

## PART 1 – GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and Division 00 and 01, apply to this Section.
- B. Related Sections include the following:
  - 1. Division 23.
  - 2. Division 22.

### 1.2 SUMMARY

- A. Section includes Medical Gas Systems consisting of Oxygen O2, Nitrous Oxide N2O, Nitrogen N2, Medical Air MA, Medical Vacuum MV and Waste Anesthesia Gas Disposal (WAGD) systems. These systems shall be installed complete, ready for operation and certified, including all necessary piping, fittings, valves, cabinets, station outlets and inlets, rough-ins, ceiling services, gauges, alarms [including low voltage wiring], nitrogen control panels, cylinder manifolds and all necessary parts, accessories, connections and equipment to satisfy NFPA 99 2005 edition.

### 1.3 CODES AND STANDARDS

- A. Codes and Standards shall be the current version adopted by the Authority Having Jurisdiction.

### 1.4 PERFORMANCE REQUIREMENTS

- A. System Operating Pressures:
  - 1. Oxygen: O2 deliver 50-55 PSIG at outlets.
  - 2. Medical Air: MA deliver 50-55 PSIG at outlets.
  - 3. Medical Vacuum: MV Produce 14-19 inches HG at inlets.
  - 4. Waste Anesthesia Gas Disposal: WAGD Produce 14-19 inches HG at inlets.
  - 5. Nitrous oxide: N2O Deliver 50-55 PSIG at outlets.
  - 6. Nitrogen: N2 deliver 160-170 PSIG at N2 control panels.
- B. Gas Source:
  - 1. Gas for purging and testing shall be NF nitrogen only.
  - 2. Gas for final purging of oxygen, nitrogen, and nitrous oxide shall be provided from the owner's supply source and shall be paid for by the Owner.

### 1.5 SUBMITTALS

- A. General: See Division 23 for general requirements of Product Data, Shop Drawings, Reports and Certificates, and Operation and Maintenance data submittals.
- B. Submit under the provisions of Division 01 and Division 23.
- C. Product Data:
  - 1. Pipe and fittings.

2. Valves and valve boxes.
  3. Piping accessories.
  4. Medical gas outlets and inlets.
  5. Nitrogen control panels.
  6. Area alarm panels.
  7. Master alarm system.
  8. Emergency oxygen connection box.
  9. Cylinder manifolds.
- D. **Materials Cleaned for Oxygen Service:** Documentation certifying that piping components for all pressure gas systems (except medical vacuum and WAGD) has been cleaned as if for oxygen service per CGA G-4.1. This includes tubes, valves, fittings, and station outlets.
- E. **Brazer Performance Qualification:** Test records for each brazer used on the installation.
- F. **System Certification Agency and Test Agenda:** Submit the name and qualifications of the medical gas certification agency. The certification agency shall be financially independent of the medical gas equipment manufacturer and the system installer. Submit the testing agency's detailed procedure which will be followed in the testing of this project. Include details of the testing sequences, procedures for cross connection test, valve test, flow test, alarm tests, purity tests, etc., as required by this specification. For purity test procedures, include data on test methods, types of equipment to be used, calibration sources and method references.
- G. **Precertification Report:** Submit the Precertification report as required by the Quality Assurance Article below.
- H. **Test Reports:** At the completion of the project submit pressure test reports with the signature of the witness.
- I. **System Certification:** Submit a document that certifies that the completed systems have been installed, purged, tested and documented in accordance with the requirements of this specification and NFPA 99.

## 1.6 PROJECT RECORD DOCUMENTS

- A. **General:** See Division 23 for general requirements of Project Record Documents.

## 1.7 OPERATION AND MAINTENANCE DATA

- A. **General:** See Division 23 for general requirements of Operation and Maintenance data submittals.
- B. **Maintenance Data:** Submit a copy of submittal product data, the manufacturer's installation and O&M information and the system certification report.

## 1.8 QUALITY ASSURANCE

- A. Perform work in accordance with NFPA 99, the UPC latest adopted edition and the Plumbing authority having jurisdiction.
- B. **Pre-certification Report:** Prior to any installation work the Medical Gas System Certification Agency shall review the plans and report any conditions which would prevent them from certifying the system. Any suggested modifications should be included in the report.

- C. Brazing Qualifications: Brazing shall be performed by individuals who are qualified per AWS B2.2 or ASME Section IX as modified by NFPA 99.
- D. Pre-Brazing Meeting:
  - 1. Requirements: Prior to the start of brazing conduct a job walk thru with the owner's representative and demonstrate the following:
    - a. All system materials are carefully stored and protected from contamination.
    - b. Valves and fittings are prewashed and bagged.
    - c. Procedures for cutting pipe and preparing ends.
    - d. Installed piping runs have ends capped.
    - e. The brazing purge connection and the plan for purging and brazing the piping system.
    - f. The plan for pressure testing the piping system.
    - g. The plan for testing the piping system with outlets attached.
    - h. The location of purge ports at main shutoff valves.
- E. Scope: Make connection to owner furnished device. Pressure test and certify owner-furnished device. For gas booms provide for separate certification of gas piping up to the point where the boom connects to the mounting plate DISS fittings. Provide for certification and testing of the boom once fully installed. If leaks are detected coordinate repair with manufacturer and owner. The actual repair of owner furnished equipment is not in the scope of this section.

## 1.9 COORDINATION

- A. Coordinate the work with the structural system, wall / ceiling framing and device installations, and wall / ceiling installations of other trades.

## PART 2 – PRODUCTS

### 2.1 PIPE AND FITTINGS

- A. Pipe (except MV and WAGD): Pipe shall be hard drawn seamless medical gas tubing, ASTM B819, which is factory prewashed and capped. Use Type L for oxygen, medical air, and nitrous oxide. Use Type K for nitrogen and any med gas pipe indicated to be underground. All piping shall be labeled "OXY, MED" with the ASTM number. The minimum size shall be 1/2-inch except for connection to outlets.
- B. Pipe-Medical Vacuum and WAGD: Pipe shall be hard drawn seamless copper tubing, ASTM B88 or ASTM B819, use Type L, use Type K for pipe indicated to be underground. The minimum size shall be 3/4-inch except for connections to inlets.
- C. Fittings (except MV and WAGD): Fittings shall be wrought copper, ASTM B16.22, especially prewashed and bagged for medical gas service. Fittings shall be long radius type.
- D. Fittings-MV and WAGD: Fittings shall be wrought copper, ASTM B16.22, long radius type. The T-Drill method with brazed joint is allowed.
- E. Joints: Joints shall be brazed using Sil-Fos or other self-fluxing silver brazing alloy with an 1190 degrees F minimum melting point per ANSI/AWS A5.8 and NFPA 99. All brazing shall be done utilizing a nitrogen purge. Where threaded joints are required for connection of equipment and or gauges, oxygen safe Teflon tape or oxygen safe thread dope (Flromatic

formula 8 or Expando) shall be used. The Teflon tape shall be as manufactured by the Mill Rose Company. It shall be a special oil free PTFE oxygen thread seal tape.

- F. Pipe and Fittings for Medical Vacuum Pump (and WAGD Pump) Discharge:
  - 1. Pipe 3-inch and Smaller: Provide Type L copper tubing and fittings with brazed joints per Section 23 05 00.
  - 2. Pipe 4-inch and Larger: Provide Type L copper tubing, copper fittings with mechanical grooved joints or brazed joints.
- G. Pipe and Fittings for Medical Air Compressor Intake Piping: Provide same as Medical Air Piping.
- H. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.

## 2.2 VALVES

- A. Manufacturers:
  - 1. Allied Healthcare.
  - 2. BeaconMedaes.
  - 3. Squire Cogswell.
  - 4. Tri-Tech.
  - 5. Amico.
  - 6. Nibco.
  - 7. Stockham.
  - 8. Grinnell.
  - 9. Milwaukee.
  - 10. Apollo.
  - 11. Or Approved Equal.
- B. Ball Valves (4-inch and Smaller) (Except MV and WAGD): Brass or bronze body 3-piece bolted construction, full port, 600 PSIG W. O. G., TFE seats and seals, chrome plated brass ball with brass blow-out proof stem. Handles shall be equipped with mechanism to lock valve open utilizing an owner-furnished padlock. Valves shall be cleaned for oxygen service. Valves shall have Type K copper tubing extensions brazed to valve sweat connection ends. At contractor option, tubing extensions may be provided by the contractor provided that an approved procedure is submitted. The downstream tubing extensions shall have a 1/4-inch FPT gauge port with plug. Where provided at main line service shutoff valves (other than zone valve boxes) provide the valve with an additional upstream 1/4-inch gauge port to facilitate purging.
- C. Ball Valves for MV and WAGD: Same as above except cleaning for oxygen service is not required. The tube extension gauge port requirements shall be the same.
- D. Zone Valve Boxes:
  - 1. Manufacturers:
    - a. Allied Healthcare.
    - b. BeaconMedaes.
    - c. Squire Cogswell.
    - d. Tri-Tech.
    - e. Amico.
    - f. Or Approved Equal.

2. Requirements:

- a. Provide 18-gauge steel box with white epoxy finish and brackets to mount box to studs.
- b. Size of box shall be specifically designed to house the number and size of valves (per valve spec above) indicated.
- c. The valve box shall have an opaque cover with pull ring for easy removal.
- d. The cover shall have view ports to observe the pressure gauges and valve labels.
- e. The cover shall have a warning label not to close valves except in an emergency.
- f. Valves shall be oriented so cover cannot be installed with any valve closed.
- g. The valves inside and the cover shall be labeled per NFPA 99.
- h. Pressure gauges shall be 1-1/2-inch diameter, cleaned for oxygen service, with 0-100 PSIG range for O<sub>2</sub>, N<sub>2</sub>O, MA, 0-300 PSIG range for N<sub>2</sub>, 0-30-inch HG range for MV and WAGD.

E. Check Valves:

1. Manufacturers:

- a. Allied Healthcare.
- b. BeaconMedaes.
- c. Squire Cogswell.
- d. Tri-Tech.
- e. Amico.
- f. Or Approved Equal.

2. Requirements:

- a. 3-inch and under shall be 2-piece bronze body, non-slam type, stainless steel spring loaded ball check valve with sweat connection ends.
- b. The ball check shall be fast acting, quiet, vibration free and shall rest on a cone seat.
- c. The valve shall be cleaned for oxygen service.
- d. Provide Type K copper tubing extensions brazed to the valve body while valve is disassembled.

3. Basis of design: Allied Health Care.

F. Relief Valves:

1. Manufacturers:

- a. Allied Healthcare.
- b. BeaconMedaes.
- c. Squire Cogswell.
- d. Tri-Tech.
- e. Amico.
- f. Or Approved Equal.

2. Requirements:

- a. Safety Valves: Bronze-body, ASME-construction, poppet, pressure-relief type with settings to match system requirements.

## 2.3 PIPING ACCESSORIES

- A. Flexible Connectors: Manufactured specifically for operating pressures and temperatures. Provide corrugated bellows type, stainless steel, with solid pipe extensions at each end. End connections shall be sweat fit for pipelines in the building and threaded at equipment. Provide with stainless steel or bronze wire double braided outer reinforcing over bellows. Use manufacturers recommended length for the intended service. For Positive pressure, medical gas systems and medical air compressor intake piping flexible connectors shall be cleaned for oxygen service.
- B. Gauges:
1. Manufacturers:
    - a. Allied Healthcare.
    - b. BeaconMedaes.
    - c. Squire Cogswell.
    - d. Tri-Tech.
    - e. Amico.
    - f. Or Approved Equal.
  2. Requirements:
    - a. 4-1/2-inch diameter pressure and vacuum gauges, stainless steel case with plastic lens, 1/4-inch NPT male connection made of brass, soft soldered phosphor bronze tube internals.
    - b. White background with black graduation markings.
    - c. Accuracy shall be within 1/2% of scale range.
    - d. Provide 0-100 psig range for positive pressure gasses, 0-200 psig range for Nitrogen and 0-30-inch HG range for vacuum applications. Gauges for positive pressure shall be cleaned for oxygen service.
  3. Basis of design: Allied Healthcare.

## 2.4 MEDICAL GAS OUTLETS AND INLETS

- A. Manufacturers:
1. Allied Healthcare.
  2. BeaconMedaes.
  3. Squire Cogswell.
  4. Tri-Tech.
  5. Amico.
  6. Or Approved Equal.
- B. Type and Style: DISS modular wall and or ceiling outlets or Quick Disconnect wall outlets complying with NFPA 99.
- C. Basis of Design: (DISS) Allied Healthcare Chemetron, (Quick Disconnect) Allied Healthcare Chemetron. This is the medical facility standard [no substitutions] [Substitutions by Amico with outlets of the Allied Healthcare Chemetron design are permitted.]
- D. Application: Provide DISS outlets for ceiling installations to receive hose connections. For Wall outlets provide [Quick Disconnect style outlets] [DISS style outlets].

- E. Vacuum Bottle Brackets: One piece, with pattern and finish matching corresponding service cover plate.

## 2.5 NITROGEN CONTROL PANELS

### A. Manufacturers:

1. Allied Healthcare.
2. BeaconMedaes.
3. Squire Cogswell.
4. Tri-Tech.
5. Amico.
6. Or Approved Equal.

### B. Requirements:

1. Recessed with surface mounted cover, isolation valve, regulator valve, DISS outlet on cover, inlet and outlet pressure gauges all NFPA 99 compliant and cleaned as if for oxygen service.
2. The cover shall be labeled for nitrogen with all panel face items identified.

### C. Basis of Design: Allied Healthcare.

## 2.6 AREA ALARM PANELS

### A. Manufacturers:

1. Allied Healthcare.
2. BeaconMedaes.
3. Squire Cogswell.
4. Tri-Tech.
5. Amico.
6. Or Approved Equal.

### B. Requirements:

1. Recessed with surface mounted cover, NFPA 99 compliant, UL listed, 120 volt (1 amp) single phase primary power, low voltage control wiring, integral transformer, pressure transducer for each gas mounted in panel with gas specific quick disconnect connection to gas piping.
2. The quick disconnect fitting and pipe connection to the pressure transducer shall be designed for easy removal of the transducer for annual functionality tests. [The contractor may request approval to remote mount transducers to an accessible location and provide low voltage wiring in conduit.]
3. The gas pressure for each gas shall have a LED display in PSIG (or inch HG for vacuum).
4. Alarm limits shall be set at NFPA limits.
5. Provide Type K tubing extensions from panel.
6. All pipe and transducers shall be cleaned for oxygen service.
7. Provide alarm horn, light, horn silence button, and push to test button.
8. In a power failure situation, the panel shall not alarm nor shall a manual reset be required upon restoration of normal power.
9. The panel shall be modular and shall accommodate from 1 to 6 gas systems.
10. The actual panel size shall be for only the number of gasses indicated.

C. Basis of Design: Amico.

## 2.7 MASTER ALARM SYSTEM

A. Master Alarm Pressure Switches: Provide Allied Health Care Series for sensing both vacuum and low and high pressure alarms. Provide with contacts for two alarm circuits. Alarm contacts shall be closed when the switch is in the pressurized normal pressure range. The same alarm contacts shall be opened when the pressure goes above or below the normal pressure range. Provide quick disconnect fitting for installing the switch. Compliant with NFPA 99 and UL listed. Alarms switches shall be set to alarm at levels required by NFPA 99.

1. Other Approved Manufacturers:

- a. BeaconMedaes.
- b. Squire Cogswell.
- c. Tri-Tech.
- d. Amico.
- e. Or Approved Equal.

B. Master Alarms: The following alarms shall be provided at the two existing Master alarm panels at the Maintenance Shop and the Level 1 PBX Room. The locations refer to pressure switch and or alarm actuation contact location. [Edit panel locations]

- |                                     |                               |
|-------------------------------------|-------------------------------|
| 1. Oxygen pressure high             | at master press. switch       |
| 2. Oxygen pressure low              | at master press. switch       |
| 3. Reserve tank low level           | at Reserve tank level gauge   |
| 4. Reserve pressure low             | at PRV cabinet at O2 park     |
| 5. Reserve in use                   | at PRV cabinet at O2 park     |
| 6. Main tank reorder                | at main tank level gauge      |
| 7. Main tank low level              | at main tank level gauge      |
| 8. Nitrous oxide pressure high      | at master press. switch       |
| 9. Nitrous oxide pressure low       | at master press. switch       |
| 10. Nitrous Oxide reserve in use    | at cylinder manifold          |
| 11. N2O reserve pressure low        | at cylinder manifold          |
| 12. Nitrogen oxide pressure high    | at master press. switch       |
| 13. Nitrogen oxide pressure low     | at master press. switch       |
| 14. Nitrogen Oxide reserve in use   | at cylinder manifold          |
| 15. N2 reserve pressure low         | at cylinder manifold          |
| 16. Medical Vacuum low vacuum       | at master vacuum switch       |
| 17. MV lag compressor on            | at MV starter / control panel |
| 18. MV discharge high temperature   | at MV starter / control panel |
| 19. Medical air pressure high       | at master pressure switch     |
| 20. Medical air pressure low        | at master pressure switch     |
| 21. Medical air lag compressor on   | at MA starter / control panel |
| 22. MA Dew point high               | at Dew point sensor           |
| 23. MA CO level high                | at CO sensor                  |
| 24. MA compressor high temperature  | at MA starter / control panel |
| 25. WAGD low vacuum                 | at master vacuum switch       |
| 26. WAGD lag compressor on          | at MV starter / control panel |
| 27. WAGD discharge high temperature | at MV starter / control panel |

C. Master Alarm Panels (Digital Non-Gauge):

1. Manufacturers:

- a. Allied Healthcare.
- b. BeaconMedaes.
- c. Squire Cogswell.
- d. Tri-Tech.
- e. Amico.
- f. Or Approved Equal.

2. Requirements:

- a. Recessed with surface mounted cover, NFPA 99 compliant, UL listed, 120-volt single phase primary power, 5 VDC low voltage control wiring, integral rectifier.
- b. Alarm panel shall display alarm light and sound audible alarm when the specific alarm circuit is opened by either, alarm switch / contact device or a break in the alarm wiring circuit.
- c. Each alarm circuit shall display an LED red light for alarm condition and shall display a green LED light for normal condition.
- d. Adjacent to each pair of status lights there shall be a label for each alarm.
- e. Provide alarm horn, horn silence button, and push to test button.
- f. The panel shall not include a pressure display for specific gas pressures.
- g. Each alarm circuit shall have spare contacts for remote monitoring of alarm thru the building automation DDC system.
- h. These contacts shall be electrically isolated from the 5 VDC master alarm system.
- i. In a power failure situation, the panel shall not alarm nor shall a manual reset be required upon restoration of normal power.
- j. The panel shall be modular and shall accommodate 36 alarm signals.

3. Basis of Design: Allied Healthcare.

D. Wiring: See Part 3 of this section. Coordinate accordingly.

## 2.8 EMERGENCY OXYGEN CONNECTION BOX

A. Manufacturers:

1. Allied Healthcare.
2. BeaconMedaes.
3. Squire Cogswell.
4. Tri-Tech.
5. Amico.
6. Or Approved Equal.

B. Requirements:

1. Surface mounted box with padlock provision. NFPA 99 compliant, 1-1/4-inch valve, pressure gauge, relief valve mounted inside the box.

C. Basis of Design: Allied Healthcare.

## 2.9 CYLINDER MANIFOLDS

A. Manufacturers:

1. Allied Healthcare.

- a. BeaconMedaes.
- b. Squire Cogswell.
- c. Tri-Tech.
- d. Amico.
- e. Or Approved Equal.

B. Requirements:

1. General: Automatic change over cylinder manifold system for use with high pressure gas cylinders. The manifold shall be NFPA compliant, UL listed and 120 volt (1 amp) single phase power requirement.
2. Operation: Automatic, pressure-switch-activated changeover from one cylinder bank to the other when first bank becomes exhausted, without line-pressure fluctuation or resetting of regulators and without supply interruption by shutoff of either cylinder bank header. In a power failure situation, the manifold shall not alarm nor shall a manual reset be required upon restoration of normal power.
3. Product Requirements: [Wall mounted] [Floor mounted] manifold consisting of sheet metal housing with indicator lights, alarm lights, alarm horn with silence button, one delivery (low pressure side) and two supply (high pressure side) pressure gauges mounted in panel face, manifold bar shutoff valves to left and right side of the cabinet. The delivery connection to the building system shall be on top and shall not be less than  $\frac{3}{4}$ " in size. A relief valve connection shall also be on top of the cabinet. The inside of the cabinet shall include primary and secondary pressure regulators for right and left sides, pressure switches, check valves, relief valves, selector valves, all pre-piped, cleaned for oxygen service and tested in accordance with NFPA 99. Provide high pressure manifolds with 24-inch-long flexible stainless steel cylinder pigtail connections. Each pigtail shall include an integral check valve. Design pressure shall be 3000 psig on the high-pressure manifolds and valving.
4. Master Alarm Functions: The manifold shall have alarm lights and a horn which shall illuminate and annunciate when either of the following conditions occur. At the point when the primary bank is exhausted and the reserve is in use. At the point where the reserve high pressure manifold no longer has sufficient pressure to provide one days reserve capacity. Provide contacts for these two alarms for connection to the master alarm system. These contacts shall be electrically isolated for the 5 VDC master alarm system. The contacts shall be normally closed when the system is in the normal condition. An alarm horn silence button shall be provided on the front of the panel.

C. Basis of Design:

1. Nitrous Oxide: Provide BeaconMedaes with 8 primary cylinders and 8 reserve cylinders. The flow rate shall not be less than 37 SCFM at 50 psig delivery pressure and 150 psig intermediate manifold pressure. Setpoint delivery pressure shall be 55 psig.
2. Nitrogen: Provide BeaconMedaes with 8 primary cylinders and 8 reserve cylinders. The flow rate shall not be less than 107 SCFM at 165 psig delivery pressure and 300 psig intermediate manifold pressure. Setpoint delivery pressure shall be 180 psig.

## PART 3 – EXECUTION

### 3.1 PREPARATION

- A. Cleaning: Handle all piping to prevent entry of dirt and contaminants. Factory-cleaned and sealed piping, cleaned as specified herein, shall have ends kept sealed until immediately ready for use. Provide temporary caps for all pipes and stations during construction. Comply with NFPA 99 regarding special washing, cleaning and flushing required before erection.

### 3.2 INSTALLATION

- A. Cutting and Fitting: Cut tubing with a tubing cutter (sawing is not permitted), debur end of tubing and remove any chips. Blow out tube with nitrogen prior to assembly into the system.
- B. Joint Preparation: Clean surfaces to be brazed with a clean stainless steel brush or 3M Scotchbrite pad (sanding cloth is not allowed). Do not use steel wool as it may contain oil. After mechanical cleaning the surfaces shall be wiped using a clean, lint-free white cloth. Joints shall be brazed within one hour of being cleaned.
- C. Brazing: All joints shall be brazed by qualified brazers. A nitrogen purge shall be used during brazing and until the joints are all cool to the touch. After brazing wash the outside of each joint with a wet rag and a wire brush. The use of flux is prohibited except when brazing copper to brass. In such cases the pipe interior shall be re-cleaned after brazing.
- D. Pipe Bending: Field bends in piping are not permitted.
- E. Pipe Isolation: Isolate copper tubing from contact with dissimilar metal contact using 10 mil PVC tape or plastic grommets. Medical gas piping shall not be used as a part of an electrical grounding system.
- F. Hangers: Individual hangers 4-inch and less shall be copper band hangers with steel adjustable swivel nut per MSS SP-69. Larger pipes may be steel clevis type with tape or felt liner to isolate med gas pipe from dissimilar metal. Support hangers on steel all-thread rod. Trapeze hangers of Unistrut with individual clamps for each pipe are acceptable provided PVC tape is used to isolate the med gas pipe from dissimilar metal. Hanger strap is not allowed.
- G. Install hangers copper tubing with the following maximum spacing:

Nom. Pipe Size (Inches)	Copper Tube Max. Span (Feet)
1/2"	6
3/4"	7
1"	8
1-1/4"	9
1-1/2" and Up	10

- H. Riser Supports: Tubing risers shall be supported at each floor but in no case shall the support distance exceed 15 feet. In such cases or where pipe size is less than 2-inches provide additional intermediate floor support from other vertical surfaces or from supplementary steel support rack. Riser clamps shall be MSS Type 8 or 42 clamps. Pipe drops in general shall be anchored to walls, floors or other structure.
- I. Pipe Slope: In general, horizontal piping for Medical Vacuum and WAGD systems shall slope toward the vacuum source. Provide drains at low points of the piping system. Drains shall consist of two ball valves in series, with 6-inch vertical dirt leg in between valves, to enable drainage while isolating the dirt leg from vacuum system. Provide pipe plug on outlet of downstream ball valve.
- J. Piping Identification: See Division 23 for requirements. Apply pipe labeling during installation process and not after installation is completed.

- K. After installation of the piping and before installation of outlets, all pipe lines shall be blown clean with nitrogen.
- L. Purge Ports: At all mainline shutoff valves which serve more than 1 room, and which are not located in a zone valve box, install purge ports on both sides of the valve to facilitate purging during initial installation or future system changes. The purge ports shall consist of either of the following:
1. Provide a 1/2-inch tee with a female adapter and a brass plug.
  2. Provide valves as specified with 1/4-inch gauge ports and plugs.
- M. Outlet Support: Provide backing as required to firmly attach outlets to wall and/or ceiling framing. Ceiling backing shall be sturdy enough to support a 10-pound load on the outlet without noticeable deflection of the ceiling or the outlet.
- N. Protection: Exposed piping in areas subject to physical damage by carts, stretchers, portable equipment, or vehicles shall be protected with steel barriers.
- O. Shutdowns: Prior to submitting a shutdown request determine the areas effected by the valves(s) being shutdown. Submit the shutdown request for approval.
- P. Connections to Existing Systems: Final tie-in connections to existing systems shall be leak tested with source gas at normal operating pressures. Maintain pressure while each new joint is examined for leakage with soapy water. Do not connect to existing system until the following are done.
1. Installer's tests are complete (see below).
  2. Part of the certification agency's tests are complete up to and including piping purity test (see below).
- Q. Seismic Restraints: For piping system comply with Division 23.
- R. Cylinder Manifolds: Securely fasten manifold to wall and install cylinder manifolds per manufacturer's installation instructions. Test cylinder manifold connection piping at 2000 psig and perform soapy water test at each joint. Arrange for first set of cylinders to be delivered to manifold room by owner. Connect initial set of primary and reserve cylinders. Verify auto changeover controls function. Assist electrician in connecting alarm wiring to correct terminals.
- S. Underground Piping: Underground piping shall be installed inside schedule 40 PVC pipe of a size that allows approximately 0.75-1 inch of annular space all around between the two pipes. Provide plastic grommets to space the interior pipe in the middle of the carrier pipe. Cut PVC pipe longitudinally as required to install and test the medical gas piping prior to covering. Tape the PVC pipe up water tight and pour concrete around pipe. Concrete shall extend a minimum of 6-inches above, below and to both sides of the piping. The minimum depth of bury to top of concrete shall be 18 inches. Provide buried utility warning tape (6-inches wide polyethylene with continuous lettering stating "WARNING – BURIED OXYGEN") along the length of the concrete located 6-inches above the concrete.
- T. Master Alarm Wiring: Master alarm wiring shall be under Divisions 26 or 27. All wiring shall be in accordance with the alarm panel manufacturer's instructions and shall be in accordance with Division 26 and 27 specifications. Coordinate accordingly. All wiring shall be in conduit. Alarm wire shall be 22 gauge AWG for up to 2000-foot wire lengths. Coordinate with alarm panel installation instructions. Master alarm circuits shall be wired so they are normally energized (supervised) circuits in the non-alarm state. Wire the alarm switch contacts so the

contacts are closed in the normal "non-alarm" state. Any break in the circuit shall cause the master panel to go into alarm. Wiring shall be totally redundant such that a break in a wire to one alarm panel will only show up on that panel. Pull four wires per alarm signal (a pair for each master panel) and splice down to two wires in a j-box within a couple feet of the alarm contact switch. Junction boxes shall have wiring terminal strips (no wire nuts allowed). All wire shall be identified by color or by labels as to the specific alarm it serves. Provide a schedule of wires and alarms. All master alarm 120-volt power shall be life safety emergency power per NFPA. All master alarm power shall be life safety emergency power per NFPA. [This paragraph shall be used for Division 26/27 wiring.]

- U. Master Alarm Wiring: Master alarm wiring shall be under this section. All wiring shall be in accordance with the alarm panel manufacturer's instructions and shall be in accordance with Division 26 and 27 specifications. Coordinate accordingly. All wiring shall be in conduit. Alarm wire shall be 22 gauge AWG for up to 2000-foot wire lengths. Coordinate with alarm panel installation instructions. Master alarm circuits shall be wired so they are normally energized (supervised) circuits in the non-alarm state. Wire the alarm switch contacts so the contacts are closed in the normal "non-alarm" state. Any break in the circuit shall cause the master panel to go into alarm. Wiring shall be totally redundant such that a break in a wire to one alarm panel will only show up on that panel. Pull four wires per alarm signal (a pair for each master panel) and splice down to two wires in a j-box within a couple feet of the alarm contact switch. Junction boxes shall have wiring terminal strips (no wire nuts allowed). All wire shall be identified by color or by labels as to the specific alarm it serves. Provide a schedule of wires and alarms. All master alarm 120-volt power shall be life safety emergency power per NFPA. 120-volt power shall be provided to the master panels under Division 26. [This paragraph shall be used for Division 22 wiring.]
- V. Service Valves and In-line Valves: For each medical gas service or in-line valve, as defined by NFPA 99, provide a padlock that is common keyed per facility standards. The padlocks shall be Master-Lock. Lock each valve in the open position per NFPA 99.
- W. Valves for Future Connections: For each medical gas valve installed for a future connection, as defined by NFPA 99, provide a padlock that is common keyed per facility standards. The padlocks shall be Master-Lock. Lock each valve in the closed position per NFPA 99. Extend pipe past the tubing extension on the downstream side of the valve and braze a cap on. See paragraph above on purge ports.

### 3.3 LABELING AND IDENTIFICATION

- A. Piping: Label during installation per Division 23.
- B. Zone Valves: Obtain a CADD background of the area served by the valves. Lettering shall be minimum 1/4-inch high. Draw as built locations of outlets in room and show the zone valve location. Include room numbers (actual number on door) for each room with an outlet. Include "You are here" note at the zone valve. Symbols shall be colored to match to match CGA med gas colors (MV shall be black). Install area drawing in 8-1/2" x 11" frame with Plexiglas cover install frame next to the zone valve.
- C. Area Alarm Panels: Provide a drawing (similar to zone valves above) showing the zone valve and the rooms covered by that alarm. Include room numbers and "you are here" label. Install area drawing in 8-1/2" x 11" frame with Plexiglas cover. Install frame next to the area alarm panel. If the zone valve and area alarm panel are installed in the same location only one placard is required.
- D. Valves (Concealed): Provide a typed list of the room numbers served (actual room numbers on the door) and the valve number in a clear plastic valve tag holder. Chain the tag to the

valve with a metallic chain. Main line valves, service valves and riser valves shall have additional valve tag with verbiage per NFPA 99.

### 3.4 FIELD QUALITY CONTROL FOR HEALTHCARE FACILITY MEDICAL GAS

- A. Do not interconnect medical gas pipelines. Perform pressure testing with individual pipe system charging and measurement for each system.
- B. After installation of shutoff valves and outlets, but before installation of system components (switches, gauges, alarms, manifolds, etc.) each section of the new piping system shall be subjected to a test pressure of 1.5 times the working pressure, but not less than 150 psig, by means of oil free, dry nitrogen. This test pressure shall be maintained until each joint has been examined for leakage by means of soapy water. All leaks shall be repaired and the section retested.
- C. After completion of the above test procedure the finishing assemblies of station outlets, alarms, and all components (e.g. pressure switches, gauges, relief valves, etc.), except those for Vacuum, shall be installed and all medical gas piping systems shall be subjected to a 24-hour standing pressure test at 20% above the normal operating line pressure. Use oil free, dry nitrogen for test gas. The source shutoff valve shall be closed during this test. Pressure gas systems are to remain leak free. Vacuum is to be subjected to a test pressure of 60 psig. Vacuum test pressure at the end of 24 hours is to be within 5 psig of initial test pressure. Any leaks shall be located, repaired, and systems retested.
- D. Attach vacuum alarm switches and vacuum gauges to the medical vacuum system. Perform vacuum tests on each zone. Subject piping to a vacuum in excess of 12-inches Hg. Close valves to areas tested. The loss of vacuum is to be less than 1-1/2-inches Hg in a one hour period.
- E. Blowdown each pressure gas system in order to remove particulate matter in pipelines. A high flow, intermittent purge shall be put on each outlet using appropriate adapters. Continue until purge produces no discoloration in a white cloth.
- F. To determine that no cross connections to other pipeline systems exist, reduce all systems to atmospheric pressure. Disconnect all sources of test gas from all of the system with the exception of the one system to be checked. Pressure this system with oil-free dry nitrogen to a pressure of 50 psig. With appropriate adapters matching outlet labels, check each individual station outlet of all systems installed to determine that test gas is being dispensed from only the outlets of this system.
- G. Disconnect the source of test gas and reduce the system tested to atmospheric pressure. Proceed to test each additional pipeline system in accordance with the procedure outlined above. Vacuum systems can be tested with vacuum instead of pressure.
- H. Pressure tests should be witnessed by a representative of the hospital. The installing contractor shall supply written documentation that the pressure tests have been completed and the systems meet these specifications.
- I. After 24 hour standing leakage testing is completed, allow piping to remain pressurized with test gas until certification agency performs final tests.
- J. Vacuum Vent Pipe Test: Cap pipes at the vacuum pumps and fill with water to the roof terminus. There shall not be any perceptible drop in water level or any noticeable leaks over a 2-hour period.

- K. Medical Air Compressor Suction Piping Test: Test with nitrogen at 25 psig for 24 hours with no perceptible drop in pressure.

### 3.5 CERTIFICATION AGENCY TESTS

- A. System verification is to be performed by the approved medical gas certification agency. Verify that systems, as installed, meet or exceed the requirements of NFPA 99, 2005 and this specification and that systems operate as required.
- B. Hoses are to be installed in rail systems and hose drops for certifier's outlet tests.
- C. Medical gas concentration analysis is to be performed with instruments designed to measure the specific gas dispensed.
- D. Perform and document all tests required in NFPA 99, 2005; 5.1.12.3.
  - 1. Cross connection.
  - 2. Valve test.
  - 3. Outlet flow and pressure drop.
  - 4. Master alarms.
  - 5. Area alarms.
  - 6. Piping purge with a .45-micron filter.
  - 7. Piping purity.
  - 8. Final tie-in and blowdown of existing piping.
  - 9. Operational pressure test with source gas.
  - 10. Medical gas concentration.
  - 11. Medical air purity.
  - 12. Labeling of outlets, valves, and alarms.
  - 13. Source equipment operation.
- E. Problem Resolution: Any discrepancies discovered during the inspection shall be noted and corrected. All portions of the system affected by corrective action shall be retested and findings recorded after retest.
- F. Final Certification Report: Record results of certification tests and submit report with O&M manual.

### 3.6 MASTER ALARM TESTING/COMMISSIONING

- A. Requirements:
  - 1. Provide assistance during testing of each master alarm signal.
  - 2. Review test agenda proposed by the Owners Engineer/Commissioning Agent.
  - 3. During tests perform adjustments to system as required to test each alarm signal.
  - 4. Engineer/Commissioning Agent shall record all test results.
  - 5. Restore systems to normal operating condition after tests are completed.

### 3.7 DEMONSTRATION

- A. Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain [medical gas alarm system]. Refer to Division 01.

END OF SECTION