

**SECTION \_\_\_\_\_ - MEDICAL GAS AND VACUUM PIPING SYSTEMS**

**PART 1 – GENERAL**

**1. RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this Section.
- B. All equipment and installation shall be in accordance with NFPA-99, Health Care Facilities, current edition. MECHANICAL CONTRACTOR shall be responsible for compliance with all local, state, or federal codes applicable to this section.
- C. Related work shall be found in the following Specification Sections:
  - Section 15000 - Mechanical General
  - Section 15000 - Testing Mechanical Systems.
  - Section 15000 - Piping and Fittings.
  - Section 15307 - Certification Procedure for Medical Gas Piping.
  - Division 16000 - Electrical

**2. SCOPE OF WORK**

- A. Work under this section shall include furnishing, installing, testing, and certification of a complete medical gas piping system for the following medical gases: Oxygen [O<sub>2</sub>], Nitrous Oxide [N<sub>2</sub>O], Medical Air [AIR], Nitrogen [N<sub>2</sub>], Carbon Dioxide [CO<sub>2</sub>], Waste Anesthetic Gas Disposal [WAGD] and Medical Vacuum [VAC].
  - 1. Outlets, valve boxes, valves, alarm systems, pressure and vacuum switches, air compressor, vacuum pump and miscellaneous accessories for complete systems.
  - 2. Manifold systems for oxygen, medical air, nitrous oxide, nitrogen and carbon dioxide.
  - 3. Pressure testing, cross connection testing, and final testing, including purging and analyzing.
  - 4. ITEMS TO BE FURNISHED FOR INSTALLATION BY OTHERS
    - a. Cylinders for oxygen, nitrous oxide, medical air, carbon dioxide, and nitrogen will be provided by gas supplier under separate contract with the Owner.
    - b. Oxygen supplier under a separate contract will provide bulk oxygen storage and control equipment [liquid and cylinder] with the Owner.
    - c. Oxygen supplier will make all final tie-ins after the contractor provides all piping to the oxygen pad.
    - d. Screened inlet and discharge fittings for the medical air compressor and medical vacuum pump, as required.
    - e. Electrical wiring (120V and above) for alarms and other electrical equipment associated with the system shall be part of Division 16 of this specification.
    - f. The remaining wiring shall be performed under this section and shall be in accordance with Division 16: Electrical, and the manufacturer's recommendations

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- B. All systems shall be complete in every respect and ready to be put into operation. All material used shall be new and of the best grade and quality obtainable, and workmanship shall be first class in every respect.
  - 1. Comply with current NFPA 99 standards for pressure gases, and CGA P-2.1 recommendations for vacuum systems, plus applicable local, state, and federal codes.
  - 2. Employ only qualified journeymen for this work. Employ a competent, qualified mechanic to supervise the work.
  - 3. ALL ITEMS IN PART 9 ("PRODUCTS") OF THIS SPECIFICATION SECTION SHALL BE PROVIDED BY A SINGLE MANUFACTURER HAVING NOT LESS THAN FIVE (5) YEARS EXPERIENCE IN MEDICAL GAS SYSTEM COMPONENT MANUFACTURING AND ASSEMBLY.

### 3. COORDINATION

- A. Coordinate with other trades to assure timely installations and to avoid conflicts and interference.
- B. Work closely with the metal stud partition installer and/or mason to assure that anchors, sleeves, and similar items are provided in sufficient time to avoid delays; chases and openings are properly sized and prepared.
- C. Coordinate layout of medical gas systems in all spaces, and identify all piping accurately and in accordance with coded paint color required.

### 4. SUBMITTALS

- A. Product submittals: Include rated capacities, operating characteristics, furnished specialties, and accessories for all equipment to provide a complete medical gas system.
- B. Qualification data for installers: Brazer performance qualification test records for each brazer used on the installation. Brazers shall be qualified per NFPA-99, current edition.
- C. System verifier qualifications: System Verification testing report and certification including (1) a certification summary report, (2) a complete inventory of the equipment tested and (3) fully documented test data and analysis. The "System verification" report must document that each component in each individual system is complete and functioning in accordance with NFPA-99 current edition.
- D. Start-up service reports.

### 5. PIPING MATERIALS

- A. Piping shall be hard drawn seamless medical gas copper ASTM B 819 tubing, type K or L, permanently labeled and delivered plugged or capped. The installer shall furnish documentation certifying that all installed piping materials comply with the requirements of NFPA-99 (current edition). For systems with operating pressures above a gauge pressure of 1275 kPa (185 psi), ASTM B819 Type K copper shall be used.
- B. Valves, fittings, and other piping components shall be cleaned for Oxygen service by the manufacturer or other qualified agency or supplier in accordance with CGA-4.1. NO onsite cleaning shall be permitted.
- C. Fittings shall be wrought copper, brass, or bronze complying with ANSIB16.22 designed expressly for brazed connection. All fittings shall be individually bagged in heat sealed bags with labels enclosed verifying that the fittings are Cleaned for Oxygen Service. Flared and compression-type connections shall be prohibited throughout the piping system.

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- D. Copper to copper joints shall be brazed without flux. Brazing material shall be a copper-phosphorous or copper-phosphorous-silver filler metal, without flux.
- E. Dissimilar metals, such as copper and bronze or brass, shall be brazed using an appropriate flux with a silver Bag series brazing filler metal. Dissimilar metal brazing with flux must be done on the bench, so that any flux residue can be washed from the joint area before installation onto the pipeline.
- F. Medical air system intake pipelines shall be installed as a medical gas pipeline, with Oxygen cleaned pipe and fittings, and brazed under Nitrogen purge with AWS 5.8 alloy.
- G. Medical vacuum systems and vacuum exhaust shall be ASTM B 88, B 280, or B 819 Type K, L, or M, hard drawn copper tube with wrought copper fittings. Medical Oxygen Service is NOT required for this piping.

### 6. INSTALLATION

- A. All copper pipe, tubing, valves, and fittings shall be pre-cleaned and prepared for Oxygen service in accordance with NFPA 99, except those supplied specially prepared for Oxygen service by the manufacturer and received sealed on the job.
- B. All joints in the piping, except those at equipment requiring threaded connections, shall be made with silver brazing alloy or similar high melting point (at least 1000°F) brazing metal. During the brazing of pipe connections, the interior of the pipe shall be purged continuously with nitrogen. The outside of the tube and fittings shall be cleaned by washing with hot water after assembly and the tube and fittings are cool enough to touch.
- C. Threaded joints in piping systems shall be tinned or made up of polytetrafluorethylene ("Teflon") tape or other approved oxygen sealing compounds. Sealants shall be applied to male threads only.
- D. All piping shall be supported with pipe straps or hangers at appropriate intervals and NOT supported by other piping.
- E. All pipe and tubing shall be labeled or painted to indicate its gas content. Labeling shall appear on the piping at intervals of not more than 20 feet and at least once in each room and each story traversed by the piping system. Labeling identification shall be consistent with NFPA 99 requirements.
- F. Piping exposed to physical damage shall be adequately protected.
- G. A certified and licensed medical gas installer shall install the medical gas system
- H. All medical gas piping equipment shall be installed according to manufacturer instructions and in accordance with NFPA-99 current edition guidelines and all local, state, or federal codes applicable to that equipment.

### 7. INSTALLER PERFORMANCE TESTING

- A. During the installation of the pipeline system, the Installer Performance Tests shall be performed and documented as detailed in NFPA 99 current edition.

### 8. SYSTEM VERIFICATION

- A. After the successful completion of the installer performance tests, the system verification shall be completed as detailed in NFPA 99 current edition.
- B. MECHANICAL CONTRACTOR shall obtain and present to the Owner, Architect, and Engineer a pipeline certification report. This certification report shall indicate that the system is properly

installed and operates in accordance with NFPA 99, U.S.P., C.G.A., and applicable state standards, manufacturer design specifications, and safe medical practices.

- C. Certification of the medical gas system shall be performed by a testing agency that is independent of the manufacturer and mechanical contractor.

## 9. PRODUCTS

### A. OILLESS MEDICAL AIR COMPRESSOR

- 1. The Medical Air Compressor System shall be a [simplex/duplex/triplex/quadruplex] factory packaged, continuous duty rated ("continuous on demand" rated systems will not be acceptable) system which complies in all respects with NFPA 99. The system shall be completely piped and wired for single point connection. The size and quantity of compressors shall be in accordance with the attached schedule and as shown on the drawings. The system shall meet the following minimum requirements.

NOTE TO SPECIFIER: SPECIFICATIONS CAN BE ADDED IN HERE FOR PARTICULAR TYPE OF AIR COMPRESSOR SYSTEM THAT IS REQUIRED – OILLESS MEDICAL RECIPROCATING OR OILLESS MEDICAL ROTARY SCROLL, EITHER ONE WITH DESSICANT OR REFRIGERATED DRYER TYPE AIR TREATMENT CENTER. PLEASE CONTACT TRI-TECH MEDICAL INC. FOR SPECIFICATIONS TO BE ADDED UNDER THIS SECTION.

### B. MEDICAL VACUUM PUMP

- 1. The medical vacuum system shall be a [simplex/duplex/triplex/quadruplex] factory packaged, continuous duty rated system. Package shall be constructed in compliance with latest NFPA code and shall be completely piped and wired for single point connection. System shall meet the following requirements as minimum.

NOTE TO SPECIFIER: SPECIFICATIONS CAN BE ADDED IN HERE FOR PARTICULAR TYPE OF VACUUM PUMP SYSTEM THAT IS REQUIRED – OIL LUBRICATED ROTARY VANE, OILLESS DRY ROTARY VANE, OILLESS DRY ROTARY CLAW, LIQUID RING, AND REGENERATIVE BLOWER TYPE. PLEASE CONTACT TRI-TECH MEDICAL INC. FOR SPECIFICATIONS TO BE ADDED UNDER THIS SECTION.

### C. MEDICAL GAS WALL OUTLET STATIONS (QUICK CONNECT)

- 1. The medical gas wall outlets shall be Tri-Tech Medical Inc. Frontall™ Ohmeda-style quick connect medical gas outlets. The outlets shall be modular singles, and shall incorporate full faceplate color-coding. Outlets that do not incorporate full faceplate color-coding are not acceptable. The single modular outlets shall be of a design that provides for ganging of rough-in plates in the field to form multiples. The gas services shall be sequentially arranged and located as shown on the plans with a minimum centerline spacing of 4 ½ inches (11.5cm) between outlets.
- 2. The medical gas outlets shall be designed so that, once installed, routine service of the primary check valve can be accomplished **without** removing the nameplate or gas specific portions. So that the primary check valve can be removed for service **without** shutting off the gas supply to the outlet, the secondary check valve shall operate automatically to stop the free flow of the pressure gas. Medical gas outlets that require the removal of the nameplate or gas specific components for routine service shall not be acceptable.
- 3. The medical gas outlets shall incorporate a double o-ring seal on the outlet front brass shaft that insures a tight tolerance into the back brass sleeve and allows replacement of the sealing o-rings **without** shutting off the gas supply to the outlet. Medical gas outlets that use a gasket seal in the outlet back shall not be acceptable.

4. The outlet nameplate shall be permanently color coded and sealed behind a Lexan protective cover. The outlet faceplate shall be chrome plated zinc, attached with the nameplate to the rough-in assembly, and provide automatic plaster adjustment from 1/2 to 7/8 of an inch (13 to 22 mm). The name of the gas service shall be permanently marked on the outlet bracket and the outlet. The outlet's rough-in plate shall be nickel plated steel. The outlet's rough-in supply tube shall be a 7 inch (18 cm) length of 1/2" O.D. copper Type K for all gas services and labeled with the name of the gas service.
5. Medical gas outlets shall be cleaned for oxygen service in accordance with the current Compressed Gas Association (CGA) Pamphlet G-4.1, capped and placed in a protective container for shipment. The outlets shall be installed in strict accordance with manufacturer's instructions, and tested before use in conformance with local and federal codes.

#### D. MEDICAL GAS WALL OUTLET STATIONS (QUICK CONNECT)

1. The medical gas wall outlets shall be Tri-Tech Medical Inc. Allied-style quick connect medical gas outlets. The outlets shall be modular singles, and shall incorporate full faceplate color-coding. Outlets that do not incorporate full faceplate color-coding are not acceptable. The single modular outlets shall be of a design that provides for ganging of rough-in plates in the field to form multiples. The gas services shall be sequentially arranged and located as shown on the plans with a minimum centerline spacing of 4 1/2 inches (11.5cm) between outlets.
2. The medical gas outlets shall incorporate a double o-ring seal on the outlet front brass shaft that insures a tight tolerance into the back brass sleeve and allows replacement of the sealing o-rings **without** shutting off the gas supply to the outlet. Medical gas outlets that use a gasket seal in the outlet back shall not be acceptable.
3. The outlet nameplate shall be permanently color coded. The outlet faceplate shall be chrome plated metal, attached with the nameplate to the rough-in assembly, and provide automatic plaster adjustment from 1/2 to 7/8 of an inch (13 to 22 mm). The name of the gas service shall be permanently marked on the outlet bracket and the outlet. The outlet's rough-in plate shall be nickel plated steel. The outlet's rough-in supply tube shall be a 7 inch (18 cm) length of 1/2" O.D. copper Type K for all gas services and labeled with the name of the gas service.
4. Medical gas outlets shall be cleaned for oxygen service in accordance with the current Compressed Gas Association (CGA) Pamphlet G-4.1, capped and placed in a protective container for shipment. The outlets shall be installed in strict accordance with manufacturer's instructions, and tested before use in conformance with local and federal codes.

#### E. MEDICAL GAS WALL OUTLET STATION (DISS)

1. The medical gas wall outlets shall be Tri-Tech Medical Inc. Frontall™ DISS medical gas outlets. The outlets shall be modular singles, and shall incorporate full faceplate color-coding. Outlets that do not incorporate full faceplate color-coding are not acceptable. The single modular outlets shall be of a design that provides for ganging of rough-in plates in the field to form multiples. The gas services shall be sequentially arranged and located as shown on the plans with a minimum centerline spacing of 4 1/2 inches (11.5cm) between outlets.
2. The outlets shall be capable of supporting dispensing equipment without the use of slide brackets.
3. The medical gas outlets shall be designed so that, once installed, routine service of both the primary and secondary check valves can be accomplished **without** removing the nameplate or gas specific portions. The primary check valve shall be unitized and of the

cartridge type. So that the primary check valve can be removed for service **without** shutting off the gas supply to the outlet, the secondary check valve shall operate automatically to stop the free flow of the pressure gas. There shall be no secondary check for vacuum or gas evacuation service. Medical gas outlets that require the removal of the nameplate or gas specific components for routine service shall not be acceptable.

4. The outlet nameplate shall be permanently color coded and sealed behind a Lexan protective cover. The outlet faceplate shall be chrome plated zinc, attached with the nameplate to the rough-in assembly, and provide automatic plaster adjustment from 1/2 to 7/8 of an inch (13 to 22 mm). The name of the gas service shall be permanently embossed on the outlet bracket and the chrome plated brass outlet body. The outlet's rough-in plate shall be nickel plated steel. The outlet's rough-in supply tube shall be a 7 inch (18 cm) length of 1/2" O.D. copper Type K for all gas services and labeled with the name of the gas service.
5. Medical gas outlets shall be cleaned for oxygen service in accordance with the current Compressed Gas Association (CGA) Pamphlet G-4.1, capped and placed in a protective container for shipment. The outlets shall be installed in strict accordance with manufacturer's instructions, and tested before use in conformance with local and federal codes.

#### F. NITROGEN CONTROL PANEL

1. The Nitrogen Control Panels shall be Tri-Tech Medical Inc. NP100 series and must be installed and tested in strict accordance with NFPA 99 standards and or other local codes before use.
2. Rough in box assembly shall be of 14 Ga. Steel construction. Box shall be supplied with a plaster flange for easy mounting. Two 1/4" nominal 3/8" OD Type K copper stubs shall be supplied to facilitate piping to the box and to any optional remote outlets. Box assembly shall be factory piped to allow for pipeline testing before nitrogen panel is installed.
3. The gas panel shall include a high flow self-relieving pressure regulator capable of providing pressures up to 250 psi. A quarter turn brass, ball type valve shall be used to supply pressure to the regulator. Two 0-300 psi 2" diameter pressure gauges shall be provided to monitor both supply and outlet pressure.
4. Panel shall also include a front loaded CGA DISS gas specific outlet. The medical gas outlets shall be designed so that, once installed, routine service of both the primary and secondary check valves can be accomplished **without** removing the nameplate or gas specific portions. The primary check valve shall be unitized and of the cartridge type. So that the primary check valve can be removed for service **without** shutting off the gas supply to the outlet, the secondary check valve shall operate automatically to stop the free flow of the pressure gas
5. The gas control panel shall be factory piped and 100% tested. All components shall be panel mounted on a stainless steel, silk-screened front panel.

#### G. EMERGENCY O2 SUPPLY CONNECTION

1. The Emergency Medical Oxygen Inlet Box shall be Tri-Tech Medical Inc. EOI-100 series and must be installed and tested in strict accordance with NFPA 99 standards and or other local codes before use.
2. The EOI-100 Tri-Tech Medical Emergency Inlet Box shall consist of a 1" (25mm) ball valve, pressure gauge and a 1" NPTF (plugged) connection housed in a tamper resistant, weathertight, maintenance free, fiberglass enclosure. The enclosure shall be labeled "Emergency Low Pressure Gaseous Oxygen Inlet," and shall include a padlock staple to

prevent tampering or unauthorized access. The emergency oxygen supply line and components shall be provided per NFPA 99.

3. A fast acting 1" check valve shall be included in the EOI-100 Tri-Tech Medical Emergency Inlet Box as recommended by NFPA 99. The check valve shall have a cast bronze body and straight – through design for minimum pressure drop.
4. A 75 psig relief valve shall be included in the EOI-100 Tri-Tech Medical Emergency Inlet Box as recommended by NFPA 99. The relief valve shall have a brass body, single seat design, and shall be cleaned for oxygen. The relief valve shall automatically open to 'relieve' or vent pressures greater than 75 psig to atmosphere and shall automatically reseal to provide a bubble tight seal after the pressure drops below 75 psig.

## H. MASTER ALARMS

1. The Master Alarm Panel shall be the Tri-Tech Medical DU series Master Alarm Panel. The panel shall be microprocessor controlled and designed to comply with NFPA 99. The panel shall be 100% digital and shall not require re-calibration. The panel shall be able to interface with building management systems with the use of an MCP circuit board. The master alarm panel shall be compatible with the T-Net™ PC based medical gas information management system. The alarm panel shall be enclosed in a steel box and shall be designed to accept an electrical input range of 120-240 volts AC – 50-60 hertz. The source voltage shall be stepped down with a self-contained transformer. The panel shall contain audible and visual alarm indicators. The audible alarm may be silenced by pressing the alarm silence button, but the visual alarm indicator can only be cancelled by fault correction. The alarm shall detect and filter out transient signals (less than 0.6 seconds). The alarm shall be capable of displaying alarm history for all possible alarm conditions.
2. Each source signal module shall monitor 16 signals. The alarm shall be capable of monitoring and displaying up to 64 medical gas source signals in increments of 16 source signals. The alarm is modular and may be initially installed as a smaller unit (i.e. 16 signals) and later expanded (i.e. to 32, 48, or 64 signals).
3. In addition, each 16 signal Master Alarm Module shall incorporate the following features:
  - Individual user programmable remote signal alarm points to accept NO or NC signals, or may be disabled. Factory preset to accept Normally Closed signals
  - LED indicators (Green) confirms normal status, (Red) indicates abnormal condition
  - Each signal easily labeled and positioned to suit any requirement using self adhesive labels provided with the alarm
  - A set of dry contacts with relay to trigger an optional remote alarm in the event of an alarm condition

## I. AREA ALARMS

1. The alarm shall be the Tri-Tech Medical DU series Area Alarm Panel. The panel shall be microprocessor controlled and designed to comply with NFPA 99. The panel shall be 100% digital and shall not require re-calibration. The area alarm panel shall be compatible with the T-Net™ PC based medical gas information management system. The alarm panel shall be enclosed in a steel box and shall be designed to accept an electrical input range of 120-240 volts AC – 50-60 hertz. The source voltage shall be stepped down with a self-contained transformer. The panel shall contain audible and visual alarm indicators. The audible alarm may be silenced by pressing the alarm silence button, but the visual alarm indicator can only be cancelled by fault correction. The alarm shall detect and filter

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out transient (less than 0.6 seconds) signals created by R.F.I. The alarm shall be capable of displaying alarm history for all possible alarm conditions.

2. Each vertical slot shall display up to three gases. The alarm shall be capable of monitoring and displaying up to 14 gases per alarm panel. Gas modules can be arranged in accordance with project requirements.
3. In addition, each Area Alarm Module shall incorporate the following features:
  - Each gas module can be easily labeled to indicate the area being monitored
  - Does not require re-calibration
  - Gas specific sensor with DISS nut & nipple. An error message will be displayed if incorrect sensor or no sensor is attached.
  - User programmable pressure limits (Programmed from factory at 60/40 psig and 12 in Hg)
  - Shall be capable of displaying gas readouts in PSI (in Hg), BAR or kPa.
  - Gas audible alarm repeat feature factory set at 10 minutes, adjustable from 1 minute to 240 minutes, or off
  - Digital Transducers may be mounted inside the alarm for easy access, or may be mounted remotely up to 5,000 ft (1,524 m) utilizing twisted pair wiring (the # of transducers which will fit in the back box is limited – some models will require remote locating of transducers)
  - Gas specific DISS risers with serviceable Frontall™ (front end loaded) cartridge demand check valve
  - Transducers shall easily mount in electrical junction box without modification

### J. COMBINATION ALARMS

1. The alarm shall be the Tri-Tech Medical DU series Area / Master Combination Alarm Panel. The panel shall be microprocessor controlled and designed to comply with NFPA 99. The panel shall be 100% digital and shall not require re-calibration. The panel shall be able to interface with building management systems with the use of an MCP circuit board. The combination alarm panel shall be compatible with the T-Net™ PC based medical gas information management system. The alarm panel shall be enclosed in a steel box and shall be designed to accept an electrical input range of 120-240 volts AC – 50-60 hertz. The source voltage shall be stepped down with a self-contained transformer. The panel shall contain audible and visual alarm indicators. The audible alarm may be silenced by pressing the alarm silence button, but the visual alarm indicator can only be cancelled by fault correction. The alarm shall detect and filter out transient (less than 0.6 seconds) signals created by R.F.I. The alarm shall be capable of displaying alarm history for all possible alarm conditions.
2. Each vertical slot shall display up to three gases or up to 16 remote master signals. The alarm shall be capable of monitoring and displaying up to 14 gases per alarm panel, or up to 64 medical gas source signals, or any combination in increments up to three gases or 16 source signals. Gas or source signal modules can be arranged in accordance with project requirements.

### K. MEDICAL GAS INFORMATION MANAGEMENT SYSTEM

1. Medical gas information management system shall be Tri-Tech Medical T-Net™ information management system. The T-Net™ system consists of: medical gas devices

(area alarms, master alarms, combination alarms, manifolds), a networked system, and a host computer (Windows® 98 or newer) with interface hardware and T-Net software. The network may be a wireless and/or Ethernet and/or RS 485 microprocessor based medical device polling network. Ethernet and wireless and RS 485 connections are capable of seamless simultaneous communication with the PC. It shall continuously scan all connected medical devices in the hospital and display the alarm & manifold topology and clone image of each device on a local PC and/or create a website allowing remote monitoring anywhere in the world.

2. The system will support the following Tri-Tech Medical devices: Area Alarms, Combination Alarms, Master Alarms and Manifolds. Any alarm conditions shall be displayed on the PC as they occur with both a visual and audio notification.
3. The T-Net™ wireless system consists of: one transceiver base station with antennae, a network interface card with antennae in each alarm, a network interface card with antennae in each manifold, one computer with Windows 98 or newer and the T-Net™ server software and the client software. Repeater stations and/or a high gain antennae may be required and added as necessary.
4. The T-Net™ Ethernet system consists of : a network interface card in each alarm, a network interface card in each manifold, one host computer with Windows 98 or newer and the T-Net™ server software and the client software.
5. The T-Net™ RS 485 system consists of : a network interface card in each alarm, a network interface card in each manifold, one host computer with Windows 98 or newer and the T-Net™ server software and the client software.
6. The host computer shall be accessible to the internet either directly or via the hospitals LAN network. Additional computer stations within the facility may also monitor the T-Net™ system by simply installing the client software (provided they are connected to the same LAN network as the host computer.
7. The system shall accommodate up to 560 devices. No wires shall be needed (wireless installation only) to interface the devices or the host PC. The user will have the ability to input information into the host PC in order to customize the display (location of device, color codes, etc.) The T-Net™ system builds and updates a history log file logging incidents as they occur and correct themselves.

#### L. PRESSURE/VACUUM SWITCHES

1. Pressure and vacuum switches for the medical gas source signal alarm system shall incorporate U.L. listed single pole double throw snap-action micro switches. Normally open or normally closed circuitry shall be field-selected to be compatible with the medical gas alarm system. Electrical rating shall be 10 amperes at 120 volt AC.
2. Low pressure gases such as oxygen, nitrous oxide, carbon dioxide and medical air are typically set to alarm at 40 psig (low line pressure) and 60 psig (high line pressure). High pressure nitrogen is typically set to alarm at 140 psig (low line pressure) and 180 psig (high line pressure). The vacuum switch is pre-set at the factory to alarm at 12 in/Hg. Switches are field adjustable (if necessary).
3. Pressure and vacuum switches for the medical gas source signal alarm system shall be assembled with 4" diameter pressure/vacuum gauges and gas specific DISS union demand check valves. Entire assemblies shall be cleaned for oxygen service.

#### M. ZONE VALVE BOX

1. Zone valve boxes shall be the Tri-Tech Medical Z series and must be installed and tested in strict accordance with NFPA 99 standards and or any other local codes before use.

2. The valves shall be bronze, ball-type, with Teflon (TFE) seats and seals. All valves shall be dual gauge ported and rated at a working pressure of 600 psi (29 in/Hg vacuum), and shall be operated by a lever-type handle, requiring only a quarter turn from a fully open position to a fully closed position. Valves shall incorporate an adjustable packing and a blow-out proof stem. Only full port valves having flow rates comparable to equivalent size of pipe shall be used. Valves shall be piped from left to right. valves shall be provided with type K copper tubing extensions to facilitate installation. Valves shall be 3 piece in-line repairable type. Each valve assembly shall be supplied cleaned for oxygen service in accordance with current CGA standards. The valve tube ends shall be capped and sealed in a protective container to prevent contamination prior to installation.
3. Gauges shall be 1 ½" diameter for monitoring pressure and vacuum, and shall state: "USE NO OIL". Dual scale gauges are not acceptable for U.S.A. installations. A fully color coded label package shall be supplied with each valve box assembly for application by the installer.
4. The valve box shall be 16 gauge sheet steel construction painted with two part epoxy to prevent rust. A single box shall house from one to three valves. Boxes may be coupled with other boxes with a part # ZV-801 zone valve box coupler kit. Box shall be supplied with a ¾" plaster flange.
5. Valve box assembly shall be supplied with a formed steel decorative frame painted black which encloses an easily removable flexible window. The window shall be a "smoked" translucent flexible plastic with a pull-out ring pre-mounted to the center of the window. The window shall not be replaceable while any valve is in a closed position. Window shall be silk screened with the following statement "CAUTION: MEDICAL GAS SHUTOFF VALVES. CLOSE ONLY IN EMERGENCY."

#### N. ZONE VALVE BOX WITH E Z BACKFEED™ PORT VALVES

1. Zone valve boxes shall be the Tri-Tech Medical E Z Backfeed™ series and must be installed and tested in strict accordance with NFPA 99 standards and or any other local codes before use.
2. Valve(s) shall include Tri-Tech Medical E Z Backfeed™ gas specific DISS backfeed port(s). Backfeed port shall allow backfeeding of gas without interruption of gas service, so that backfeeding a piped gas system through a station outlet will not be necessary. Backfeeding a piped gas system through a station outlet shall not be acceptable.
3. The valves shall be bronze, ball-type, with Teflon (TFE) seats and seals. All valves shall be dual gauge ported, rated at a working pressure of 600 psi (29 in/Hg vacuum), and shall be operated by a lever-type handle, requiring only a quarter turn from a fully open position to a fully closed position. Valves shall incorporate an adjustable packing and a blow-out proof stem. Only full port valves having flow rates comparable to equivalent size of pipe shall be used. Valves shall be piped from left to right. Valves shall be provided with type K copper tubing extensions to facilitate installation. Valves shall be 3 piece in-line repairable type. Each valve assembly shall be supplied cleaned for oxygen service in accordance with current CGA standards. The valve tube ends shall be capped and sealed in a protective container to prevent contamination prior to installation.
4. Gauges shall be 1 ½" diameter for monitoring pressure and vacuum, and shall state: "USE NO OIL". Dual scale gauges are not acceptable for U.S.A. installations. A fully color coded label package shall be supplied with each valve box assembly for application by the installer.
5. The valve box shall be 16 gauge sheet steel construction painted with two part epoxy to prevent rust. A single box shall house from one to three valves. Boxes may be coupled with other boxes with a part # ZV-801 zone valve box coupler kit. Box shall be supplied with a ¾" plaster flange.

6. Valve box assembly shall be supplied with a formed steel decorative frame painted black which encloses an easily removable flexible window. The window shall be a “smoked” translucent flexible plastic with a pull-out ring pre-mounted to the center of the window. The window shall not be replaceable while any valve is in a closed position. Window shall be silk screened with the following statement “CAUTION: MEDICAL GAS SHUTOFF VALVES. CLOSE ONLY IN EMERGENCY.”
7. If the digital transducers for Area Line Pressure Alarms are being mounted remotely, then the Tri-Tech Medical E Z series Zone Valve Box with E Z Backfeed™ port valves shall be additionally supplied with Tri-Tech Medical E Z Find™ DISS gas specific backfeeding port with DISS gas specific transducer connection. Remotely mounted digital transducers shall be mounted in the Tri-Tech Medical E Z series Zone Valve Box.

#### N. MAIN GAS VALVES

1. All valves shall be Tri-Tech Medical 51 series and must be installed and tested in strict accordance with NFPA 99 standards and or any local codes before use.
2. The valves shall be forged bronze body, ball-type, with Teflon (TFE) seats and seals. Valves shall be rated at working pressure of 600 psi (29 in/Hg vacuum) and shall be operated by a lever-type handle requiring only a quarter turn from fully open position to a fully closed position. Optional locking handles are available.
3. All valves shall be equipped with type K copper tubing extensions with two brass 1/8 NPT female gauge/purge ports (one on each side of the valve), to facilitate installation. Gauge/purge ports shall be shipped with a 1/8 NPT plug. Valves shall be 3 piece in-line repairable type. Valves shall incorporate an adjustable packing and blow-out proof stem. Only full port valves having flow rates comparable to equivalent size of pipe shall be used.
4. Adhesive backed caution labels shall be acquired separately and field installed. The labels shall state: CAUTION – (gas name) VALVE, DO NOT CLOSE EXCEPT IN EMERGENCY and/or any other required labeling per NFPA 99. Labels shall be color coded for the appropriate gas service and include a section for stating the area being serviced by the valve.
5. Each valve assembly shall be supplied cleaned for oxygen service in accordance with the current Compressed Gas Association (CGA) Pamphlet.

#### O. FULLY-AUTOMATIC DIGITAL MANIFOLDS

1. The NFPA 99 compliant digital, fully automatic manifold shall be a Tri-Tech Medical *Genesys*™ series.
2. No manual resetting of valves or levers shall be required. The unit shall switch from “Bank in Use” to “Reserve” bank without fluctuation in line delivery pressure. Simultaneously, the “Reserve in Use” alarm shall be triggered by the manifold microprocessor. The manifold shall continue to provide gas, in the event of a power failure, until both banks are depleted. After the switchover, the “Reserve” bank shall then become the “Bank in Use”. The manifold microprocessor shall also trigger the “High Line Pressure” and “Low Line Pressure” alarms without the need for additional pressure switches or transducers. When the manifold is used with low or medium pressure portable bulk vessels with a high pressure reserve, the manifold microprocessor shall also trigger the “Emergency Reserve in Use” and “Emergency Reserve Low” alarms when used with transducers supplied separately. The fully automatic manifold shall be compatible with the T-Net™ PC based medical gas information management system. The manifold shall be capable of being upgraded after installation, to be used with low or medium pressure portable bulk vessels or for use at higher or lower delivery pressures. Includes unit of measure switching (psi, kPa, BAR) and allows input power of 120 – 240 VAC, 50 to 60 Hz. Utilizes 400 psig differential rated solenoid.

## MEDICAL GAS AND VACUUM PIPING SYSTEMS

3. The control panel shall incorporate a text display for the Left Bank, Right Bank, Emergency Reserve, Delivery Pressures, and error messages. Analog gauges are also provided so that line and both bank pressures may be observed in the event of a power failure. The control panel shall also incorporate a set of LED's for each bank, green for "Bank in Use", amber for "Ready" and red for "Empty".
4. All manifold regulators, piping and control switching equipment shall be cleaned for use with oxygen service and installed in a steel cabinet (weatherproof version available) to provide protection and minimize tampering.
5. The header bars shall be equipped with emergency high pressure shutoff valves outside the cabinet to allow for emergency isolation of the header bars. The header bar shall incorporate integral check valves for each station, and shall be built for expansion by adding header extensions.
6. Line pressure sensor with DISS check valve union shall be included with the manifold, which may be mounted inside the cabinet or remotely located to eliminate the need for a high/low pressure switch for master alarm operation.

### P. FULLY AUTOMATIC ANALOG MANIFOLDS

1. The NFPA 99 compliant analog, fully automatic manifold shall be a Tri-Tech Medical *Genesys*<sup>™</sup> series.
2. No manual resetting of valves or levers shall be required. The unit shall switch from "Bank in Use" to "Reserve" bank without fluctuation in line delivery pressure. Simultaneously, the "Reserve in Use" alarm shall be triggered by the manifold's circuit board. The manifold shall continue to provide gas, in the event of a power failure, until both banks are depleted. After the switchover, the "Reserve" bank shall then become the "Bank in Use". The manifold shall be capable of being upgraded after installation, to be used with low or medium pressure portable bulk vessels or for use at higher or lower delivery pressures. Allows input power of 120 – 240 VAC, 50 to 60 Hz. Utilizes 400 psig differential rated solenoid.
3. The control panel shall also incorporate a set of LED's for each bank, green for "Bank in Use", amber for "Ready" and red for "Empty".
4. All manifold regulators, piping and control switching equipment shall be cleaned for use with oxygen service and installed in a steel cabinet to provide protection and minimize tampering.
5. The header bars shall be equipped with emergency high pressure shutoff valves outside the cabinet to allow for emergency isolation of the header bars. The header bar shall incorporate integral check valves for each station, and shall be built for expansion by adding header extensions.

END OF SPECIFICATION SECTION