

# Medical Gas

# Installation Handbook

## A-Z

A guide to installing Medical Gas equipment  
from alarm panels to zone valves.



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## Before installing any Medical Gas equipment:

- **This handbook is not intended to cover all of the requirements of NFPA 99 and should not be used as a substitute for NFPA 99.**
- **All Medical Gas piping should be installed in accordance to the latest edition of the NFPA 99 code.**
- **All electrical procedures:**
  - **Must be in compliance with all national, state and local codes and requirements**
  - **Be performed by a certified electrician**

For further technical assistance or service, please contact your local Patton's Medical sales representative or:

### Patton's Medical

Customer Service: 1-866-960-0087

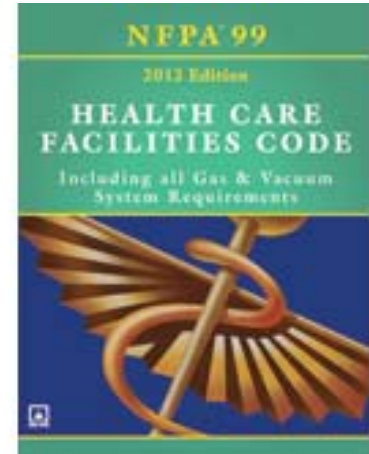
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## 1.0 Alarms

### 1.1 Area Alarm Panels

- Monitors local pressure of systems serving Anesthetizing, Vital Life Support and Critical Care Areas
- Not connected to the Master Alarm System
- Located at nurses station or similar location of the area being served
- Labeled for area / room served
- Sensors for Vital Life Support and critical areas are to be installed on the patient side of the valve box serving the area
- Sensors for Anesthetizing area are to be installed on the Source side of any of the individual room valve boxes

**Note:** If an Area alarm is provided for each individual Anesthetizing area, the sensor may be installed on the patient side of the valve box

- Sensors are to have Gas Specific connection to the piping system
- Sensors are to be located to permit access for testing
- Alarm wiring is to be a minimum of 22 AWG
- Power is to be from the Life Safety Branch of the Emergency Electrical System

## 1.0 Alarms

### 1.2 Local Alarm Panels

- Normally located on the source equipment
- Installed to monitor the function of the:
  - Medical Air System
  - Medical/Surgical Vacuum System
  - WAGD System
  - Instrument Air System
- Some Signals connected to the Master Alarm panels
- Normally provided as integral part of the systems

## 1.0 Alarms

### 1.3 Master Alarm System

- Monitors operation and condition of the source and main line pressure
- Not connected to area alarms
- Two panels required in separate locations (Engineering/Maintenance & 24 hour staffed location)
- Each Master Alarm shall be connected directly to the switch/contact that they monitor (No relaying from one panel to another)
- High/Low pressure switches shall be installed immediately downstream of the source valve
- Main Line gauges required adjacent to pressure switches
- Switches / Gauges shall have a gas specific connection to the piping system

**Note:** If a “Main Line” valve is required, pressure switches and gauges shall be installed downstream of the Main Line valve

- Alarm wiring shall be a minimum of 22 AWG
- Power shall be from the Life Safety Branch of the Emergency Electrical System
- Computer can be utilized as the second Master Alarm but must meet the criteria outlined by NFPA

## LEVEL 1 - LOCAL Source Alarm Requirements

ALARM	Oil-less Compressors	Instrument Air	Liquid Ring (water-sealed)	Medical/Surgical Vacuum Pump	WAGD Pumps
<b>Back-up LAG Pump in Use</b>	<input checked="" type="checkbox"/> 5.1.3.5.14.5 5.1.9.5.4(1)	<input checked="" type="checkbox"/> 5.1.3.5.14.5 5.1.9.5.4(1)	<input checked="" type="checkbox"/> 5.1.3.5.14.5 5.1.9.5.4(1)	<input checked="" type="checkbox"/> 5.1.3.8.10.1(1) 5.1.9.5.4(4)	<input checked="" type="checkbox"/> 5.1.3.7.4.1 5.1.3.7.4.4 5.1.9.5.4(4)
<b>Carbon Monoxide High</b>	<input checked="" type="checkbox"/> 5.1.3.5.15(2) 5.1.9.5(2)	<input checked="" type="checkbox"/> 5.1.3.5.15(2) 5.1.9.5(2)	<input checked="" type="checkbox"/> 5.1.3.5.15(2) 5.1.9.5(2)		
<b>High Discharge Air Temp (HAT)</b>	<input checked="" type="checkbox"/> 5.1.3.5.14.3 5.1.9.5.4(9)	<input checked="" type="checkbox"/> 5.1.3.5.14.3 5.1.9.5.4(9)			
<b>High Water in Receiver</b>	<input checked="" type="checkbox"/> 5.1.3.5.14.1 5.1.9.5.4(7)	<input checked="" type="checkbox"/> 5.1.3.5.14.1 5.1.9.5.4(7)	<input checked="" type="checkbox"/> 5.1.3.5.14.1 5.1.9.5.4(7)		
<b>Medical Air Dewpoint HIGH</b>	<input checked="" type="checkbox"/> 5.1.32.5.15(1) 5.1.9.5(2)	<input checked="" type="checkbox"/> 5.1.3.8.10.1(2)	<input checked="" type="checkbox"/> 5.1.32.5.15(1) 5.1.9.5(2)		
<b>Instrument Air Dewpoint High</b>		<input checked="" type="checkbox"/> 5.1.3.8.10.1(12) 5.1.9.5.4(6)			

# Medical Gas Installation Handbook

Master Alarm Signal	NFPA Requirement	Input Device	Input Device Location	Note
<b>Manifold Systems O<sub>2</sub>, N<sub>2</sub>O, Air, CO<sub>2</sub>, N<sub>2</sub>, etc.</b>				
Changeover to Secondary Bank	Yes	Switch	On the Manifold	
Reserve Supply in Use	Yes*	Switch	On the Manifold	
Reserve Low	Yes*	Switch	On the Manifold	
<b>All Pressure Gases O<sub>2</sub>, N<sub>2</sub>O, Air, CO<sub>2</sub>, N<sub>2</sub>, etc.</b>				
Pressure High	Yes	Switch	In Mainline After the Main Shut-off Valve	Hi/Low for O <sub>2</sub> , N <sub>2</sub> O, Air, CO <sub>2</sub> , N <sub>2</sub> ,
Pressure Low	Yes	Switch	In the Mainline After the Main shutoff Valve	Hi of N <sub>2</sub> Low of N <sub>2</sub> ,
<b>Bulk Gas System</b>				
Changeover to Reserve Supply	Yes	Switch	In the Bulk Tank Park	
Reserve Pressure Low	Yes, if cryogenic reserve	Switch	In the Bulk Tank Park	
Reserve Low	Yes, if cryogenic reserve, or if check valves not provided for each cylinder lead	Switch	In the Bulk Tank	
Liquid Level Low	Yes	Switch	In the Bulk Tank	



## 2.0 Outlets

### 2.1 Station Outlets/Inlets

- Protected from physical damage
- Drops to individual station outlets & inlets shall not be smaller than ½” ID (5/8” OD) for pressure gases
- Vacuum drops shall not be smaller than ¾” ID (7/8” OD)
- Hose drops, ceiling columns and booms shall be installed prior to certification
- If Nitrous Oxide outlet is installed, a WAGD outlet must be installed
- Special attention to deep outlets (double sheet rock) should be considered. A standard outlet will work with up to 1 inch drywall, anything thicker than that will require special outlets.





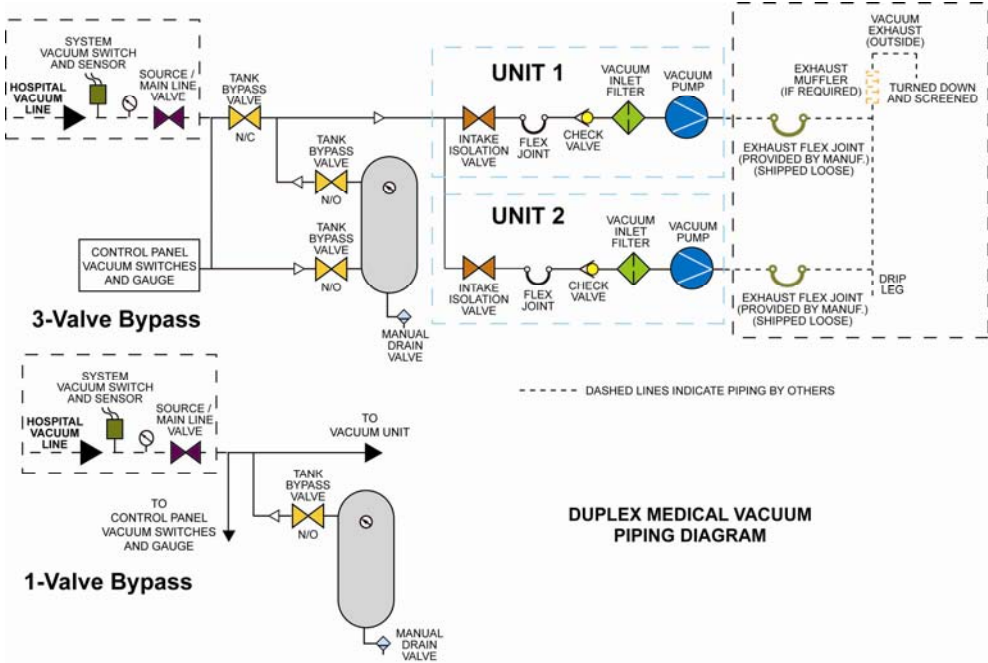
## 3.0 Piping

### 3.1 Medical Air Intake Piping

- Intake should be located above roof level, 10 feet from any door, window, exhaust or other intake or opening.
- Locate intake a minimum of 20 feet above ground
- CAUTION: Be careful of exhaust flue from boiler or generator exhausts
- Intake piping must be made of hard-drawn seamless copper tubing and brazed

## 3.0 Piping

### 3.2 Typical piping for a Duplex Medical Vacuum system.



## 3.0 Piping

### 3.2 Medical Vacuum Exhaust Piping

- Exhaust should be located outdoors above roof level
- 10 feet from any door, window, air intake or other opening.
- At a different level from air intakes
- CAUTION: Be careful of prevailing winds, adjacent buildings, topography or other influences that may divert the exhaust into occupied areas or prevent dispersion
- Exhaust piping must be made of hard-drawn seamless copper tube or stainless steel tube
- Some vacuum pumps may require mufflers be installed in the exhaust line

## 3.0 Piping

### 3.3 Branch Takeoffs

- Run-outs from horizontal piping shall be taken off above the centerline of the main or branch pipe and rise vertically or at an angle of not more than 45° from vertical

## 3.0 Piping

### 3.4 Brazed Joints

- Made using a brazing alloy with a minimum melting point of 1000° F
- Copper to Copper joints brazed using BCuP series without flux
- Continuously purged with NF Grade Nitrogen. Regular Nitrogen cylinders are not monitored for contamination or vacuumed down before filing thereby ruining the system during installation
- Purge gas shall be monitored for when the source is low
- Oxygen analyzer shall be used to verify effectiveness of the purge
- Purge gas flow shall be maintained until joint is cooled

## **3.0 Piping**

### **3.5 Fittings**

- Cast copper alloy fittings not permitted



## 3.0 Piping

### 3.6 Labeling

- Pipe labels shall comply with NFPA 99
- Pipe labels shall be located as follows:
  - at intervals of not more than 20 Ft.
  - at least once in or above every room
  - on both sides of walls or partitions penetrated by the piping
  - at least once in every story height traversed by risers
- For buried pipe, a continuous tape or marker shall be placed immediately above the pipe to identify the pipe-line by specific name

Piping System Contents	Band	Tape Colors	Stenciled Legends
Oxygen	Green	White w/ Green Letters	Oxygen or O <sub>2</sub>
Nitrous Oxide	Blue	Blue w/ White Letters	Nitrous Oxide or N <sub>2</sub> O
Medical Vacuum	White	Yellow w/Black Letters	Medical Vacuum or VAC
Nitrogen	Black	Black w/ White Letters	Nitrogen or NIT
Carbon Dioxide	Gray	Gray w/Black Letters	Carbon Dioxide or CO <sub>2</sub>
Medical Air	Yellow	White & Black w/Contrast Letters	Medical Air or Med Air
Waste Anesthetic Gas Disposal	Violet	Violet w/White Letters	WAGD

## 3.0 Piping

### 3.7 Location /Protection of Piping

- Piping in exposed areas subject to damage must be protected
- Piping underground within buildings or embedded in concrete must be installed in a continuous conduit
- Piping is **NOT** permitted in kitchens or elevator shafts
- When installed in service trench or tunnel, the space must be ventilated
- Underground piping should be protected from physical damage
- For buried pipe, a continuous tape or marker should be placed immediately above the pipe to identify the pipe-line by specific name
- For buried pipe, a continuous warning should be placed one-half the depth of the bury

## 3.0 Piping

### 3.8 Piping Material (Positive Pressure Medical Gas Systems)

- ASTM B 819 Medical Gas tube, type L for pressures under 185 PSI
- ASTM B 819 Medical Gas tube, type K for pressures over 185 PSI
- ASTM B 819 Medical Gas tube, type K for all tubing over 3" ID (3-1/8" OD)
- Manufacturer cleaned and identified prior to installation
- Plugged or capped and kept sealed until prepared for Installation
- Fittings, valves & other components kept sealed until prepared for installation
- Furnish documentation certifying that installed piping materials comply with the requirements of NFPA 99

## 3.0 Piping

### 3.9 Piping Material (Medical-Surgical Systems)

- ASTM B88 Seamless copper water tube (Types K, L, M)
- ASTM B280 Seamless copper refrigeration tube (Type ACR)
- ASTM B819 Medical Gas tube (Type K or L)
- Stainless steel tube
- B 88 & B280 if used must be labeled to identify it from Medical Gas tube
- Fittings must be cleaned for Oxygen service
- Joints shall be brazed

## 3.0 Piping

### 3.10 Piping Material (Medical-Surgical WAGD Systems)

- ASTM B88 Seamless copper water tube (Types K, L, M)
- ASTM B280 Seamless copper refrigeration tube (Type ACR)
- ASTM B819 Medical Gas tube (Type K or L)
- Stainless steel tube
- B 88 & B280 if used must be labeled to identify it from Medical Gas tube
- Fittings must be cleaned for Oxygen service
- Joints shall be brazed

## 3.0 Piping

### 3.11 Preparation of Tubing

- Cut tubing using clean tubing cutter (No hacksaw)
- Clean exterior of tubing prior to brazing using clean non-shedding abrasive pad (steel wool or sand cloth is **NOT** permitted)
- After removing plugs from end of piping look thru pipe for additional plugs. It is not uncommon for factory to install one plug on top of the other.  
A burned plug will require replacing all piping downstream and outlet.
- Joints shall be brazed within eight hours of being cleaned

## 3.0 Piping

### 3.12 Sizing

- Mains and branches in Medical Gas systems shall be a minimum of 1/2" ID (5/8" OD) (Ref. NFPA 99 5.1.10.10.1.2)
- Mains and branches in Medical-Surgical vacuum systems shall be a minimum of 3/4" ID (7/8" OD) (Ref. NFPA 99 5.1.10.10.1.3)
- Drops to individual station outlets or inlets shall be a minimum of 1/2" NPS or (5/8" OD) (Ref. NFPA 99 5.1.10.10.1.4)

## 3.0 Piping

### 3.13 Supports

- Hangers for copper tube shall have a copper finish and be sized for copper tube
- Maximum support spacing shall be in accordance with the following table:

Maximum Pipe Support Spacing		
Pipe Size		Hanger Spacing in Feet (meters)
NPS 1/4" (3/8" OD)	DN8	5 (1520)
NPS 3/8" (1/2" OD)	DN10	6 (1830)
NPS 1/2" (5/8" OD)	DN15	6 (1830)
NPS 3/4" (7/8" OD)	DN20	7 (2130)
NPS 1" (1-1/8" OD)	DN25	8 (2440)
NPS 1-1/4" (1-3/8" OD)	DN32	9 (2740)
NPS 1-1/2" (1-5/8" OD) and larger	DN40	10 (3050)
Vertical risers, all sizes, every floor		15 (4570)



## 3.0 Piping

### 3.14 Threaded Joints

- Limited to connections to pressure/vacuum indicators, alarm devices, check valves, threaded unions for MRI shielding, and Source equipment
- Use only **Oxygen Safe** thread sealant
- Use Teflon tape and sealant only on male threads of a joint

## 4.0 Source Equipment

### 4.1 Medical Gas Manifolds

#### 4.1.1 Location (Indoors):

- Separate secured room with 1 hour fire rating used for no other purpose
- Properly labeled per NFPA 99 5.1.3.1.9

**CAUTION  
Medical Gases**

**NO Smoking or Open Flame**

- May contain other Medical Gas manifolds and cylinders
- Electrical devices located at or above 5’-0” AFF
- Natural ventilation permitted for total gas systems below 3000 cu. ft.
  - Two openings (72 sq in) located within 1 foot of floor and ceiling
- Mechanical ventilation required for total gas systems above 3000 cu. ft.
  - Ventilation intake within 1 foot of floor. Makeup air shall be provided
- Indoor rooms heated by indirect means (steam or hot water) if needed
- Relief valves shall be piped to the outside. Discharge turned down & screened
- Relief valve piping shall be copper and be silver brazed
- Source valve located in the immediate vicinity of the Source

Reference NFPA 99 5.1.3.3.2 (1-9) for design and construction details for locations of central supply systems and storage of positive pressure gases

Gas Volumes in “H” or “K” Cylinders	
Medical Air	231 cu. ft.
Nitrogen	226 cu. ft.
Nitrous Oxide	577 cu. ft.
Oxygen	244 cu. ft.

## 4.0 Source Equipment

### 4.1 Medical Gas Manifolds

#### 4.1.2 Location (Outdoors):

- Secure enclosure constructed of noncombustible materials
- Impermeable walls shall have protected ventilation openings at the base
- Relief valves shall be turned down & screened
- Temperature not lower than 20° F or greater than 130° F
- Source valve shall be located in the immediate vicinity of the Source
  - Main line valve required where the line enters the building
- Emergency Oxygen Supply Connection (EOSC) may be required

## 4.0 Source Equipment

### 4.2 Medical Air Compressors

#### 4.2.1 Location:

- Indoors in a dedicated mechanical equipment area
- May be located with the Medical Surgical/WAGD vacuum pump
- Adequately ventilated to prevent accumulation of heat in excess of 100° F
- 24” clearance around system for servicing (36” in front of electrical controls)
- Connected to the Essential Electrical System

#### 4.2.2 Discharge Piping:

- Source valve located in the immediate vicinity
- **Used only for human respiration (Not for other applications)**

## 4.0 Source Equipment

### 4.2 Medical Air Compressors

#### 4.2.3 Intake Piping:

- Be piped outdoors or to air source equal or better than outside air (air already filtered for use in operating room ventilating systems)
  - Alternate source shall be available on a continuous basis (24 hours per day, 7 days per week)
  - Ventilating systems that have fans with motors or drive belts in the air stream shall not be used
- May be combined to a single intake
- Constructed of capped & cleaned brazed copper tubing (See page 17 for approved materials)
- Install flex connector on each compressor inlet

#### 4.2.4 Intake Termination:

- Outdoors, turned down and screened with non-corroding material
- Above roof level and a minimum distance of 20 ft. above the ground
- 10 ft. from any door, window, exhausts, other intakes, or openings

## 4.0 Source Equipment

### 4.3 Medical Surgical Vacuum / WAGD Vacuum Pump

#### 4.3.1 Location:

- Indoors in a dedicated mechanical equipment area
- May be located with Medical Air or Instrument Air compressors
- Adequately ventilated to prevent accumulation of heat in excess of 100° F
- 24” clearance around system for servicing (36” in front of electrical controls)
- Connected to the Essential Electrical System

#### 4.3.2 Inlet Piping:

- Source valve located in the immediate vicinity

#### 4.3.3 Exhaust Piping:

- Be piped outdoors
- May be combined to single exhaust
- Constructed of brazed copper or stainless steel tube
- Install flex connector on each pump
- Install drip leg with drain valve on individual exhaust lines
- Recommend muffler on exhaust line(s)
- Recommend exhaust piping be insulated inside the mechanical room

## 4.0 Source Equipment

### 4.3 Medical Surgical Vacuum / WAGD Vacuum Pump

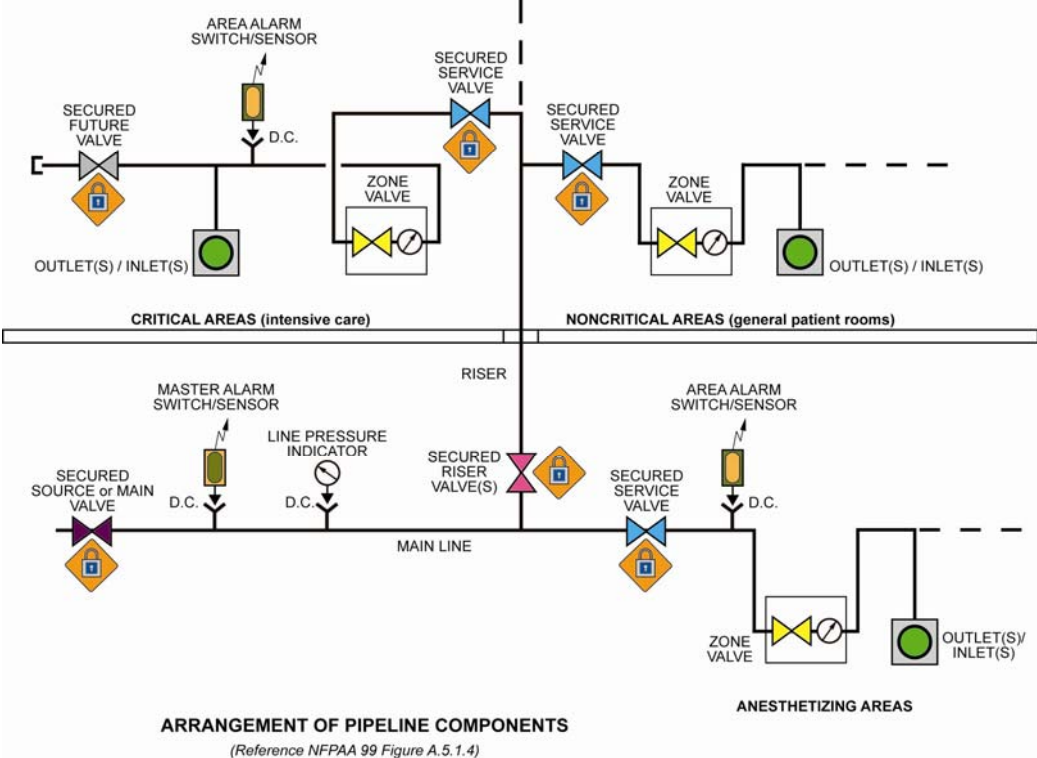
#### 4.3.4 Exhaust Piping Termination:

- Outdoors, turned down and screened with non-corroding material
- 10 ft. from any door, window, air Intake or other opening and at different level from air intakes
- Locate where prevailing winds, adjacent buildings, topography or other influences would not divert the exhaust into occupied areas or prevent dispersion.

Medical Scroll Air	System Pipe Length (ft) - See Notes										
	25	50	75	100	150	200	250	300	350	400	450
Duplex 2 HP	1.25	1.25	1.25	1.25	1.50	1.50	1.50	2.00	2.00	2.00	2.00
Duplex 3 HP	1.25	1.25	1.50	1.50	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Duplex 5 HP	1.50	2.00	2.00	2.00	2.00	2.50	2.50	2.50	2.50	2.50	2.50
Duplex 7.5 HP	2.00	2.00	2.00	2.50	2.50	2.50	3.00	3.00	3.00	3.00	3.00
Duplex 10 HP	2.00	2.50	2.50	2.50	2.50	3.00	3.00	3.00	3.00	3.50	3.50
Duplex 15 HP	2.50	2.50	2.50	3.00	3.00	3.50	3.50	3.50	3.50	4.00	4.00

# 5.0 Valves

## 5.1





## 5.0 Valves

### 5.2 Source

- Placed at the immediate connection of each Source to the distribution system
- Must be secured (locked room or locking handle)
- Labeled “**Source Valve**”

## 5.0 Valves

### 5.3 Main Line

- Required where “Source Valve” is **NOT** accessible inside building being served
- Located where the main line enters the building
- Must be secured (behind locked access door or locking handle)
- Labeled “**Main Line Valve**”

## 5.0 Valves

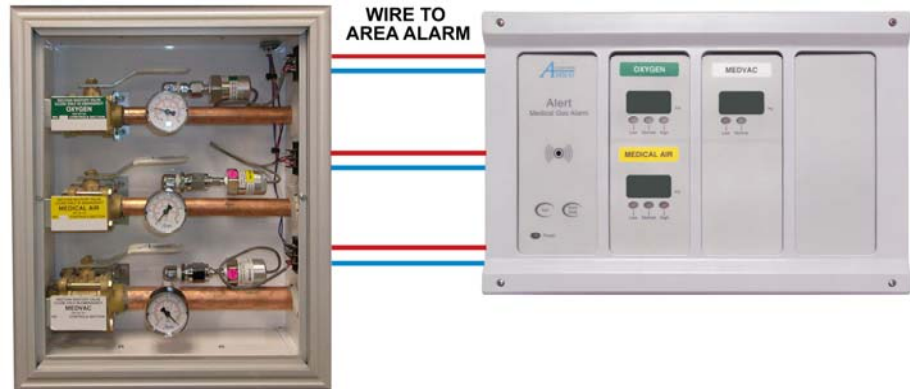
### 5.4 Riser

- Placed in each riser supplied from the Main line
- Must be accessible and secured
- Labeled per NFPA 99

## 5.0 Valves

### 5.5 Zone

- Located in zone valve box with removal cover
- Be placed such that a wall intervenes between the zone valve and the outlets it controls
- Be placed on the same floor of the outlets it controls
- Accessible at all times
- Not be installed behind doors
- Labeled per NFPA 99 to include area served



### **Emergency Oxygen Supply Connection (EOSC)**

EOSCs shall be installed to permit connection of temporary source of supply for emergency or maintenance situations under the following conditions:

(5.1.3.4.14)

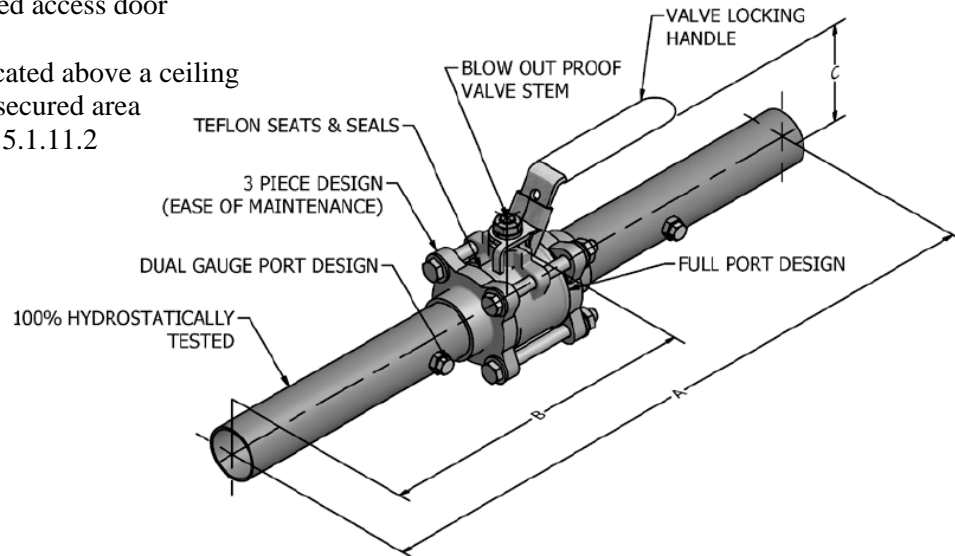
1. Where the bulk cryogenic liquid central supply system is outside of and remote from the building that the oxygen supply serves
2. Where there is not in the building a connected oxygen reserve sufficient for an average day's supply (See 5.1.3.4.15 for requirements for such reserves)
3. Where multiple freestanding buildings are served from a single oxygen source such that damage to the interconnecting oxygen line could result in one or more buildings losing oxygen supply. In this situation, each building shall be provided with a separate emergency connection.

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## 5.0 Valves

### 5.6 Service

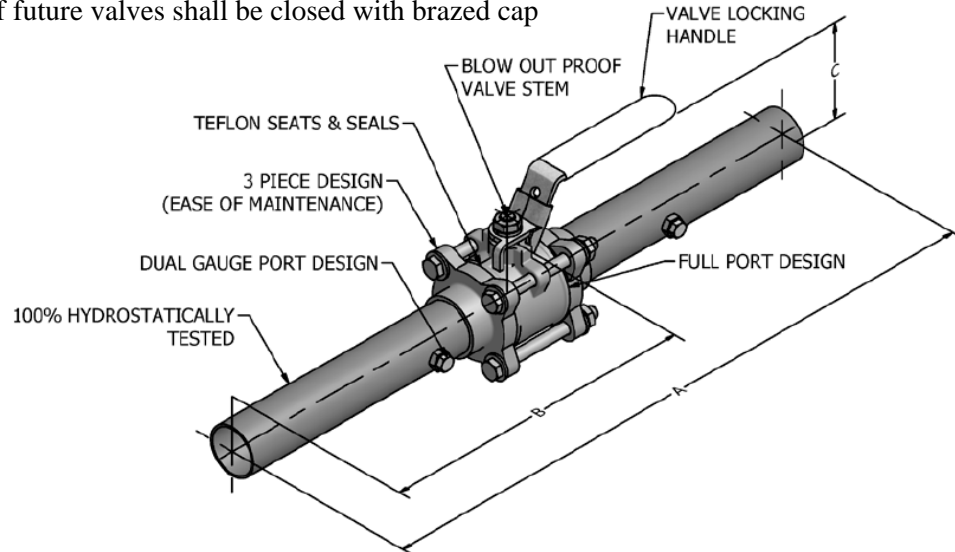
- Placed in branch piping prior to any zone valve box on that branch
- Only one required for each branch regardless of the number of valve boxes on that branch.
- Located behind a locked access door
- Lockable
  - Locked open if located above a ceiling
  - Locked open in a secured area
- Labeled per NFPA 99 5.1.11.2



## 5.0 Valves

### 5.7 In-Line and for Future Connection

- Permissible to isolate piping for maintenance and future piping
- Downstream piping of future valves shall be closed with brazed cap
- Lockable
- Labeled per NFPA 99



## 6.0 Installer Testing

- Grade oil-free nitrogen, grade NF (NFPA 5.1.12.2.1.2) shall be used for purging and testing.
- All joints should be checked with OXYGEN SAFE soap.
- Initial Blow Down Test (NFPA 5.1.12.2.2)
- All gauges and pressure sensors must be removed prior to pressure testing of system (pressure on a vacuum gauge or sensor will ruin it, high pressure on a 50 PSI gauge and sensor will have the same result).
- Cross-Connection Test (NFPA 5.1.12.2.4 – 5.1.12.2.4.6) The installer needs to do a cross connection test and a white cloth test before calling the certifier. Cross connections test is performed by pressurizing one gas at a time, and check all outlets for pressure for that gas, good time for white cloth test. Verify correct labeling of all outlets
- Initial Pressure Test (NFPA 5.1.12.2.3 – 5.1.12.2.3.7) - Remove all components that can be damaged (gauges, alarm sensors, outlet trim latch valves) and test to 1.5 TIMES working pressure or 150 PSI. All joints checked with OXYGEN SAFE soap. The trim plate should not be installed until High Pressure Test is completed and pressure reduced to 24 hour test pressure.
- Pressure test the vacuum system at 60 psi; vacuum gauges and alarm sensors should be removed to avoid damage
- 24 Hour Standing Pressure Test (NFPA 5.1.12.2.6 – 5.1.12.2.6.6) - is performed after all components are installed (gauges, switches, outlet trims, alarm sensors). This test is performed at 20% above working pressure (60 PSI for oxygen, air, nitrous oxide and carbon dioxide. Nitrogen is tested at 200 PSI and vacuum at 12 inches

When all of the tests are satisfied the certifier can be called. Note that certifier will require at least two bottles of each pressurized gas to verify manifold operation. Alarm wiring should be completed. Vacuum and air compressors are to be started by factory rep and running for at least 24 hours. 39



## 7.0 Verification Procedures

- Verifier qualifications
- Source equipment operation
- System leak test
- Zone valve leak test
- Cross-connection test
- Valve test
- Emergency oxygen line test
- Outlet flow test
- Alarm test
- Piping purge/particulate test
- Piping purity test
- Final tie-in test
- Emergency oxygen connection
- Source gas purge

**NOTES**

A large grid of graph paper for taking notes, consisting of 20 columns and 20 rows of small squares. The grid is light blue and occupies most of the page below the header.

# NOTES

A sheet of graph paper with a grid of small squares. The word "NOTES" is written in bold, black, uppercase letters in the top-left corner of the grid. The rest of the grid is empty.



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