

**CT Department of Construction
Services**

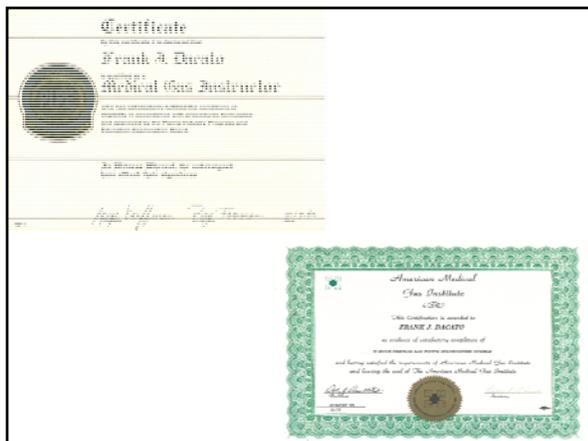
N.F.P.A. 99-C

2002 Edition

Gas and Vacuum Systems

INTRODUCTION

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Discussion Topics

- Why a state medical gas certification
- Public Act 02-92
- ASSE 6000
- N.F.P.A. 99-C

Why A State Medical Gas Certification

- There have been many documented cases of medical gas related deaths.
- Some are due to installation methods.
- Some are due to improper testing.
- But all could be avoid if the standard is followed and enforced.

Some Cases in Point

- Dayton, Ohio
 - Oxygen System Mix-Up Suspected In Nursing Home Deaths
 - 2 death, 8 others hospitalized
- Allen, Texas
 - Parents Get \$4.7 Million
 - 14 month old baby's death due to cross connection
- Temple, Texas
 - Mystery Tangles Hospital Death
 - 6 death, 70 others under observation



Public Act 02-92

An Act Ensuring the Proper Installation and Maintenance of Medical Gas and Vacuum Systems

- Approved June 3, 2002
- Effective July 1, 2003



**Sec. 2. Section 20-334a
General Statutes**

Amended by adding subsection (g) as follows
(New) (g) On or after July 1, 2003, a medical gas and vacuum systems certificate for medical gas and vacuum systems work may be issued by the department, upon the authorization of the Plumbing and Piping Work Board or the Heating, Piping and Cooling Work Board, as appropriate to any person who...

Sec. 2. Section 20-334a

(1) has been issued a P-1, P-2, S-1, S-2, S-3 or S-4 license under subdivision (1) of subsection (a) of this section, (2) has been certified as a medical gas and vacuum system brazer issued in accordance with the standards of Section IX entitled "Welding and Brazing Qualifications" of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code, and

Sec. 2. Section 20-334a

(3) Has been certified as having completed an approved training course on medical gas and vacuum system installation as required by American National Standards Institute-American Society of Sanitary Engineering Series 6000. No person shall perform medical gas and vacuum systems work unless such person has obtained a certificate pursuant to this subsection. Such certificate shall be renewed consistent with the renewal process for the prerequisite licenses. The fee for such certificate shall be twenty-five dollars.

Certification Samples

NITC Identification Card State of CT Certification



A.S.S.E. Series 6000

A.S.S.E. Series 6000 is a "Professional Qualifications Standard for Medical Gas Systems Installers, Inspectors, Verifiers, Maintenance Personnel and Instructors."

A.S.S.E. Series 6000

A.S.S.E. Series 6000 is broken down into five sub sections & nine appendix (A-I).

1. Standard 6010—Installers
2. Standard 6020—Inspectors
3. Standard 6030—Verifiers
4. Standard 6040—Maintenance Personnel
5. Standard 6050—Instructors

Standard 6010—Installers

- 10-1.1 Scope
 - Applies to anyone who installs medical gas and vacuum systems & equipment covered in this standard which include health care facilities and laboratories within the scope of NFPA 99 and 99-C. Installers include anyone who works on or installs piping or components, including brazers.

Standard 6010—Installers

- 10-1.2 Purpose
 - Provide *minimum* performance criteria.
- 10-1.3 Limitations For a Medical Gas System Installer
 - Compliance with this standard in itself shall not constitute compliance with the requirements for 6020, 6030, 6040 or 6050.

**Minimum Performance Criteria
Installers**

- 32 hours of instruction to include
 - Review of N.F.P.A. 99-C
 - Hands on brazing
 - Certification Test
- Proctored third party test
 - 100 question closed book test based on 99-C
 - Two 1 ½” brazed couplings
 - One in the horizontal position
 - Second in the vertical position (both up flows)

N.I.T.C. (Third Party)

Mr. Michael T. Massey, Executive Vice President
National Inspection Testing Certification
501 Shatto Place, Suite 201
Los Angeles, CA 90020
Phone: 877-457-6482 Fax: 213-351-7632
Web Site: www.nationalitc.com
ISO 9000 Certified

Standard 6020—Inspectors

- 20-1.1 Scope
 - Applies to any individual who inspects installations of medical gas and vacuum distribution systems. Medical gas pipeline systems & equipment covered in this standard which include health care facilities and laboratories within N.F.P.A. 99 and 99-C

Minimum Performance Criteria Inspectors

- 24 hours of instruction to include
 - Review of N.F.P.A. 99-C
 - Certification Test
- Proctored third party test
 - 100 question closed book test based on 99-C

ASSE 6005: Specialist Certification

- The 24-hour ASSE 6005: Specialist Certification Program was developed to provide medical gas supervisors, architects, engineers, project managers, project estimators, code officials, administrators, or anyone else who has an interest in the proper design, installation, use, and maintenance of medical gas and vacuum systems, with the certification necessary to ensure that the individual has met the requirements of the ASSE Series 6000 Professional Qualifications Standard and are technically competent and experienced with medical gas systems and vacuum systems.
- Prerequisite: None Required.

ASSE 6035 Bulk Medical Gas Verifiers

- The 16-hour ASSE 6035: Bulk Medical Gas Systems Verifier Certification Program was developed to provide qualified individuals, who are responsible for the proper verification of bulk medical gas systems, with the certification necessary to ensure that the individual has met the requirements of the ASSE Series 6000 Professional Qualifications Standard and are technically competent and experienced in the field of medical gas systems inspection.
- Prerequisite: Current ASSE 6030 Medical Gas Systems Verifier Certification and (2) years of documented practical experience in the verification and/or inspection of bulk medical gas systems.

N.F.P.A. 99

- The State of Connecticut currently is under the 2002 edition of N.F.P.A. 99.
- N.F.P.A. 99-2002 is broken down into 21 chapters.
- Chapter 5—Gas and Vacuum Systems, is N.F.P.A. 99-C which addresses
 - Levels 1, 2 and 3 of medical gas and vacuum systems.

N.F.P.A. 99-C

In the 1999 edition of N.F.P.A. 99-C is chapter 4 of N.F.P.A. 99. In the 2002 edition of N.F.P.A. 99 the chapter on Gas and Vacuum Systems was changed to chapter 5. Level 4 was removed and changed to chapter 11, Laboratories. In the 2005 edition, Gas & Vacuum Systems has remained as chapter 5.

N.F.P.A. 99-C

Chapter 3, Definitions, in the 2002 edition of N.F.P.A. defines Levels 1, 2 and 3 as

- **Level 1 Medical Piped Medical Gas and Vacuum Systems.**
 - Systems serving occupancies where interruption of the piped medical gas and vacuum system would place patients in imminent danger of morbidity or mortality.

N.F.P.A. 99-C

- **Level 2 Medical Piped Gas and Vacuum Systems**
 - Systems serving occupancies where interruption of the piped medical gas and vacuum system would place patients at manageable risk of morbidity or mortality

N.F.P.A. 99-C

- **Level 3 Piped Gas Systems**
 - Systems serving occupancies where interruption of the piped medical gas system would terminate procedures but would not place patients at risk of morbidity or mortality

N.F.P.A. 99-C

What are some of the concerns of a person inspecting a medical gas system?

- Is the installation up to the standard?
- Is the person doing the installation certified?
- Are the materials being used up to the standard?
- Are all required testing procedures being followed?

N.F.P.A. 99-C

- As previously discussed. NFPA 99-C is for the most part Chapter 5, Gas and Vacuum Systems however it also includes Chapter 1 Administration, Chapter 3 Definitions as well as sections of other of the documents chapters.

Chapter 5 Gas & Vacuum Systems 2002 Edition

- 5-1 Level 1 Piped Gas & Vacuum Systems
- 5-2 Level 2 Piped Gas & Vacuum Systems
- 5-3 Level 3 Piped Gas & Vacuum Systems
- Chapter 11 Laboratories
 - Laboratories within health care facilities

1-1 Scope

1.1 The scope of this document is to establish criteria to minimize the hazards of fire, explosion, and electricity in health care facilities providing services to human beings.

1.1 Scope

Chapter 5 covers the performance, maintenance, installation, and testing of the following;

1. Nonflammable medical gas systems with operation pressures below a gage pressure of 300 p.s.i.
2. Vacuum systems used within health care facilities
3. Waste anesthetic gas disposal (WAGD) systems
4. Manufactured assemblies that are intended for connection to the medical gas, vacuum, or WAGD systems.

Chapter 5

- 5.1.1 Applicability
- 5.1.2 Nature of Hazards
- 5.1.3 Level 1 Sources
- 5.1.4 Valves
- 5.1.5 Station Outlet/Inlets
- 5.1.6 Manufactured Assemblies
- 5.1.7 Surface-Mounted Medical Gas Rails (MGR)

Chapter 5

- 5.1.8 Pressure and Vacuum Indicators
- 5.1.9 Level 1 Warning Systems
- 5.1.10 Level 1 Distribution
- 5.1.11 Labeling & Identification
- 5.1.12 Performance Criteria & Testing—Level 1 (Gases, Medical-Surgical Vacuum and WAGD.
- 5.1.13 Level 1 Operations & Management
- 5.1.14 Level 1 Support Gases

5.1.3 Level 1 Sources

- Cylinder
 - 5.1.3.4.9 Manifolds for Gas Cylinders without Reserve Supply
 - 5.1.3.4.10 Manifolds for Cryogenic Liquid Cylinders with a Reserve Supply
- 5.1.3.4.11 Bulk Cryogenic Liquid Systems
 - Oxygen=20,000 cubic feet in storage & unconnected reserves (NFPA 50)
 - Nitrous Oxide=3,200 lbs approximately 28,000 cu ft

5.1.3 Level 1 Sources

- 5.1.3.4.12 Emergency Oxygen Supply Connection (EOSC)
- 5.1.3.4.1. 13 In-Building Emergency Reserves
- 5.1.3.5 Medical Air Systems
- 5.1.3.6 Medical-Surgical Vacuum Supply Systems
- 5.1.3.7 Waste Anesthetic Gas Disposal (WAGD)
- 5.1.3.8 Instrument Air Source

5.1.3.3 Central Supply System Locations

- Any of the following systems shall be permitted to be located together in the same outdoor location.
 - Manifold for gas cylinders without or with a reserve supply.
 - Manifolds for cryogenic liquid cylinders.
 - Bulk cryogenic systems.

5.1.3.3 Central Supply System Locations

- Any of the following systems shall be permitted to be located together in the same indoor location.
 - Manifold for gas cylinders without or with a reserve supply.
 - Manifolds for cryogenic liquid cylinders.
 - In building emergency supplies.
 - Instrument air standby headers.

5.1.3.3 Central Supply System Locations

- Any of the following systems shall be permitted to be located together in the same room.
 - Medical air compressor supply sources.
 - Medical-surgical vacuum sources.
 - Waste anesthetic gas disposal (WAGD) sources.
 - Instrument air sources.

5.1.3.3.3 Ventilation

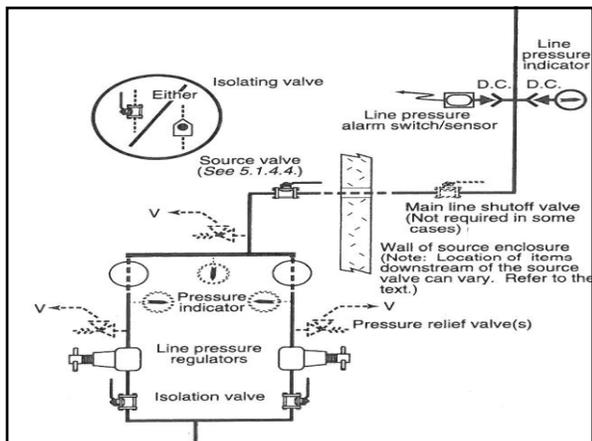
- This section addresses how and where rooms containing medical gas source supplies shall be ventilated. It also references which section address how and where relief valves shall be vented.

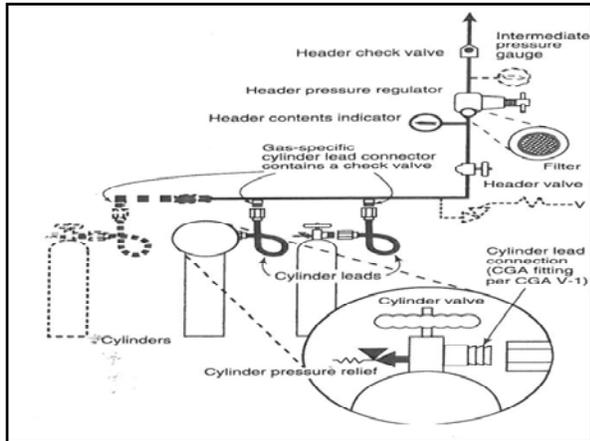
What are central supply systems?

Systems that supply medical gas to a point of use such as manifolds with and without reserves, manifolds for cryogenic liquid cylinders, bulk cryogenic liquid systems, medical air and instrument air systems, as well as medical surgical and waste anesthetic gas disposal systems are considered central supply systems

Central Supply Systems.

- 5.1.3.4.4 Final Line Pressure Regulators
- 5.1.3.4.5 Relief Valves
- 5.1.3.4.6 Multiple Pressures
- 5.1.3.4.7 Local Signals
- 5.1.3.4.8 Headers

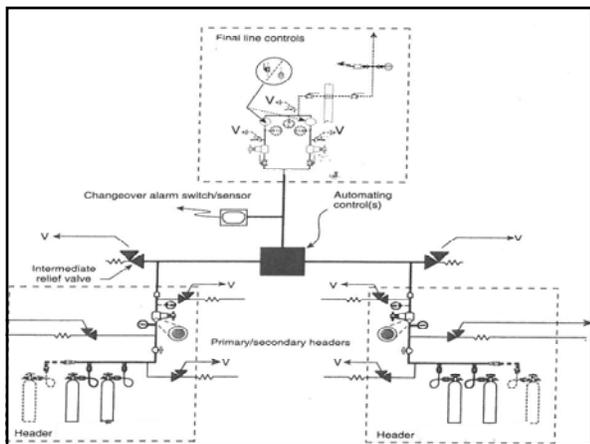




5.1.4.3.9 Manifold w/o a Reserve Supply

System consisting of...

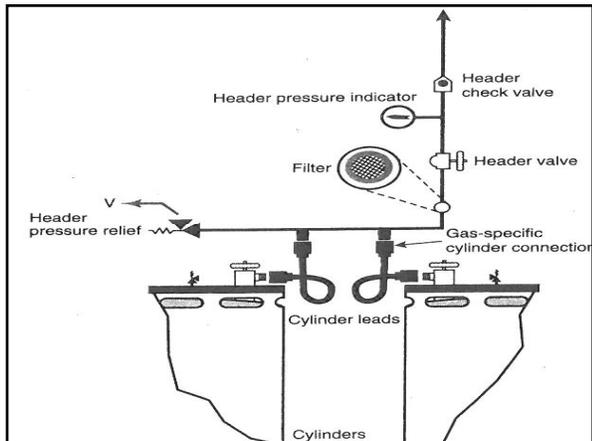
- 2 equal headers
- Minimum of 1 days supply but not less 2 tanks per header.
- Pressure regulators
- Alarm activation switches.
- Isolation valves.
- Relief valve

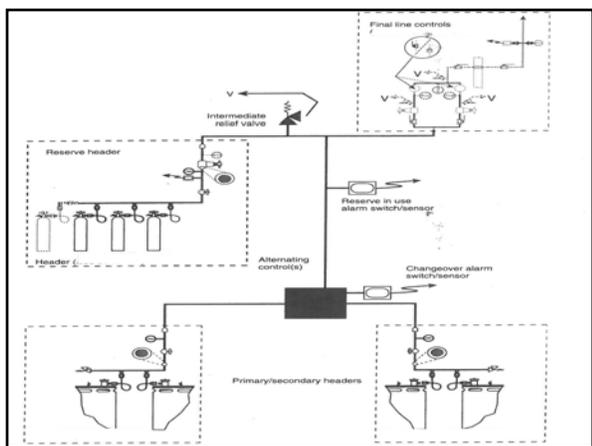


5.1.3.4.10 Manifold for Cryogenic Liquid Cylinders

System consisting of...

- 2 equal headers
- Minimum of 1 days supply but not less 2 tanks per header.
- Pressure regulators
- Alarm activation switches.
- Isolation valves.
- Relief valve also..
- A 3rd header with a minimum of 1days supply and a minimum of 3 tank connections.

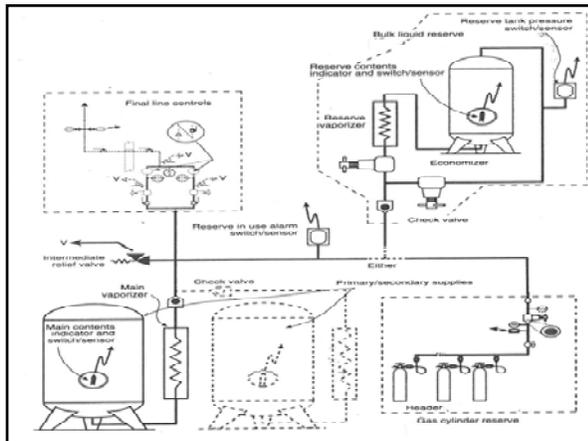




5.1.4.3.11 Bulk Cryogenic Liquid Systems

Systems consists of...

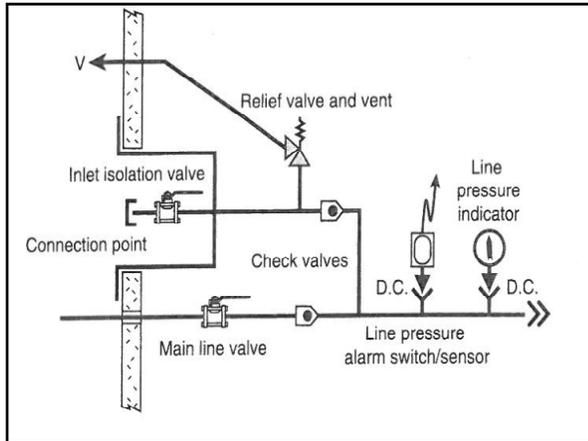
- Cryogenic tank(s)
- Vaporizer
- May have a cryogenic or cylinder reserve system.
- Pressure regulators
- Alarm activation switches.
- Isolation valves.
- Relief valves
- Filters



5.1.3.4.11 Bulk Cryogenic Liquid Systems

Emergency oxygen supply connections (EOSC) are located on the outside of building in areas accessible by emergency vehicles at all times and in all weather conditions.





5.1.3.5 Level 1
Medical Air Supply Systems
 NFPA 99-C 2005
 Medical Gas & Vacuum Code

- 5.1.3.5 Medical Air**
- 5.1.3.5.1 Quality of Medical Air
 1. Be supplied from cylinders, bulk containers medical air compressor sources or be reconstituted from O₂ USP and oil-free dry nitrogen
 2. Meet the requirements of medical air USP
 3. Have no detectable liquid hydrocarbons
 4. Have less than 25 ppm gaseous hydrocarbons
 5. Have equal to or less than 5mg/m³ of permanent particulates sized 1 micron or larger in the air at normal atmosphere.
 - 5.1.3.5.2 Medical air sources shall be connected to the medical air distribution system only & shall be used only for air in the application of human respiration, & calibration of medical devices for respiratory application.

5.1.3.5.3 Medical Air Compressor Sources

- 5.1.3.5.3.1 Medical air compressor systems shall be located as per 5.1.3.3 (pg 16) as follows:
 1. Indoors in a dedicated mechanical equipment area, adequately ventilated & w/any required utilities (e.g., electricity, drain, lighting, etc.)
 2. In a room constructed per 5.1.3.3.2 (pg 17)
 3. In a room ventilated per 5.1.3.3.3 (pg 17)
 4. For air cooled equipment, in a room designed to maintain the ambient temperature range as recommended by the manufacturer

Medical Air Intake

- Draws air from clean source.
- If from outside turn down & screened
- 10' from any door, window, exhaust, other intake or openings.
- 20' above the ground.
- Material B-819 medical gas tube or B-88 water tube (K,L or M), or B-280 ACR tube.

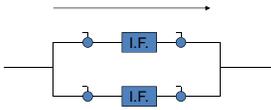
Medical Air Intake (indoors)

5.1.3.5.13.3 If an air source equal to or better than outside air (e.g., air already filtered for use in O.R. ventilating systems) is available, it shall be permitted to used for the medical air compressors with the following provisions...

1. This alternate source of supply air shall be available on a continuous 24-hour-per-day, 7-day-per-week basis.
2. Ventilating systems having fans w/motor or drive belts located in the air stream shall **not** be used as a source of medical air intake.

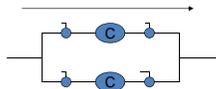
Air Intake Filters

- If common header to intake must be capable of being isolated by either manual valve, check valve, blind flange or cap.



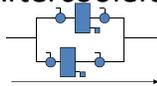
Medical Air Compressors

- Be located indoors.
- Be duplexed.
- Piping & valves between compressors shall be compatible with oxygen.
- Elimination of oil anywhere in the compressor.
- Flexible connectors on intake & outlet piping.
- Anti-vibration mountings by manufactures recommendation.

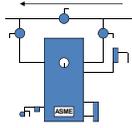


Aftercoolers

- Be duplexed.
- Required if compressor outlet air temperature 100 degrees F or greater.
- Provided with individual condensate traps.
- Provided with individual isolation valves.
- Anti-vibration mounting by manufactures recommendation.
- With only one open to the air flow at a time.

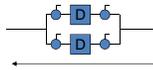


Receiver



- Not used as aftercoolers.
- Not required to be duplexed.
- Made of corrosion resistant materials.
- Be equipped with relief valve, automatic drain, manual drain, sight glass, pressure indicator and 3 valve by-pass.
- ASME plate.

Medical Air Dryers



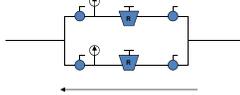
- Be duplexed.
- Provide air at maximum dew point that is below the frost point of 32 degrees F.
- Provided with individual manual isolation valves upstream and manual or check valves downstream.
- Located upstream of final line regulars.
- Only one dryer open to air flow at a time.
- Be sized for 100% of peak calculated demand

Medical Air Filters



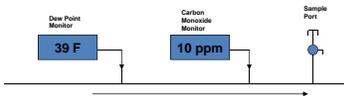
- Be duplexed.
- Provided with manual isolation valves upstream and manual or check valves downstream.
- Sized for 100% of the system peak calculated demand & be rated for a minimum of 98% efficiency at 1 micron or greater.

Final Line Regulators



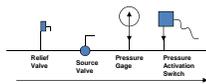
- Shall be duplexed.
- Provided with manual valves upstream & manual or check valves downstream.
- Be equipped with gages indicating outlet pressure.

Medical Air Quality Monitoring

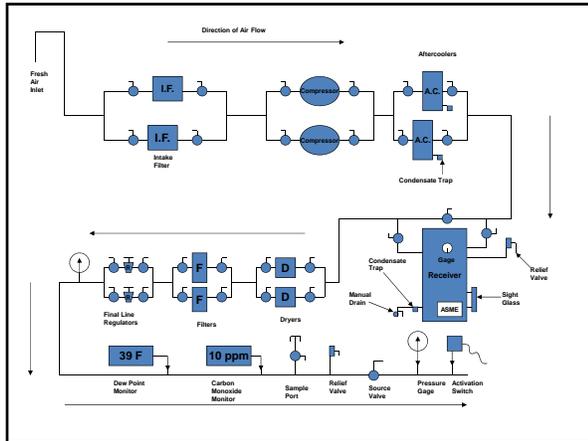


- Dew Point Monitor
 - Provided with a quick disconnect
 - Activate the master alarms at 39 degrees F.
- Carbon Monoxide Monitor
 - Provided with a quick disconnect
 - Activate the local alarm at 10 ppm.
- 1/4" Sample port.

Source to Distribution



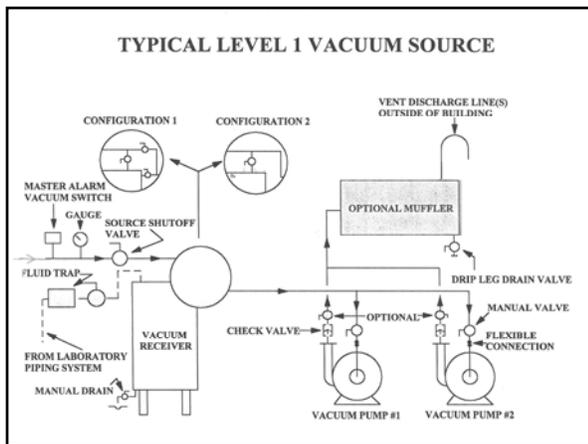
- Relief Valve (upstream of source valve)
- Source Valve
- Pressure Gage (with quick disconnect)
- Pressure Activation Switch (with quick disconnect)



5.1.3.6 Medical-Surgical Vacuum Sources

Systems consist of...

- Minimum of 2 vacuum pumps
- Receiver
- Receiver by-pass
- Exhaust
- Alarms



5.1.3.7 Waste Anesthetic Gas Disposal (WAGD)

- Installation same as Medical Surgical Vacuum System.
- WAGD systems are use to remove exhausted anesthetic gas during use.
- May be used in conjunction with medical surgical vacuum systems provided...
 - Comply with flammable anesthetics.
 - System sized to comply with needs.

5.1.3.8 Instrument Air Supply Systems

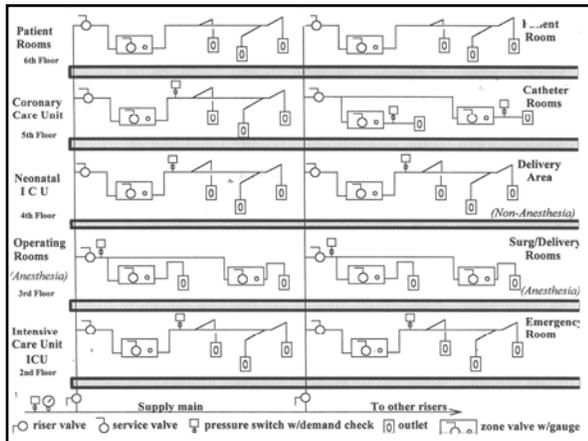
- Dry to a Dew Point of -40 F
- Outlet pressure 200 PSI
- Source 2 compressors or 1 compressor and 1 standby header with minimum of 1 hour supply of normal operation.
- Air allowed can be drawn from equipment room.
- After coolers, air receivers, air dryers and air regulators installed as per medical gas systems.

5.1.4 Valves

- Except those in zone valve boxes shall be located in a secure areas or locked and labeled as to gas and area(s) controlled.
- Valve Types...
 - Quarter turn, full ported
 - Brass or bronze construction
 - Have extensions for brazing
 - Have a handle indicating open or closed
 - Consist of three-pieces permitting inline serviceability.
- Valves for positive pressure must be cleaned of oxygen service by the manufacturer
- Valves for vacuum systems shall be of the ball or butterfly type & not be required to cleaned for oxygen service.

Valves

- Source 5.1.4.4
- Main Line 5.1.4.5
- Riser 5.1.4.6
- Service Valve 5.1.4.7
- Zone Valve 5.1.4.8
- Inline Valve 5.1.4.9
- Future Valve 5.1.4.10



5.1.5 Station Outlets/Inlets

- 3.3.167 Station Inlet—An inlet point in a piped medical/surgical vacuum distribution system at which the user makes connections and disconnections.
- 3.3.168 Station Outlet— An outlet point in a piped medical gas distribution system at which the user makes connections and disconnections.
 - Gas Specific
 - Pressure Specific
 - Excess of 80 psi be D.I.S.S. (Diameter Index Safety System)
 - 200 to 300 psi designed to relieve pressure before being disconnected.

5.1.6 Manufactured Assemblies

- Addresses testing requirements.
- Pressure rating
- General standards

5.1.7 Surface-Mounted Medical Gas Rails (MGR)

- Permitted to be installed where multiple uses of medical gases and vacuum at a single patient location are required or anticipated.
- Also addresses manufacture standards.

5.1.8 Pressure & Vacuum Indicators

- Cleaned for oxygen service
- Range positive pressure analog fall within the middle 50% of the scale.
- Digital gages not more than two times the working pressure of the system served
- Vacuum gages 0-29.9 inches except gages with normal range display indicate normal only above 12 inches.
- Indicators located next to master actuators & area alarms & labeled to identify system.

5.1.9 Level 1 Warning Systems

- 3.3.4.1 Area Alarm System-A warning system within an area of use that provides continuous visible and audible surveillance of Level 1 & 2 medical gas and vacuum systems.
- 3.3.4.3 Local Alarm System-A warning system that provides continuous visible & audible surveillance of medical gas & vacuum source equipment at the equipment site.
- 3.3.4.4 Master Alarm System-A warning system that monitors the operation & condition of the source of supply, the reserve source, if any, & the pressure in the main lines of each medical gas & vacuum systems.

5.1.9 Level 1 Warning Systems

- Alarm activate at $\pm 20\%$ of operating pressure.
- Alarm activates drop to or below 12" of vacuum.
- Alarm activates when dew point on the medical air reaches 39 degrees F.
- Alarm activates when dew point on the instrument air reaches -22 degrees F.

5.1.10 Level 1 Distribution

- Tubes, valves, fittings, station outlets and other piping components in medical gas systems shall have been cleaned for oxygen service by the manufacturer prior to installation. They may be permitted to cleaned by a supplier other than the manufacture.
- Tubing delivered and kept capped or plugged until use.
- Fitting, valves & other components delivered sealed, labeled & kept sealed until prepared for installation

5.1.10 Level 1 Distribution

- Tubing Type “L” ASTM B 819 marked OXY, MED OXY/MED OXY/ACR ACR/MED, Type “K” for pressures of 185 psi or greater.
- Vacuum systems may use Type K, L or M ASTM B 819, ASTM B 88 or ASTM B 280.
- Fitting shall conform to ANSI B16.22 or MSS SP-73 braze fittings (short sockets)
- Thread fitting comply with ANSI B1.20.1 only allowed on pressure /vacuum indicators, alarm devices or source equipment.
- Made up with Teflon tape.

Joining

- Positive Pressure
 - Brazed
 - Orbital Weld
 - Special Fitting
- Vacuum
 - Brazed
 - Orbital Weld
 - Special Fitting
 - Mechanically formed, drilled & extruded tee branch connections
- Threaded Joints
 - Distribution piping limited to gauges & alarm devices and source equipment.

Prohibited Joins

- Flared—Compression
 - Including connections to station outlets and inlets, alarm devices and other components.
- Other straight threaded connections

Brazed Joints

- Use alloy melting alloy in excess of 1000 degrees F.
- Filler metal comply with ANSI/AWS A.5.8 using BCuP series.
- Tubing cut square, cutting wheels free of grease oil or other lubricant also deburred.
- Clean tube ends with non abrasive pad fitting cups cleaned with stainless steel wire fitting brush. Clean with clean rag.
- Joint must be brazed within one hour of being joined*.

Nitrogen Purge

- Done with oil free dry NF
- Source of purge gas monitored with audible alarm.
- Regulator alone cannot control flow rate must use flow meter.
- Hole at the end of piping to maintain purge.
- Capped when cooled & nitrogen atmosphere maintained within the piping system.
- Final connection may be made without a purge.

5.1.10.5.7 Inspection of Brazed Joint

- Joint exhibiting the following conditions shall not be permitted
 1. Flux or flux residue-repaired once
 2. Base metal melting or erosion-must be replaced
 3. Unmelted filler metal-repaired once
 4. Failure of the filler metal to be clearly visible all the way around the joint at the interface between the socket and the tube-repaired once
 5. Cracks in the tube or component-must be replaced
 6. Cracks in the braze filler metal-repaired once
 7. Failure of the joint to hold test pressure-repaired once

5.1.10.6 Installation of Piping & Equipment

- Pipe Sizing
 - Positive pressure mains & branches not less than ½”.
 - Vacuum mains & branches not less than ¾”
 - Drops to individual outlets & inlets not less than ½”
 - Alarm Panel runouts not less than ¼”

5.1.10.6 Installation of Piping & Equipment

- Protection of Piping
 - Against freezing, corrosion & physical damage.
- Location of Piping
 - In pipe shafts if protected.
 - In service trench or tunnel with fuel gas lines, fuel oil lines, electrical lines, steam lines, & similar utilities provided that the space is ventilated & temperature limited to 130° F.
 - Not permitted where subject to contact with oil, including possible flooding area in case of major oil leak.

Piping Support

- Supported from the building
- Have copper finish & be sized for tube
- In damp locations be plastic coated or otherwise insulated from the tube
- Seismically restrained where required.

Pipe Size	Hanger Spacing	Pipe Size	Hanger Spacing
1/4"	5'	1"	8'
3/8"	6'	1 ¼"	9'
1/2"	6'	1 ½" & larger	10'
3/4"	7'	Vertical risers once ever floor not to exceed	15'

- **Underground Piping Outside of Buildings**
 - Buried below the local frost level. Backfill shall be clean.
 - Installed in a continuous enclosure which must be spilt or otherwise allow access to joints for testing.
 - Continuous tape or marker immediately above the enclosure and again halfway in between the top.
- **Branch Takeoffs**
 - Above the center line of the pipe & rise vertically or at an angle on not less than 45 degrees from the vertical.
- **Prohibited System Interconnections**
 - Two or more medical gas or vacuum piping systems shall not be interconnected for installation, testing or any other reason. Leak testing shall be done by testing of individual piping systems.
- **Changes in use**
 - Positive pressure system allowed if all provisions of new gas are met. Vacuum may not be changed to a positive pressure system.

5.1.10.6.11 Qualification of Installers

- This section will address that an installer shall meet the requirements of ANSI/ASSE 6010 and that they shall provide and maintain documentation on the job site of their brazing procedures.

5.1.10.6.11 Qualification of Installers

License Category	License Number	Expiration Date

5.1.10.6.12 Qualification of Brazing Procedures and Brazing

- This section will set the standard to which the braze procedure is qualified under section IX of ASME *Boiler and Pressure Vessel Code*, or AWS B2.2, *Standard for Brazing Procedure and Performance Qualifications*. It will also address what the brazing procedure shall cover and what the procedure specification shall document.

5.1.10.6.12 Qualification of Brazing Procedures and Brazing

- Employer Responsibilities.
 - Obtain copy of both brazing procedure specification & supporting qualification records
 - Qualify at least 1 brazer following each brazing procedure specification used.
- Employer Permitted to accept previous documentation from another employer if...
 - Employee qualified under same procedure
 - Obtains copy or braze record and signs and dates records accepting responsibility qualification performed by previous employer.

Maintaining Your Certification



Testing



5.1.12 Performance Criteria and Testing-Level 1 (Gases, Medical-Surgical Vacuum, and WAGD)

- 5.1.12.1 General

- 5.1.12.1.6 The inspection and testing reports shall be submitted directly to the party that contracted for the testing, who shall submit the report through channels to the responsible facility authority and any others that are required.
- 5.1.12.1.7 Report shall contain detailed listings of all findings and results.
- 5.1.12.1.9 All documentation pertaining to inspections and testing shall be maintained on-site within the facility

5.1.12 Performance Criteria and Testing-Level 1 (Gases, Medical-Surgical Vacuum, and WAGD)

- 5.1.12.1.10 Before piping systems are initially put into use, the facility authority shall be responsible for ascertaining that the gas delivered at the outlet/inlet is shown on the outlet/inlet label and that the proper connecting fittings are installed for the specific gas/vacuum service.
- 5.1.12.1.11 Acceptance of the verifier's report shall be permitted to satisfy the requirements in 5.1.12.1.10

5.1.12.2 Installer Performed Tests

- 5.1.12.2.1 General
 - 5.1.12.2.1.2 The test required by 5.1.12.2 shall be performed and documented *by the installer* prior to the test listed in 5.1.12.3 System Verification
- Initial Blow Down
- Initial Pressure Test
- Cross Connection Test
- Piping Purge Test
- Standing Pressure Test for Positive Pressure Medical Gas Piping
- Standing Pressure Test for Vacuum Systems.

Initial Blow Down 5.1.12.2.2.2

- Medical gas and vacuum distribution system blown clear with oil-free dry nitrogen.
- Done after installation of the distribution system.
- Prior to installation of system components

Initial Pressure Test 5.1.12.2.2.3

- After installation of the outlets/inlets
- Prior to installation of components that may be damaged by test.
- Source valve closed during test
- Test pressure for pressure gases 1.5 x working pressure but not less than 150 psi
- Test press for vacuum 60 psi
- Each joint check w/soapy water or other means that is safe to use with oxygen

Cross-Connection Test 5.1.12.2.4

- All piping systems reduced to atmospheric pressure.
- Gas sources shall be disconnected from all piping systems with the exception of the system being tested
- Oil Free Dry Nitrogen NF shall to be used to charge the system being tested to a gage pressure of 50 p.s.i.

Cross-Connection Test 5.1.12.2.4

- This test shall be conducted after the installation of individual faceplates, with the appropriate adapters.
- Each inlet/out shall be checked to check that gas is only being dispensed from the system being tested.
- The test shall be repeated for each installed medical gas & vacuum system.
- Proper labeling of inlets/outlets shall also be confirmed at this time.

5.1.12.2.6 Piping Purge Test

- Each outlet shall be purged to remove any particulate matter.
- Using appropriate adapters, each outlet purge with an intermittent high-volume flow of test gas, must show no discoloration in a clean white cloth.
- Purge started at the furthest point from the zone valve box.

5.1.12.2.6 Standing Pressure Test for Positive Pressure Medical Gas Piping

- Tests shall be conducted after the final installation of system components.
- Source valve closed during this test.
- Test 24 hours at 20% above normal system operating pressure with oil-free dry nitrogen NF.
- There shall be no change in the test pressure, other than that attributed to changes of ambient air temperature.

5.1.12.2.7 Standing Pressure Test for Vacuum Systems

- Test conducted after installation of all system components.
- Test press shall be 12in gage HV for 24 hours.
- Vacuum source of the test shall be disconnected from the system.
- There shall be no change in vacuum, other than that attributed to changes of ambient air temperature.

5.1.12.3 System Verification

- 5.1.12.3.1 General
- 5.1.12.3.2 Standing Pressure Tests
- 5.1.12.3.3 Cross-Connection Tests
- 5.1.12.3.4 Valve Test
- 5.1.12.3.5 Alarm Test
- 5.1.12.3.6 Piping Purge Test
- 5.1.12.3.7 Piping Particulate Test

5.1.12.3 System Verification

- 5.1.12.3.8 Piping Purity Test
- 5.1.12.3.9 Final Tie-In Test
- 5.1.12.3.10 Operational Pressure Test
- 5.1.12.3.11 Medical Gas Concentration Test
- 5.1.12.3.12 Medical Air Purity Test (Compressor System)
- 5.1.12.3.13 Labeling
- 5.1.12.3.14 Source Equipment Verification

Why we have redundant testing.



The following is a summarization of problem occurrences in medical gas systems during the testing of approximately 150,000 outlets.

1. 205 instances of wrong connections.
 - 16 Air to Vacuums
 - 10 Oxygen to Air
 - 8 Nitrogen to Oxygen
 - 47 Oxygen to Vacuums
 - 36 Oxygen to Nitrogen Oxide
 - 2 Nitrogen Oxide to Nitrogen
 - 2 Oxygen to Nitrogen
2. 104 installations Water in Air system.
 - 13 installations Water in Oxygen system
 - 3 installations Water in Nitrogen Oxide system
3. 580 instances of leakage in piping systems.
4. 87 instances of improperly wired alarm panels.
5. 120 instances of main intervals being plugged with solder or rubber disks.
6. 188 instances of improper delivery pressures for gases.
7. 223 instances in which the alarm panels had not been installed in accordance with JGFA 302.
8. 78 instances of systems contaminated with oil.
 - 10 Air systems
 - 12 Oxygen systems
 - 8 Nitrogen Oxide systems
9. 126 instances of improper installation of supply systems as defined in JGFA 302. A breakdown number of these discrepancies has been submitted with the Medical Air system.
10. 10 instances of Oxygen systems exhibiting undersizing of the control system at the bulk installation.

5.2 Level 2 Piped Gas and Vacuum Systems

Much of level 2's section require that they comply with their corresponding sections for level 1. There are exceptions in Medical Air systems, Medical-Surgical Vacuum systems, and Waste Anesthetic Gas Disposal systems. There are also exceptions for Warning Systems

5.3 Level 3 Pipe Gas & Vacuum Systems

Unlike level 2 systems level 3 has most of its own requirements. With level 1 and 2 systems we are dealing with the possibility of mortality or morbidity. Since level 3 does deal with neither of these, requirements are less stringent.

Credit where credit is due.

- Drawings from NFPA 99-C standards and from the United Association of Plumbers and Pipefitters instructors training manuals.
- Letters and forms from NITC and the United Association of Plumbers and Pipefitters instructor training manual.
