryer auto/off selector switches,
- .8 one continuous/controlled dryer purge selector switch,
- .9 internal pressure sensors and pressure switches for controlling stop/start operation of compressors,
- .10 multi-unit compressor package control through Siemens S7-1200 Programmable logic controller with alternating strategy to equalize compressor run time, and coordinate automatic back-up from stand-by units.
- .11 visual and audible alarms for;

Signal	Medical Air with oil-less type compressor system
High line pressure	●
Low line pressure	●
Lag compressor in use	●
Reserve in use	●

Reserve low pressure	•
High dew point	•
High discharge temperature	•
Desiccant dryer tower switching failure	•
Primary transformer failure	•
Motor overload	•

.12 Automatic controls sequences;

- (a) start lead compressor when pressure falls to 862 kPa (125 psig)
- (b) stops lead compressor when pressure reaches 931 kPa (135 psig)
- (c) start lag 1 compressor when system pressure falls to 827 kPa (120 psig)
- (d) stops lag 1 compressor when pressure reaches 896 kPa (130 psig)]
- (e) alternate assignment of compressors between lead and lag,
- (f) adjustable minimum run timer on each compressor,
- (g) "Compressor(s) Disabled, Reserve in Use" alarm contacts

.13 Network Communications:

- (a) Ethernet IP based network protocol compatible with medical gas Supply System Alarm Panel, or over BACnet IP, BACnet MSTP or MODBUS RTU.

1.16 Oxygen Deprivation Monitor

- .1 Provide oxygen deprivation alarm(s) in cylinder manifold rooms with remote repeater alarm(s) (audible and visible) where enclosure has multiple entrances.
 - .1 Unit to alarm at 19.6% oxygen with a second alarm at 18% oxygen.
 - .2 Range to be 0.1% to 25 % oxygen.
 - .3 Unit response time to be 15 seconds or less for oxygen Push button calibration
 - .4 Power supply: 110 vAC

Standard of Acceptance

- Air Liquide Healthcare /Beacon Medaes #4107 2121 04
-

1.17 Oxygen Concentration System with Reserve Backup

- .1 System
 - .1 Factory assembled and tested system including:
 - (a) Oxygen concentrator,

- (b) Air compressor,
- (c) Vacuum pump,
- (d) Oxygen storage tank,
- (e) Sample port with shut-off valve immediately downstream of storage tank,
- (f) Pressure regulator(s),
- (g) Air filters(s),
- (h) Two oxygen analysers,
- (i) One carbon dioxide analyser,
- (j) One carbon monoxide analyser,
- (k) Control panel c/w motor starters, alarms and controls,
- (l) Epoxy finished structural steel base frame and shipping hardpoints, and powder coated.

.2 System redundancy:

- (a) Shall consist of at least three sources of supply:
 - At least one of which shall be an oxygen concentrator source of supply and,
 - At least one of which shall be a portable cylinder source of supply (high pressure and/or liquid supply system) that acts as reserve source.
- (b) Triplex arrangement with 3 sources, requiring one source to run to meet average peak demand load and two sources on standby.

.3 Performance:

- (a) System shall produce oxygen that meets the specification for oxygen 93 USP.
 - Oxygen delivery per source: 1030 LPM @ 586 kPa,
 - Power required
 - oxygen concentrator: ; vacuum pump: 15hp (11kw) @ 575v/3ph/60hz; air compressor: 50hp @ 575v/3ph/60hz.

.2 Feed air system

- .1 Rotary screw type compressor,
- .2 Motor driven by a fixed speed drive,
- .3 Feed air path completely free of oil. Two oil filters in line between compressor and oxygen concentrator. One pre-filter at 10 microns, and one coalescing at 0.01 microns.

.3 Air receiver

- .1 Capacity: 1,000 Us gallons
- .2 ASME rated, CRN registered,
- .3 Construction: Galvanized carbon steel inside out as an unfired pressure vessel to CSA B51,
- .4 Design pressure: 150 psig
- .5 Provided with:
 - (a) Inlet air connection,
 - (b) Outlet air connection,
 - (c) Bottom drain with automatic drain valve,
 - (d) Pressure safety valve,
 - (e) Pressure gauge, and
 - (f) Site glass.

.4 Vacuum pump

- .1 Rotary vane oil lubricated vacuum pump,
- .2 Oil-free design
- .5 Oxygen concentrator
 - .1 Capable of producing 95% pure oxygen (+/- 1%),
 - .2 Capable of producing and storing the oxygen at 85 psi without secondary booster pump.
- .6 Oxygen storage tank
 - .1 Capacity: 2 @ 1060 US gallons,
 - .2 Construction: corrosion-resistant at least to galvanized carbon steel as an unfired pressure vessel to CSA B51,
 - .3 Design pressure: 1030 kPa (150 psig),
 - .4 ASME rated, CRN registered,
 - .5 Provide with:
 - (a) Inlet oxygen connection,
 - (b) Outlet oxygen connection,
 - (c) Bottom drain with automatic drain valve,
 - (d) Pressure safety valve, and
 - (e) Pressure gauge.
- .7 Oxygen concentrator control system
 - .1 Integrated control system controls the interaction between air compressor, air receiver, vacuum pump, and oxygen concentrators.
 - .2 Mounted in NEMA 12 enclosure,
 - .3 Two main disconnect switch, each is wall mounted for each vacuum pump and compressor,
 - .4 On/off selector switch,
 - .5 Motor circuit breaker with thermal overload protection, magnetic short circuit protection, and through the door manual disconnect and reset,
 - .6 Fixed speed drive vacuum pump,
 - .7 Two transformers,
 - .8 One transformer switching relay,
 - .9 Alarm buzzer, silence button, alarm reset button,
 - .10 PLC controls,
 - .11 Concentrator with manual adjustable set points, pressure transducers and digital display with user setpoints lockable,
 - .12 Compressor with pressure transducers and digital display with locking security set points,
 - .13 0-1000 LPM digital mass flowmeter,
 - .14 High resolution colour touch-screen c/w system status and alarm events, hour meters, user adjustable setting, oxygen purity level display, oxygen usage and password protection,
 - .15 Numbered terminal strip with dry contacts available for site connection to system alarm panel,

- .16 System complete with on-site alarm remote monitoring capability and software, alarms able to be remotely monitored at BAS computer(s) via hospital's intranet system and requires no additional proprietary software,
 - .17 Automatic controls sequences:
 - (a) Starts lead unit when pressure in storage tank falls below 77 psi,
 - (b) Stops lead unit when pressure in storage tank reaches 87 psi,
 - (c) Starts lag1 unit when pressure in storage tank falls below 77 psi,
 - (d) Stops lag 1 unit when pressure in storage tank reaches 87 psi,
 - (e) Provides lead/lag operation in accordance with the above to meet the system requirements,
 - (f) Alternates lag unit designation on shut-down,
 - (g) Alternates assignment of units between lead and lag 1.
 - (h) Runs lead and lag units together under peak demand condition with adjustable time delay (0- 20 seconds) between start of lead and lag unit,
 - (i) Adjustable minimum run time on each unit,
 - (j) "unit(s) Disabled, Reserve in Use" alarm contacts. When units disabled, concentrator malfunction alarm is relayed to alarm panel.
 - .18 Oxygen quality control monitoring system
 - (a) Pre-paid five (5) year quality control service,
 - (b) The output of each concentrator is monitored and recorded in real time through oxygen analyzers to meet the specification for Oxygen 93 USP,
 - (c) 4 analyzers (2 for oxygen, one for CO, and one for CO2) continually monitor the product being produced by the concentrator. If any of the analyzers read off spec gas, the concentrator closes a valve, isolate the gas from leaving the concentrator, and goes into purging mode to exhaust off spec gas. While continually analyzing the gas during purge mode, if concentrator cannot reach oxygen 93 USP or greater, the concentrator will shut down and send an alarm to the main alarm panel of "concentrator malfunction".
 - (d) Supplier shall maintain ownership of the quality control module throughout the term, and shall provide on-site performance verification and sensors calibration a minimum of three times per year,
 - (e) Supplier shall provide the client with a GMP quality control compliance report following each calibration, complete with a digital copy of the recorded data set for client's records retention,.
 - .19 Network communications:
 - (a) Ethernet IP based network protocol compatible with medical gas supply system alarm panel, or over BACnet IP, BACnet MSTP or MODBUS RTU.
- .8 Warranty oxygen concentration system for ten (10) years, and warranty to include:
- .1 For labour and materials used, excluding travel expenses.

Standard of Acceptance
◦ Air Liquide Healthcare / ON2 Solutions

2 EXECUTION

2.1 Cleaning

- .1 Materials to be supplied cleaned using methods specified in CGA G-4.1, visually inspected, and capped or sealed in a package to prevent contamination and labeled, on the part or package, by the manufacturer or Oxygen cleaning subcontractor.
- .2 Where contamination with oil, grease and other readily oxidizable materials is suspected;
 - .1 wash the part before installation with hot solution of trisodium phosphate in water 500 g in 12.5 litres (1 lb in 2.5 gal),
 - .2 scrub inside of tubing, parts, and fittings with cleaning solution and agitate parts and fittings in bath of cleaning solution,
 - .3 rinse in fresh clean water and blow dry with nitrogen.
- .3 Store materials in clean and dry conditions.
- .4 Keep cutting and reaming tools scrupulously clean and free from oil or grease.
- .5 Do not use organic solvents such as carbon tetrachloride under any circumstances.

2.2 Piping fabrication and support

- .1 Install piping in accordance with CSA Z7396-1.
- .2 Make-up system with tubing joined with wrought fittings.
- .3 Use ells, tees, caps and couplings to make offsets and changes in direction and to route piping between connections.
- .4 Do not bend hard drawn tubing except for long sweep cold bending with minimum bending radius of 20 x OD, without deformation or reduction in pipe diameter.
- .5 Use adapters for connection to equipment with threaded joints
- .6 Braze connections with silver solder;
 - .1 make up joints between copper and copper materials without the use of flux, and with nitrogen backing without using flux in accordance with Clause 4.5 of CSA B51,
 - .2 joints between dissimilar metals may be fluxed with product conforming to AWS brazing flux No. 3A, in accordance with instructions provided by solder and flux manufacturers.
 - .3 brush flux over end of fitting and keep inside of pipe and fittings free from flux.
 - .4 after brazing dissimilar metals, wash with hot water to remove residual flux.
- .7 During brazing, pressurize interior of pipe and fittings with nitrogen.
- .8 When flux is used, wire brush joints after brazing.

.9 Make-up threaded joints with sealing compound suitable for the gas being transmitted.

.10 Support piping:

- .1 on trapeze channels with tubing clips to secure piping to channel. Install U-plates on each side of pipe clamp to prevent horizontal movement
- .2 individually with adjustable wrought clevis hangers, rods and anchors as specified,
- .3 vertically with riser clamps at each floor, _
- .4 with support spacing as per the following table:

Pipe/Tube Size NPS/OD	Support Horizontal Spacing m (ft)	Support Vertical Spacing m (ft)
1/2	1.8 (6)	1.8 (6)
3/4	2.4 (8)	1.8 (6)
1	2.4 (8)	2.4 (8)
1-1/4	3.0 (10)	2.4 (8)
1-1/2	3.0 (10)	2.4 (8)
2	3.0 (10)	3.0 (10)

.11 Do not support medical gas piping from other building services. Do not support other building services from medical gas piping.

.12 Cap off open ends of piping at the end of each work shift, using shipping dust caps overlaid with plastic and held in place with tape.

2.3 Buried piping

.1 Install underground medical gas piping below frost level arranged in banks.. -
.1 minimum depth of cover: 120mm (4 ft)

.2 Excavate and backfill piping conduit in accordance with section 20 05 25.

.3 At foundation walls, install watertight foundation sleeves complete with Link-Seals.

.4 Zone alarms - line pressure sensors

.5 Provide pressure sensor tubing and connections between medical gas piping and Zone alarms pressure sensors.

- .1 Provide NPS 1/2 branch connection on gas piping between zone control valve and first terminal outlet served, complete with diameter index safety system (DISS) female connector with a demand check valve.

- .2 Provide NPS 3/8 sensing line complete with male DISS connector and run line from female DISS connector to the pressure-sensing alarm device.

.6 The above requirements may be met when supplied and integrated as part of the Zone alarm panel.

2.4 Valves

- .1 Provide valves as shown.
- .2 Provide common-keyed padlocks on each service valve, not including zone valves. Leave valves padlocked in the open position, and turn five (5) copies of the common-key over to the owner.

2.5 Pressure regulators

- .1 Pipe pressure safety valves for all medical gases, except medical vacuum and AGSS, to the outside of the building and terminate a minimum of 3 m (10 ft) from any door, operable window, or ventilation intake, and be located in an accessible location to authorized personnel.
- .2 Locate discharge so that they will not endanger passersby.
- .3 Terminate piping with return bend and insect screen.

2.6 Labelling

- .1 Label medical gas systems in accordance with CSA Z7396-1.
- .2 Label piping progressively on a daily basis as piping is installed.

2.7 Electrical supply and wiring

- .1 Dedicated emergency power circuits for alarm panels will be provided under Electrical Division 26 at 120 volt 60 Hz single phase and will terminate at the device power terminal strip in each alarm panel.
- .2 Provide wiring and conduit from these junction boxes to connect control devices being electrically powered.
- .3 Install supply system alarm panels and zone alarm panels as shown.
- .4 Wiring between control and alarm panels and between panels and remote sensors to be provided in accordance with standards established under section 20 05 12, to be as recommended by unit manufacturers, and not less than #16 TWH or RW90 run in EMT conduit.
- .5 Provide terminal junction boxes wherever signal and control wiring interfaces with alarm wiring.
- .6 Alarm wiring from main panel to terminal junction boxes to be Belden multi-pair colour coded 18 - 22 gauge wire with chrome PVC jacket run in EMT conduit.
- .7 Alarms to be wired to same terminal number in each terminal junction box and alarm panel.
- .8 Provide legend showing terminal number, colour code of wire and identifying common wire used for each alarm and each spare circuit.

- .9 25% of wire pairs and terminals to be provided as spare circuits in cable and spare terminals in terminal junction boxes and alarm panels.
- .10 Control wiring outside of panels and terminal junction boxes to be not less than #16 TWH or RW90 run in EMT conduit.
- .11 Wire alarm panels in accordance with manufacturers wiring diagrams.

2.8 Network Communications Wiring

- .1 Network ethernet wiring provided under Division 25.
- .2 Coordinate with the contractor under Division 25 for configuration of IP addresses and access to alarm point data in the Building Automation System.

2.9 Oxygen supply equipment installation

- .1 Connect to oxygen supply valve located 300 mm (12 in) above concrete pad within bulk oxygen enclosure and extend piping as shown.
- .2 Install oxygen manifold as shown. Cylinders will be supplied by Owners.

2.10 Nitrous oxide supply equipment installation

- .1 Install nitrous oxide manifold as shown. Cylinders will be supplied by Owners.

2.11 Nitrogen supply equipment installation

- .1 Install nitrogen manifold as shown. Cylinders will be supplied by Owners.
- .2 Install local gas regulation control panels for nitrogen service in locations shown.

2.12 Carbon Dioxide supply equipment installation

- .1 Install Carbon Dioxide manifold as shown. Cylinders will be supplied by Owners.

2.13 Instrument Air supply equipment installation

- .1 Install instrument air manifold as shown. Cylinders will be supplied by Owners.
- .2 Install local gas regulation control panels for instrument air service in locations shown.

2.14 Medical vacuum equipment installation

- .1 Install medical vacuum producing equipment as shown and:
 - .1 connect discharge from muffler on each pump and extend to outside and terminate with return bend and insect screen in location accessible to authorized personnel,
 - .2 route medical vacuum systems piping including exhaust piping inside of building in such a way that it is not subjected to a temperature lower than 4°C ,

- .2 Dental facilities within a health care facility shall not be connected to those portions of the medical gas pipeline system that supply medical vacuum or medical air.

2.15 AGSS (Anaesthetic Gas Scavenging System)

- .1 Install AGSS producing equipment as shown and:
 - .1 connect discharge from muffler on each pump and extend to outside and terminate with return bend and insect screen in location accessible to authorized personnel,
 - .2 route AGSS systems piping including exhaust piping inside of building in such a way that it is not subjected to a temperature lower than 4°C ,

2.16 Medical air equipment installation

- .1 Install medical air producing equipment and dryers as shown and:
 - .1 connect intake piping to intake filter on each compressor and extend to outside and terminate with return bend and insect screen in location accessible to authorized personnel,
 - .2 medical air systems piping including intake shall be routed inside the building in such a way that it is not subjected to a temperature lower than 4°C .
- .2 Dental facilities within a health care facility shall not be connected to those portions of the medical gas pipeline system that supply medical vacuum or medical air.

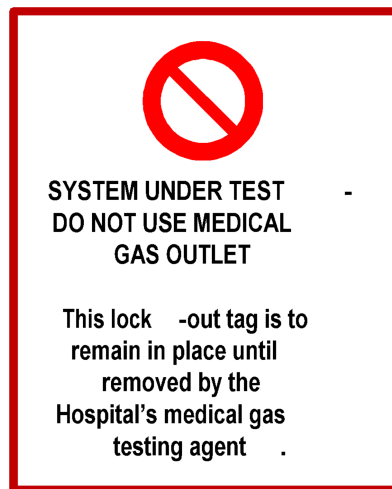
2.17 Headwall Units, Ceiling Service Columns, Ceiling Articulating Arms, Patient Service Strips and Medical Supply Unit

- .1 Coordinate with the Division providing Service Units including:
 - .1 Supply medical gas and vacuum outlets to Service Units vendor.
 - .2 Conduct factory acceptance inspection of the first manufactured unit of each Service Unit and either approve it or direct any corrections to be made.
 - .3 At Headwall Units and / or Patient Service Strips, connect in the field to the capped connection for each type of gas and / or Anaesthetic Gas Scavenging System.
 - .4 At Ceiling Service Columns and / or Ceiling Articulating Arms and / or Medical Supply Units in surgical suites, intensive care units, and other patient areas possessing single or multiple ceiling service columns, ceiling articulating arms / medical supply units, a junction point shall be provided with permanently fitted gas-specific DISS body adapter without a check valve for connection to a low-pressure flexible hose assembly within the ceiling service column, ceiling articulating arm / medical supply unit. Where multiple ceiling service columns, ceiling articulating arms / medical supply units are located in the same room, readily accessible service isolation valves shall be provided to permit isolation of each gas without disrupting the function of the other ceiling service columns, ceiling articulating arms / medical supply units. Where one (1) ceiling service column, ceiling articulating arm / medical supply unit is installed downstream of a zone valve, the zone valve can be used to isolate the ceiling service column, ceiling articulating arm / medical supply unit.
 - .5 Witness the final testing and assist the certification agency as necessary

- .2 Refer to drawings, documents and headwalls / columns / arms / service strips shop drawings for location and number of outlets.

2.18 Pipe system commissioning

- .1 Blow out piping system prior to installation of service outlet valves with oil free, dry compressed air or nitrogen taken from freshly charged medical gas storage cylinders. Continue blow out process until system is clear of free moisture and foreign matter.
- .2 Conduct commissioning on piping systems in accordance with CSA Z7396-1 as summarized herein, prior to 3rd party certification testing by the independent certifier retained by the Owner,
- .3 Conduct commissioning after the terminal units are installed, but before medical gas piping is concealed in walls, above ceilings or in vertical service spaces.
- .4 Tag-out / Lock-out requirements:
 - .1 Tag-out each medical gas outlet prior to testing of associated piping system with tag as shown or similar:



- .5 Brazing quality test:
 - .1 Cut-out samples of brazed joints as selected by the Owner or their agent. Inspect with the Owner for proper brazing techniques and absence of oxidation on inside of pipe.
 - .2 If samples show improper brazing or oxidation, remove joints on each side of selected joint and inspect for defect. Continue joint inspection process until the Owner or their agent accepts the quality of brazing.
- .6 Initial pressure test:
 - .1 conduct an initial pressure test to inspect for pipe leaks,
 - .2 do not manifold piping systems together; test each system independently,

- .3 test gas: oil free dry air,
- .4 test pressure 150% of design pressure or 1035 kPa (150 psi) whichever is greater, for positive pressure gas systems,
- .5 test pressure minimum 415 kPa (60 psig) for medical vacuum systems,
- .6 use an oxygen compatible leak detector at each joint,
Standard of Acceptance – Be sure the acceptable leak detectors are Oxygen safe
 - Swagelock Snoop
 - American Gas & Chemical Co. Ltd Leak-tec
 - Formula 300

.7 repair any detected leaks and retest pipe system.

.7 Acceptance pressure test:

- .1 repeat the initial pressure test once all repairs have been completed,
- .2 install a temperature compensated pressure recorder, or combination temperature/pressure recorder to monitor and record test pressure,
- .3 leave each system under test pressure for 24 hours,
- .4 acceptance criteria: no loss of pressure after 24 hours except as a result of temperature change.
- .5 submit a report to the Owner documenting the test methodology and test results.

.8 Purge terminal units:

- .1 after acceptance of pressure testing, purge units until test gas is clear of particulate matter, and visible moisture as droplets or mist.

.9 Cross-connection tests:

- .1 conduct cross-connection tests in accordance with Method 2 of CSA Z7386-1,
- .2 use the test gas as used for pressure testing of pressure piping, and use vacuum source for medical vacuum system,
- .3 test each piping system separately; de-pressurize other piping systems not under test,
- .4 set test pressure for system under test to 345 kPa (50 psig),
- .5 check each terminal unit on system under test that test pressure is recorded at outlet,
- .6 check all other terminal units on other systems that outlet pressure is zero, and vacuum terminal outlets are under vacuum,
- .7 measure pressures using gauge with DISS adapter for each service,
- .8 repeat test for each piping system.
- .9 submit a test record report confirming cross-contamination results to the Owner.

2.19 Contractor responsibilities during Certification Testing

- .1 Owner will retain and pay for inspection body to inspect, test and certify medical gas installation.

- .2 Provide a copy of the completed as-built drawings to the inspection body prior to certification testing.
- .3 Arrange and pay for representatives of medical gas equipment suppliers to provide technical support and operating instructions during certification.
- .4 After completion of the commissioning tests described above and while the inspection body is present, purge the distribution piping a sufficient number of times to remove the test gases. Purge airflow through each terminal unit.
- .5 Provide qualified person familiar with work of this contract to witness certification testing and assist staff of inspection body in locating pipe runs, valves, alarm sensors, alarm wiring and other components of medical gas system and repair defects in equipment, workmanship or materials discovered during certification testing.
- .6 Assist agency staff in subsequent retesting.

2.20 Medical gas system flow testing

- .1 Conduct flow tests of oxygen and medical air terminal units in accordance with CSA Z7396.1.
- .2 Repair or replace terminal units that fail to meet criterion in CSA Z7396.1 and retest.

2.21 Medical gas system certification

- .1 Medical gas certification testing will be performed by the inspection body, in accordance with CAN/CSA Z7396.1, Annex C and D. Testing of the medical gas pipeline distribution system includes:
 - .1 Supply system tests,
 - .2 Source of supply system tests,
 - .3 Inspection of pipelines and valves,
 - .4 Inspections of zone alarms.
 - .5 particulate testing,
 - .6 terminal unit gas identity test,
 - .7 terminal unit flow testing,
 - .8 terminal unit - absence of visible water moisture test,
 - .9 terminal unit minimum flow test,
 - .10 gas sample contaminant testing.

2.22 Training and instruction

- .1 Arrange for manufacturers' representatives to provide instructions of Owners staff in use and maintenance of equipment associated with medical gas systems.

END OF SECTION