

Interpretation of the NFPA 99 Standard for Healthcare Facilities, 2002 Edition From Hill-Rom

**A Review of the Medical Gas and Vacuum Systems'
Requirement Changes in the NFPA 99 Standard from the
1999 Edition to the 2002 Edition.**

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Interpretation of the NFPA 99 Standard for Healthcare Facilities, 2002 Edition

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Introduction

The National Fire Protection Agency (NFPA) 99 Standard was conceived in 1987 by incorporating the NFPA 56F, *Standard for Nonflammable Medical Gas Systems* and the NFPA 56K, *Recommended Practices for Medical Surgical Vacuum Systems*. The written format that was used in the NFPA 99 Standard did not always interpret the standards clearly to meet the user's needs. To improve the usability of the standard, the NFPA documentation department required the 2002 edition of NFPA 99 Standard go through an extensive format style change by using the NFPA Manual of Style (MOS). This is the style used in similar NFPA documents and has provided the 2002 edition of NFPA 99 Standard with a more user friendly format and is more compatible with other international standards. In keeping with other international documents, the 2002 edition of NFPA 99 Standard has all measurements shown in metric first followed by English in parentheses.

The new format will also allow for easier updates after each proposal cycle.

NFPA 99 Standard Outline

By using the table of contents on page 99-9 of the NFPA 99 Standard, it is easy to understand how it is organized. There is no longer a separation of gas and vacuum requirements. Users of medical gas and vacuum pipeline systems will find the majority of information for these two requirements are chapter 5 instead of chapter 4. Before using chapter 5 to determine the required codes of a particular healthcare facility, the user should first determine the facility's category level by referring to the following chapters:

- **Chapter 13 (Hospital Requirements)**
- **Chapter 14 (Other Healthcare Facilities)**
- **Chapter 17 (Nursing Home Requirements)**
- **Chapter 18 (Limited Care Facility Requirements)**
- **Chapter 20 (Hyperbaric Facilities)**
- **Chapter 21 (Freestanding Birthing Centers)**

Pipeline requirements for laboratories are no longer part of "Gas and Vacuum Systems" (now chapter 5). Laboratory pipeline requirements were determined to be out of the scope of the Technical Committee on Medical Gas and Vacuum Pipelines. The limited information for this type of facility which was in chapter 4 of the NFPA 99 Standard, 1999 edition, is now in chapter 11.

Since chapters 1 through 21 must follow the NFPA Manual of Style (MOS) format, only drawings and tables meeting its requirements are included in these chapters. Annexes, located in the back of the NFPA 99 Standard, provide useful information such as, detailed central system drawings and requirement tables which refer to the appropriate sections in chapter 5. Many of the drawings were redone to provide clear, easy to follow information to the user.

Appendixes are absent in the 2002 edition. The Technical Committee on Medical Gas and Vacuum Pipelines voted against including the appendixes beginning with this edition for the main reason that much of the material was outdated and there are better resources with more updated material available to the user.

Annex A (Explanatory Material)

Provides explanatory material such as, the intent of requirements, definitions, terminology, tables, graphs, drawings, and formulas. The materials in this annex are numbered to correspond with the requirements as stated in each paragraph of chapters 1 through 21.

Annex B (Nature of Hazards)

Provides information about the types of hazards associated with equipment and systems which are used in healthcare facilities. Go to B.2 in the NFPA 99 Standard, 2002 edition, for Gas and Vacuum System Hazards.

Annex C (Additional Explanatory Notes for Chapters 1 through 20)

Provides recommended procedures for conducting the medical pipeline system verification testing (initial pipeline testing), maintenance schedules & procedures, safety precautions, definitions, and the proper handling of equipment and systems used in healthcare facilities. This annex also provides steps to handle hazards and crises.

Annexes D and E

Annexes D and E are not used in medical pipeline systems and are not discussed in this booklet.

Using this Booklet

This booklet covers all of the requirement changes that the author has observed in the 2002 edition of the NFPA 99 Standard. Changes are shown in this booklet in the sequence that they are placed within the NFPA 99 Standard. Starting with new definitions in chapter 3 and ending with the requirement changes for Level 3 medical pipeline systems in chapter 5.

NFPA 99 Standard Update

Definitions of Levels (Chapter 3 of the NFPA 99 Standard, 2002 Edition)

Users of this booklet are encouraged to look through the definitions to gain a better understanding of the terms used throughout this booklet and the NFPA 99 Standard.

Since the publication of the 1996 edition of NFPA 99 Standard, many of the committee members have been bombarded with the same question from individuals who are involved in almost every aspect of medical gas and vacuum pipeline system installations. That question being, “What criteria makes a facility a certain level?” The 2002 edition provides well-defined definitions for Level 1, Level 2, and Level 3 types of healthcare facilities for medical pipelines.

NOTE:

Level 4 (laboratories) no longer exists with medical gas and vacuum systems. All of the piping requirements for laboratories are included in chapter 11.

3.3.90 Level 1 Medical Gas and Vacuum Systems

If interruption of the facility’s medical pipeline gas supply will cause a patient’s life to be in immediate danger, then this facility should be considered a Level 1. Examples of such a facility would be a hospital where very complicated procedures would not permit quick termination and convalescing facilities where patients are connected to life support equipment.

3.3.92 Level 2 Medical Gas and Vacuum Systems

If interruption of the facility’s medical pipeline gas supply will only cause the immediate halt and rescheduling of any surgery without putting the patient’s life in immediate danger, then this facility should be considered a Level 2. This type of facility would be considered a routine day or ambulatory surgery center.

3.3.95 Level 3 Piped Gas System

If interruption of the facility’s medical pipeline gas supply will only cause the immediate halt and postponement of any procedure with no danger to the patient, then this facility should be considered a Level 3. Among the facilities that would be included in this level are dental offices and health clinics.

Gas and Vacuum Systems (Chapter 5 of the NFPA 99 Standard, 2002 Edition)

5.1.3 Level 1 Sources

5.1.3.1 Central Supply Systems Definition

Central Supply Systems, known in earlier editions as Gas Central Supply Systems, is a broader term as used in the 2002 edition. Now it is defined as any system that produces or supplies medical gases or vacuum to the medical pipeline distribution system of a healthcare facility.

NOTE:

Central Supply Systems include medical and instrument air compressor systems along with vacuum systems.

5.1.3.4 Central Supply Systems as defined from the 2002 edition of NFPA 99 Standard are the following:

- Cylinder manifold for gas cylinders according to 5.1.3.4.9
- Manifolds for cryogenic liquid cylinders according to 5.1.3.4.10
- Bulk cryogenic liquid systems according to 5.1.3.4.11
- Medical air compressor systems according to 5.1.3.5
- Medical-surgical vacuum producers according to 5.1.3.6
- Waste Anesthetic Gas Disposal (WAGD) producers according to 5.1.3.7
- Instrument air compressor systems according to 5.1.3.8

5.1.3.3.1.1 Central Supply Systems permitted in the same outdoor enclosure include the following:

- Manifolds for gas cylinders without reserve supply
- Manifolds for gas cylinders with reserve supply
- Manifolds for cryogenic liquid cylinders
- Bulk cryogenic liquid systems

5.1.3.3.1.2 Central Supply Systems permitted in the same indoor enclosure include the following:

- Manifolds for gas cylinders without reserve supply
- Manifolds for gas cylinders with reserve supply
- Manifolds for cryogenic liquid cylinders
- In-building Emergency Reserve
- Instrument air standby headers

5.1.3.3.1.3 Central Supply Systems permitted to be in the same room with each other and with other facility equipment (for example, chillers, boilers, and HVAC equipment) are the following:

- Medical air compressor supply sources
- Medical-surgical vacuum sources
- WAGD sources
- Instrument air sources

5.1.3.4.1 New Requirements for Obtaining Central Supply Systems

This requirement is intended to prevent individuals not familiar with Central Supply Systems' operation or construction from assembling them in an uncontrolled environment using off-the-shelf parts and components.

Knowledgeable manufacturers of Central Supply Systems are able to provide detailed installation instructions needed by the installer to properly install these products along with support personnel to provide answers to any question related to system installation or operation.

Manifolds (Requirements for Cylinders and System Location)

Proper cylinder care has been greatly emphasized in the 2002 edition. New requirements for the room location of manifold systems and increased cylinder safety information are also noted in this section. Some of the changes the user should note are described in the following paragraphs.

5.1.3.1.3 Cylinders and Their Contents Must be Verified Before Patient Use

The cylinders of medical gases and their contents must be verified before use. The supplier of the cylinders should be able to provide the necessary documents indicating the cylinders and their contents have been verified. This requirement does not mean the user will need to invest in expensive equipment to perform the same tests the supplier conducts at their facility.

5.1.3.1.4 Door Labeling for Gas Systems Other than Oxygen and Medical Air

Indoor locations containing medical gases, other than oxygen or medical air, are required to have a label placed on the outside of the systems' room door that reads similar to the following:

CAUTION:
Medical Gases
NO Smoking or Open Flame
Room May Have Insufficient Oxygen
Open Door and Allow Room to Ventilate before Entering

5.1.3.1.5 Door labeling for Oxygen and Medical Air Systems

Indoor locations containing oxygen or medical air are required to have a label placed on the outside of the systems' room door that reads similar to the following:

**CAUTION:
Medical Gases
NO Smoking or Open Flame**

5.1.3.2.1 Use of Adapter or Conversion Fittings is Prohibited

The use of adapters to convert one gas-specific fitting to another has never been a safe practice. It only made common sense to prohibit their use within healthcare facilities to improve patient safety. The real danger of these adapters was taken very seriously by the NFPA 99 Standard Technical Committee during the last proposal cycle.

5.1.3.2.9 Filling of Empty Cylinders from the Facility's Supply Prohibited

This requirement is intended to prevent the user from filling empty cryogenic cylinders with cylinders intended for patient use via the facility's medical gas pipeline. It does not prevent anyone from ordering cryogenic cylinders for applications not related to the medical pipelines.

5.1.3.3.1.5 Manifold Systems and Cylinder Storage Areas Must Have Easy Access

Providing safe and easy access to where gas cylinders are used or stored is now mandatory and must be considered whenever a medical gas manifold is going to be installed or when it is moved to another location.

5.1.3.3.1.8 Minimum Exposed Temperatures for N₂O and CO₂ manifolds

To prevent the possibility of low operating pressures caused by extremely low cylinder temperatures, the Technical Committee agreed on a minimum temperature of -7°C (20°F) for cylinders connected to N₂O and CO₂ high-pressure gas manifolds.

5.1.3.3.2 New Requirements for Gas Cylinder Handling

Two additional requirements for handling gas cylinders were added. They are the following:

- (1) Locations of manifolds and cylinder storage areas must be constructed to allow enough room for cylinders and equipment to be moved in and out.
- (7) All cylinders must be secured individually with racks, chains, or other fastenings.

5.1.3.3.3.1 Requirements for Ventilation of Central Supply Systems in Indoor Locations

Ventilation requirements for manifolds located indoors have greatly increased and are now easier to understand. The new requirements for these systems are the following:

- (A) Manifolds located indoors must have all of their relief valves vented to outside of the facility as stated in 5.1.3.4.5.1 (5) through (9).
- (B) When the total volume of all of the gases stored or in use within an indoor enclosure exceeds 85 cu. m (3000 cu. ft), the enclosure is required to include a dedicated mechanical ventilation system which will draw air from within 30.5 cm (1') of the floor. There is no reference to the amount of flow or the location of the room register connected to the mechanical ventilation system.
- (C) The dedicated mechanical ventilation system must be connected to the healthcare facility's essential electrical system.
- (D) Indoor enclosures containing less than 85 cu. m (3000 cu. ft) of stored or in use gases are permitted to use natural ventilation. There must be two ventilation openings, one located within 30.5 cm (1') of the floor and one within 30.5 cm (1') of the ceiling. Both must have a minimum of 6.7 sq. m (72 sq. in) of free area.
- (G) When natural ventilation cannot be provided, mechanical ventilation must be used.

5.1.3.3.3.3 Requirements for Ventilation of Central Supply Systems in Outdoor Locations

Ventilation requirements for medical gas manifold systems located outdoors are now part of the NFPA 99 Standard. The new requirement addresses the Technical Committee's concerns of possible gas buildup within an enclosure surrounded by solid walls. The new requirements provide specifications for openings at the base of each wall when the walls of the enclosure are solid and completely surround the medical gas manifold system. The new requirements provide no guidance as to the size of the openings, only that the openings provide good air circulation.

5.1.3.4.3 Requirements for Materials used in Central Supply Systems

This section provides manufacturing guidance for the materials used in the construction of Central Supply Systems. Greater concern regarding the possibility of fire when parts of the oxygen manifold or the interconnecting flexible hoses used to connect the manifold to high-pressure cylinders are subjected to rapid, high-pressure, oxygen compression is addressed within this section.

5.1.3.4.4.2 Requirements for Materials used in Central Supply Systems

All Central Supply regulators are required to have a pressure indicator mounted to the piping immediately downstream of the regulator or downstream of its isolation valve. Most manufacturers already supply these pressure indicators (pressure gauges) to provide a means for ensuring proper adjustments to each of the Central Supply System's regulators.

5.1.3.4.5.1 Material Requirements Vent-to-Outside Piping

Vent-to-outside piping for relief valves must be cleaned for oxygen use as stated in 5.1.10.1. Since it will be exposed to the outside air once installed, it is not clear how this line will stay clean when the manifold is in use. It is not recommended to use plastic caps or check valves at the discharge end of the vent line to keep the line clean since they can cause restriction of flow.

5.1.3.4.5.2 Additional Relief Valve Requirements for Central Supply Systems

Additional requirements, covering the proper outdoor venting of relief valves are included within this section. The additional requirements are as follows:

- (7) A common vent line's diameter must be large enough to accommodate the discharge from all relief valves connected to the same vent line at the same time.
- (8) The final vent line discharge located outside, must be located away from any flammable material and must not expose anyone who may be passing by to discharged gases.
- (9) The vent line discharge must be turned face down and screened.

5.1.3.4.6 Requirements for Central Supply Systems with Multiple Pressures

This requirement addresses the need for some facilities, when using a Central Supply System to provide for more than one medical gas application. For example, when a bulk oxygen is used to supply both standard patient respiratory needs and the needs of a hyperbaric chamber. The dual role of this system requires each pipeline system to be fed by their own duplexed banks of final line regulators as stated in 5.1.3.4.4 and both pipelines downstream of the final line regulators must meet the requirements as stated in 5.1.3.4.

Local Alarm Signals

It is now required to have visual indicators as a local alarm when certain pre-determined conditions occur on any level 1 facility's medical gas manifolds, bulk systems, in-building emergency reserves, or remote cylinder headers.

5.1.3.4.7.2 Local Signal Requirements

The local signals must meet the following requirements:

1. Provide visual indication of alarm signals (only)
2. Be labeled for the type of service and condition being monitored
3. Be installed according to the manufacturer's specifications

Headers

Headers used on Central Supply Systems can be either gas or liquid types. They are permitted to be used for providing the following:

1. The primary and secondary supply to the gas manifold
2. The high-pressure reserve supply for a cryogenic liquid cylinder manifold
3. The secondary supply to a liquid bulk system
4. A substitute for the emergency oxygen supply connection
5. The backup supply for simplex instrument air systems

5.1.3.4.8 Requirements for Headers

Most of the requirements for headers are not new. The term "Headers" is applied in multiple source equipment applications and has come into its own using both new and old requirements such as the following:

- (1) There must be an appropriate number of cylinder connections on each header to permit the required header storage capacity for the intended application.
- (2) Cylinder leads for each cylinder must meet the requirements of 5.1.3.4.3 and have permanently attached Compressed Gas Association (CGA) connectors on the ends of each lead fitting.
- (3) Filters must be installed before any regulator to prevent debris from entering other system components. The filter is not necessarily a separate component, most regulator manufacturers install these filters into the regulator's "IN" ports.
- (4) There must be a shutoff valve located between the point where the header connects to the Central Supply System and the first cylinder connection.
- (5) There must be an indicator which shows the header's contents. On cryogenic liquid cylinders, this indicator is the liquid content gauge.
- (6) There must be a check valve to allow servicing and prevent back-flow.
- (9) When a header is used with cryogenic liquid cylinders, it must be equipped with a relief valve where all cylinder outputs are manifolded together.

Manifolds (Gas Cylinders without Reserve Supply)

5.1.3.4.9.1 (1) Manifold Location Requirements

Gas manifold locations must comply with the same distance requirements to adjacent buildings as bulk oxygen systems. Use Table A-22 in the NFPA 50 Standard for complete information and requirements.

5.1.3.4.9.4 (2) Requirements Intermediate Relief Valves Venting Intermediate Relief Valves

It is now not only required for the final line relief valve to be vented outside of the facility, but all relief valves located between the output of the intermediate regulators and the inputs of the final line delivery regulators must be vented outside as well.

5.1.3.4.9.5 (1) Requirement for Both Primary or Secondary Supplies to Have Dual Roles

Manufacturers of medical manifolds have known for years the importance of providing this feature into their manifolds. The technical committee agreed about the real danger of the secondary supply being depleted to a dangerous level if the operator forgets to replace the depleted cylinders. This requirement provides better assurance of a full secondary supply

5.1.3.4.9.6 Local Alarm and Master Alarm Requirements

Manifolds for gas cylinders without a reserve supply are required to activate a local alarm signal and the appropriate master alarm signals when either the secondary header starts to supply the systems or at a predetermined point.

Manifolds (Cryogenic Liquid Cylinders)

5.1.3.4.10.1 (1) Manifold Location Requirements

Liquid manifold locations must comply to the same distance requirements to adjacent buildings as bulk oxygen systems. Use Table A-22 in NFPA 50 for complete information and requirements.

5.1.3.4.10.3 Reserve Header Located in Remote Enclosures

It is permitted to locate the high-pressure reserve-supply header in another remote enclosure away from the system's primary and secondary headers, as long as the enclosure meets the requirements stated in 5.1.3.4.10.1.

5.1.3.4.10.4 (1) Misprint for Minimum Liquid Cylinders on Each Header

This requirement is intended to ensure each header has the appropriate number of liquid cylinders to provide at least an average day's supply. The minimum requirement of no less than two cylinders is true only on the primary and secondary headers for manifolds using high-pressure cylinders. For cryogenic liquid systems, this might mean only one liquid cylinder not two.

5.1.3.4.10.4 (3) Header Relief Valve Requirement

A relief valve is required to be located between the system's connection to the reserve supply header and the inlet of the final line pressure regulator. If the valve is located indoors, it must comply with 5.1.3.3.3.1 (A), which states that all relief valves located on indoor supply systems must be vented outside of the facility.

5.1.3.4.10.5(1) Requirement for Both Primary or Secondary Supplies to Have Dual Roles

This is the same requirement as stated for the high-pressure manifolds, although manufacturers of medical manifolds have known the importance of this feature for years, manifolds were never required to provide the ability for allowing the primary side to become the secondary and secondary to become the primary until this edition.

5.1.3.4.10.5 (2) Requirement Prohibiting the Secondary Header from Supplying the System

This requirement does not prevent the secondary supply from discharging the excessive pressure, which builds up inside a cryogenic liquid manifold, into the system. This ability is not only permitted, but required under 5.3.4.10.6

5.1.3.4.10.9 Local Alarm and Master Alarm Requirements

Manifolds for cryogenic liquid cylinders with reserve supply are required to activate a local signal and the appropriate master alarm signals:

1. When the secondary header starts to supply the systems or at a predetermined setpoint—changeover.
2. When the reserve header starts to supply the systems or at a predetermined setpoint—reserve in use.
3. When the reserve header supply falls to one average day's supply or at a predetermined setpoint—reserve low.

Bulk Cryogenic Liquid Systems

5.1.3.4.11.1 Bulk System Location Requirements

Pad locations and preparations for bulk systems must still comply with the requirements stated in NFPA 50 but must also comply with NFPA 99 Standard sections 5.1.3.3.2 (1), (2), (3), (5), (8), (9), and 5.1.3.3.3.

5.1.3.4.11.2 Other Bulk Systems Location Requirements

Requirements listed in (A) through (F) of this section, refer to the NFPA 50 location requirements and also provide NFPA 99 Standard requirements for mounting the bulk system such as: enclosure requirements, delivery-vehicle connection location requirements, and pad drainage requirements.

5.1.3.4.11.6 Local Alarm and Master Alarm Requirements

Bulk liquid systems are required to activate a local signal and the appropriate master alarm signals:

1. When the main supply reaches an average day's supply or at a predetermined setpoint—low contents.
2. When the reserve supply starts supplying the system or at a predetermined setpoint—reserve in use.
3. When the reserve supply reaches an average day's supply or at a predetermined setpoint—reserve low.
4. The reserve supply (if cryogenic liquid) operating pressure falls too low to operate the reserve supply properly or at a predetermined setpoint—reserve failure.
5. When a second main supply vessel begins to supply the system or at a predetermined setpoint—changeover.

Emergency Oxygen Supply Connection (EOSC)

5.1.3.4.12 Emergency Oxygen Supply Connection (EOSC)

EOSC provides a temporary connection using a temporary auxiliary source. An EOSC or In-Building Emergency Reserve must be installed whenever one of the following is true:

1. A bulk cryogenic liquid oxygen system is located outside of or in a remote location from the building it serves.
2. When a facility being served by a bulk oxygen system does not have an oxygen reserve connected to the facility's main oxygen supply line that is capable of supplying the facility with at least one average day's supply.
3. When there are multiple buildings being served from the same bulk oxygen system, each building is now required to have an EOSC mounted on the outside wall in the same proximity where the oxygen line first enters.

5.1.3.4.12.2 (2) Required EOSC Inlet Pipe Size

The abbreviations shown under this section for the required pipe size have nothing to do with what type of pipe thread is required at the female connection. The metric term Diameter Nominal (DN) refers to the inside diameter of a pipe measured in millimeters. This conforms to the International Standards Organization norm. The American standard Nominal Pipe Size (NPS) provides the pipe's inside diameter measurement in inches. For common equivalent pipe sizes in both millimeters and inches, use table 1 on page 13 of this booklet.

Table 1. Common Equivalent Pipe Sizes

Nominal Pipe Size	Diameter Nominal	Nominal Pipe Size	Diameter Nominal
1/8"	6 mm	1 ¼"	32 mm
3/16"	7 mm	1 ½"	40 mm
¼"	8 mm	2"	50 mm
3/8"	10 mm	2 ½"	65 mm
½"	15 mm	3"	80 mm
5/8"	18 mm	3 ½"	90 mm
¾"	20 mm	4"	100 mm
1"	25 mm	4 ½"	115 mm

5.1.3.4.12.2 EOSC's Relief Valve Venting Requirement

Although it is not stated in this section, relief valves connected to the EOSCs located indoors, must be vented outside in accordance with 5.1.3.3.3 (A).

In-Building Emergency Reserves

5.1.3.4.13.1 Definition and Purpose

This emergency reserve is to be used as a substitute for the EOSC, but not as a replacement for the bulk oxygen central system's reserve.

5.1.3.4.13.2 Location Requirements

The intent of this section is to allow a means for delivering emergency oxygen into the medical pipeline distribution system from within the facility in the event that the bulk oxygen system supply is disrupted.

This new section falls short of making it perfectly clear to the user of the NFPA 99 Standard that this reserve can only be located within the facility it services. When an In-Building Emergency Reserve supply is installed, it must meet the construction and ventilation requirements as stated in sections 5.1.3.3.2 and 5.1.3.3.3.

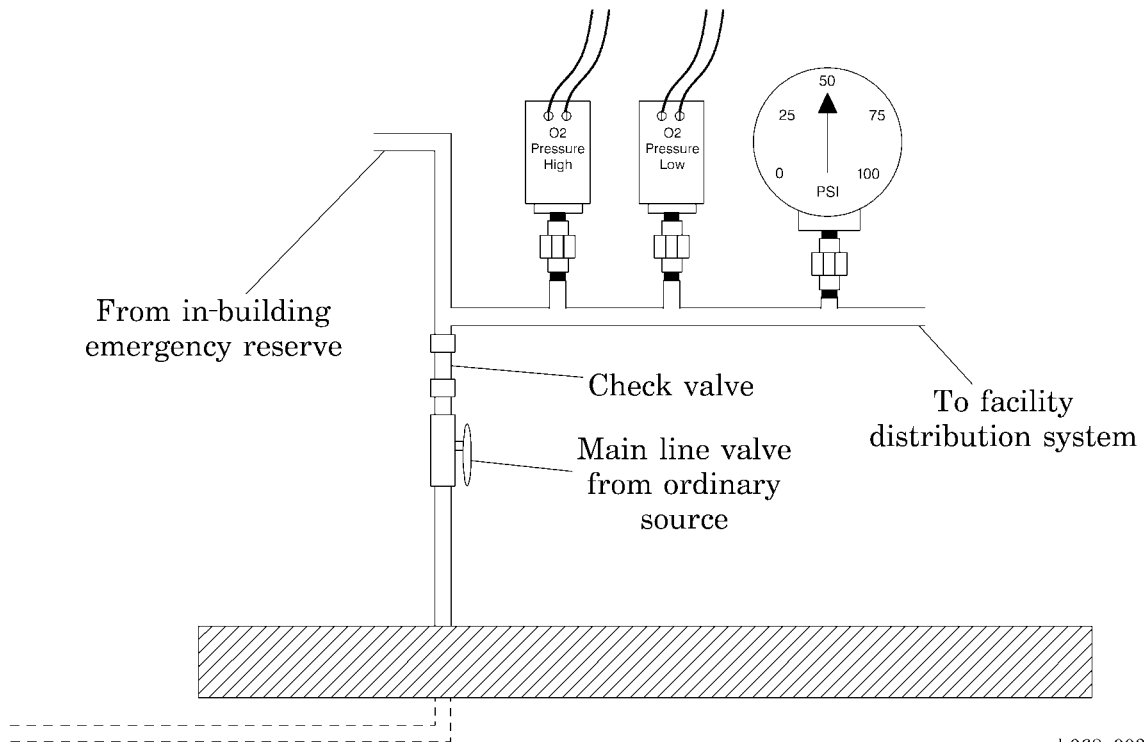
5.1.3.4.11.6 Component Requirements

The emergency reserve supply can be either a header as defined in paragraph 5.1.3.4.8 or a manifold for gas cylinders without reserve supply as defined in paragraph 5.1.3.4.9.

5.1.3.4.11.7 Check Valve Requirement

This requirement is no different than if an EOSC was used. To prevent the emergency reserve supply from flowing towards the main system, a check valve installed downstream of the main line shutoff valve is required (see figure 1 on page 14).

Figure 1. Check Valve Requirement



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5.1.3.4.11.8 Local Alarm and Master Alarm Requirements

A signal must actuate a local alarm signal and the appropriate master alarm signals when the emergency supply begins supplying the system or at a predetermined setpoint.

Medical Air Systems

Medical air systems are a type of Central Supply System providing United States Pharmacopoeia (USP) quality air into the medical air pipeline distribution system. Manifold type systems supply air to the distribution system by using either high-pressure cylinders or a bulk container (provided by a supplier) to feed into a medical gas manifold. The supplier is responsible for providing USP quality medical air inside the high-pressure liquid cylinders or bulk container.

Another method of providing medical air into the medical pipeline is to manufacture it at the facility. A medical compressed air system is the usual method used to manufacture medical air at the healthcare facility. However, another possible manufacturing method, which was not mentioned in older NFPA 99 Standard editions, allows mixing of medical oxygen with oil-free, dry nitrogen National Formulary (NF) to create medical air.

The 2002 edition of the NFPA 99 Standard, provides no guidelines for the required essential monitors or safeguards needed to prevent O₂/N₂ blenders of medical air from passing its product into the medical air pipeline in the event that the blender produces medical air at oxygen levels outside the USP requirements of 19.5% and 23.5%.

The 2002 edition provides allowances for medical air to not only to be used for patient respiratory applications, but also for calibrating respiratory medical devices. All of the other requirements for medical air quality remain the same as in the 1999 edition.

Medical Air Compressor Sources

5.1.3.5.3.1 Location Requirements

It is of interest to note that NFPA 99 Standard now requires medical air compressor systems be located indoors. The intent of this requirement is to ensure the air compressor system is sheltered from the weather and temperature extremes. Use the NFPA 99 Standard requirements for room construction 5.1.3.3.2 and ventilation 5.1.3.3.3.2 along with the manufacturer's installation requirements when choosing a proper location for a medical air compressor system. This requirement does not mean a medical air compressor system cannot be located under a protective shelter as long as the shelter conforms to the requirements as stated in 5.1.3.3.2 and 5.1.3.3.3.2. The ambient temperature range requirements for air-cooled equipment is also stressed within this section.

5.1.3.5.3.2 Systems Requirements

Most component requirements for the medical air compressor systems have not changed from the 1999 edition. However, there is one new system requirement which deserves mentioning. Paragraph 6 of this section, requiring any system piping between the compressor and its source valve to be oxygen capable and cleaned for oxygen use is actually less stringent than the system's piping requirements stated in the 1999 edition, which stated all piping of the medical air compressor system meet the same standards as the rest of the medical air pipeline distribution system.

5.1.3.5.7 Medical Air Dryers

The new requirement stating that air dryers must be designed to provide air at the maximum dewpoint of 0°C (32°F), was not intended to eliminate refrigerant dryers. The Technical Committee's desire was to provide a good buffer between the medical air compressor system's operating dewpoint and the high dewpoint alarm of 4°C (39°F). Refrigerant dryers are capable of drying air even lower than the 0°C (32°F) dewpoint by drying the air at 690 kPa (100 psi) and then expanding it to 345 kPa (50 psi). This expands the water molecules making them less dense, which drops the dewpoint temperature to the required level (see table 2 on page 16).

Table 2. Dewpoint Temperature Conversion at 690 kPa and 345 kPa (100 psi and 50 psi)

Dewpoint at 690 kPa (100 psi)	Dewpoint at 345 kPa (50 psi)	Dewpoint at 690 kPa (100 psi)	Dewpoint at 345 kPa (50 psi)
33°F	16.4°F	0.6°C	-8.7°C
34°F	17.3°F	1.1°C	-8.2°C
35°F	18.2°F	1.7°C	-7.7°C
36°F	19.2°F	2.2°C	-7.1°C
37°F	20.1°F	2.8°C	-6.6°C
38°F	21°F	3.3°C	-6.1°C
39°F	22°F	3.9°C	-5.6°C
40°F	22.9°F	4.4°C	-5.1°C
41°F	23.8°F	5.0°C	-4.6°C
42°F	24.7°F	5.6°C	-4.1°C
43°F	25.6°F	6.1°C	-3.6°C
44°F	26.6°F	6.7°C	-3.0°C
45°F	27.5°F	7.2°C	-2.5°C
46°F	28.4°F	7.8°C	-2.0°C
47°F	29.3°F	8.3°C	-1.5°C
48°F	30.3°F	8.9°C	-0.9°C
49°F	31.2°F	9.5°C	-0.4°C

Simply by changing the arrangement of the refrigerant dryer location in comparison to the other components in the system, a dewpoint temperature significantly below 0°C @ 345 kpa (32°F @ 50 psi) is possible at any flow demand a healthcare facility dictates.

5.1.3.5.11 Requirements for Component Arrangement and Redundancies

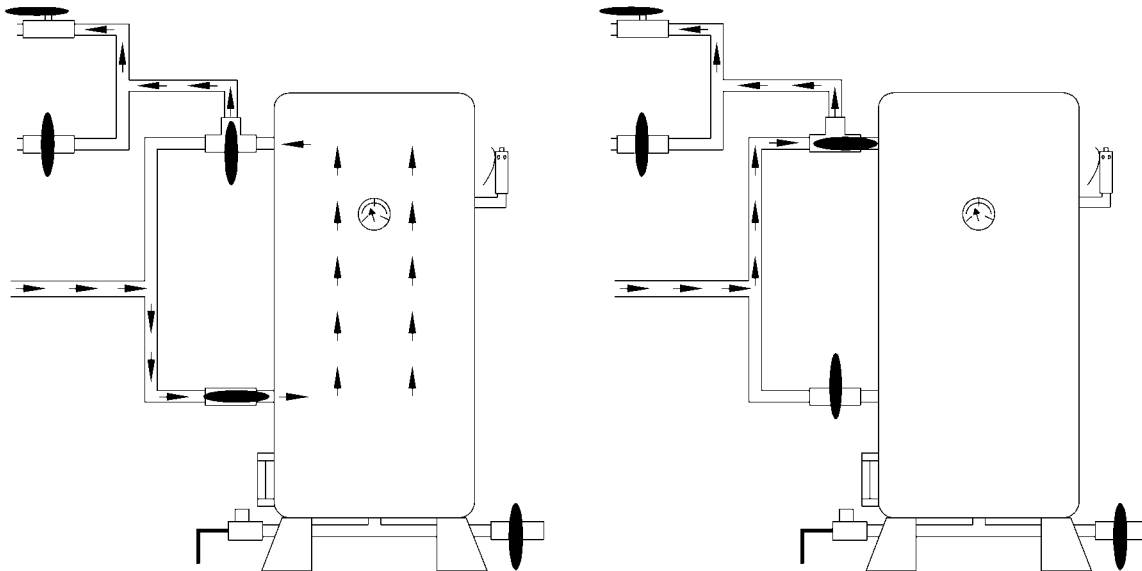
The main intent of this section, which clears up many questions, allows the components of the system to be arranged in whatever configuration the manufacturer prefers as long as it permits continuous supply during servicing. At first glance this section makes perfectly good sense, but it also limits the types of components that could be used on the system when the backup component does not have the same equal performance as the primary. For example, if the primary dryer is a desiccant dryer, a refrigerant dryer would not be allowed to be used as the backup.

5.1.3.5.11.4 Three-Valve Bypass Required for Receivers

Three-port valves are actually two valves in one. This fact allows the use of one three-port valve and one two-port valve to meet the requirements for a three-valve-bypass on medical air system receivers.

The drawing below indicates how the use of one three-port valve and one two-port valve provide proper isolation of the receiver, yet still provide continuous flow for uninterrupted service to the facility (see figure 2 below).

Figure 2. Normal and By-Pass Flow Diagrams

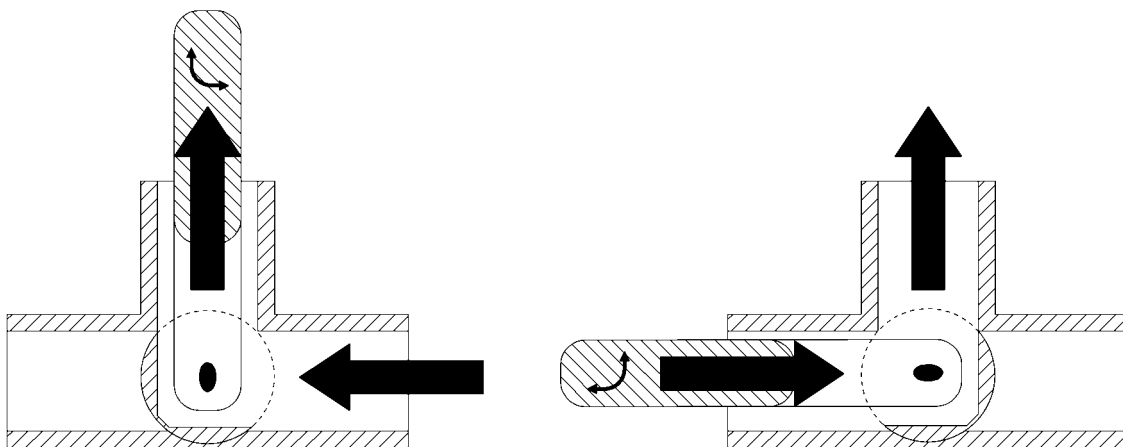


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5.1.3.5.11.7 Three-Way Valves

The term “three-way valve” is not an accurate description of how this valve operates. Since the valve has a common and two other ports, a more descriptive name should be “three-port valve” or “two-way valve.” Flow can only go in or out either one of two ways making this type of valve two valves within one assembly (see figure 3 on page 18 of this booklet). This edition allows the use of two full-port three-way valves to be used instead of four two-port valves.

Figure 3. Three-Way Valve Operation



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5.1.3.5.11.13 Medical Air Piping Systems at Different Operating Pressures

Medical air piping systems operating at different pressures are allowed to use the same compressor system. Their split must be placed after the final filters, but before the final line regulators. Both systems must have their own dual line regulator banks, dewpoint monitors, and carbon monoxide monitors.

5.1.3.5.14 Local Alarm Requirements

Depending on whether the medical air compressor is a liquid-ring, oil-free lubricated, or oil-less type of compressor, certain alarms and indicators are required. Although there have not been any major changes in these requirements from the 1999 edition, you might want to refer to table 3 on page 19 of this booklet before installing a system or performing a system verification.

Table 3. Local Alarm Requirements

Condition	Type of Compressor System	Requirement
High water level in receiver	Liquid-ring and compressors that use water-cooled heads or water-cooled after-coolers	Activate the appropriate signal at the local alarm and shutdown the system.
High water level in separator	Liquid-ring systems	Activate the appropriate signal at the local alarm and shutdown the faulty compressor.
High exhaust temperature	Oil-free lubricated or oil-less compressor systems	Activate the appropriate signal at the local alarm and shutdown the faulty compressor.
Backup compressor running	All compressor systems	Activate the appropriate signal at the local alarm.
Coalescing filter element change	Oil-free lubricated w/separation compressor systems	Visual indicator monitored continuously.
Charcoal filter with colorimetric hydrocarbon indicator	Oil-free lubricated w/separation compressor systems	Visual indicator monitored continuously.
Liquid hydrocarbon indicator	Oil-free lubricated w/separation compressor systems	Visual indicator monitored continuously.
Gaseous hydrocarbon indicator	Oil-free lubricated w/separation compressor systems	Visual indicator monitored quarterly.

5.1.3.5.15 Medical Air Quality Monitor, Dewpoint and Carbon Monoxide (CO)

All medical compressed air systems are required to provide continuous readings of dewpoint and carbon monoxide (CO). The dewpoint and CO monitors are required to activate a signal at a local alarm when either the dewpoint exceeds 4°C (39°F) or the CO level becomes higher than 10 ppm (see table 4 on page 20 of this booklet). Many monitors provide the necessary functions for them to be considered a local alarm. However, if the monitor is lacking any of the required alarm functions listed under (5.1.9.1), it will be necessary to connect the signal to an independent local alarm panel located within the equipment room where the compressor is installed.

Table 4. Air Quality Alarm Conditions

Condition	Requirement
Dewpoint high (greater than 4°C (39°F))	Activate a signal at the local alarm and both master alarms.
Carbon monoxide high (greater than 10 ppm)	Activate a signal at the local alarm.

Medical-Surgical Vacuum Supply Systems

5.1.3.6.1.1 Location Requirements

Medical-surgical vacuum systems' locations must meet the same requirements as the medical air compressor system. Room construction (5.1.3.3.2) and ventilation (5.3.3.3.2) requirements must be followed. Ambient air temperature ranges must comply with the manufacturer's specifications.

5.1.3.6.1.2 (5) Piping Materials used within Vacuum Systems

No major changes with piping materials except stainless steel piping may be used.

5.1.3.6.3 Vacuum Receiver Requirements

This section provides greater detail about the requirements for vacuum receivers than in previous editions. Manufacturers will find better guidance as far as types of receivers allowed and their required components.

5.1.3.6.5.1 (3) Extra Components Allowed on the Receiver's Laboratory Connection

This edition provides allowances for a scrubber to be installed between the laboratory connection's fluid-drain and isolation-valve located at the medical-surgical vacuum system's receiver.

5.1.3.6.7.2 Requirements for Vacuum Systems' Exhaust

The definitions for the required placement of the exhaust of a medical-surgical vacuum system is better explained within this section of the 2002 edition. There is now a minimum distance requirement from the vacuum exhaust to any building opening (for example, doors and windows). It is also important for the installer to check on other conditions, such as prevailing winds, when determining the correct location for any medical vacuum exhaust.

5.1.3.6.8 Alarm Requirements

A surgical-vacuum producer must activate the appropriate signal at the local alarm when the backup or lag producer is required to run for the system to maintain its operating pressure.

Waste Anesthetic Gas Disposal (WAGD)

5.1.3.7.1.1 Permitted WAGD Producers

Once the number and placement of WAGD terminals is determined, the designer of the WAGD system has several types of WAGD producers to select from, including the following:

1. The most common producer used for creating WAGD vacuum, the surgical-vacuum system
2. Dedicated WAGD producers, which are becoming more popular, but they must meet more stringent requirements
3. Venturi systems using instrument air or another type of inert gas, but not medical air

5.1.3.7.1.2 WAGD using Surgical-Vacuum as the Source

When the surgical-vacuum source is used as the WAGD producer, it is required for the designer to ensure that gases from WAGD applications are diluted below the lower flammability limit of the surgical-vacuum pump's components. The potential danger being if the oxygen level should increase to a level which would cause flammable substances like vacuum pump lubricating oil to have an even lower flash point.

Another factor that needs to be considered is the extra flow demand requirements from the WAGD when it becomes part of the overall vacuum flow requirement on any surgical-vacuum source supply.

5.1.3.7.1.3 Dedicated WAGD System Location Requirements

Just like all of the other mechanical source equipment, a dedicated WAGD system must be placed in a room meeting all requirements for room construction (5.1.3.3.2) and ventilation (5.1.3.3.2). Ambient air temperature ranges must comply with the manufacturer's specifications.

5.1.3.7.1.6 WAGD using a Venturi as the Source

There are several new and important requirements for venturi driven WAGD producers.

1. The venturi must use a special tool to prevent users, who are unfamiliar with its operation, to make adjustments.
2. The venturi can use instrument air or another type of inert gas to produce vacuum.
3. Medical air cannot be used to drive the venturi.

5.1.3.7.3.1 Local Alarm Requirement

A dedicated WAGD producer must activate a local alarm when the backup or lag producer is required to run for the system to maintain proper operation.

Instrument Air Supply Systems

5.1.3.8.1 Instrument Air Quality Requirements

Instrument air is a new system defined in the 2002 edition of the NFPA 99 Standard. Instrument air can be used for any application providing patient support such as: a substitute for oil-free dry nitrogen NF for pneumatic tools or to provide pneumatic power for ceiling booms and pendants. It cannot be used as a substitute for medical air.

Although a great deal of thought went into developing the requirements and quality of instrument air, no one has been able to provide any guidance as to the correct gas-specific adapter that should be used. What NFPA99 does provide are the requirements for the quality of instrument air at the user end. They are the following:

- Meet ANSI/ISA S-7.0.01 1996 instrument air requirements
- Filtered to within 0.01 micron
- Free of any liquids such as water, hydrocarbons and solvents
- Free of hydrocarbon vapor
- Maintain a dewpoint level of -40°C (-40°F)

5.1.3.8.2.2 Location Requirements

Instrument air must meet the same location requirements as other mechanical source equipment. Use room construction (5.1.3.3.20 and ventilation (5.1.3.3.3.2) requirements when installing this type of equipment. Ambient air temperature ranges must comply with the manufacturer's specifications.

5.1.3.8.3 System Requirements

Instrument air systems must produce air pressure greater than 2068 kPa (200 psi) at its output. The source must be either duplex or simplex with a standby header complying with 5.1.3.8.4.

5.1.3.8.4 Compressor Requirements

Most oil-less reciprocating compressors are not able to achieve pressures greater than 1034 kPa (150 psi); this limitation keeps these types of compressors from being used in instrument air applications. NFPA 99 Standard does not state what types of compressors are allowed to be used for this purpose, only what the final air quality is required to be. The lack of compressor requirements allows the use of oil-lubricated reciprocating or screw compressors for the purpose of creating instrument air.

5.1.3.8.6 System's Intake

The intake of an instrument air system is allowed to pull air from the room where it is located.

5.1.3.8.9 System Piping Arrangement and Component Redundancy Requirements

Instrument air systems must meet the same component, piping arrangements, and redundancy requirements as medical air compressor systems. However, the instrument air system may be a simplex if a standby header, meeting the requirements of 5.1.3.8.4, is used instead of a backup compressor.

5.1.3.8.10.1 Alarm Requirements

An instrument air producer must activate the appropriate signals at the local alarm when the backup or lag producer is required to run in order for the system to maintain its operating pressure, and when the dewpoint reading at system pressure, increases above -30°C (-22°F) indicating a "High Dewpoint" signal. The "High Dewpoint" signal must also activate the appropriate indicator at both master alarms.

5.1.3.8.10.2 Alarm Requirements for Systems with Standby Headers

When an instrument air system uses a standby header instead of a backup compressor, no "Backup Compressor Running" or "Lag Compressor Running" signals are required at the local alarm. Instead, a signal must actuate a local alarm and appropriate master alarm when the reserve from the header begins supplying the system and when the standby header reserve drops below one hour's average supply at a predetermined setpoint.

5.1.4 Valves

5.1.4.2 Accessibility

All valves, except valves in zone valve box assemblies, are now required to be either located in an area such as a locked pipe chase, or be a type of valve that can be locked or latched in the normal operating position. This requirement is not completely new for most valves. Source valves now come under the requirements of this section.

5.1.4.8 Zone Valve Requirements

Section 5.1.4.8 and paragraphs 5.1.4.8.1 through 5.1.4.8.8 cover in much more detail the requirements for the placement of zone valves. The lack of this information in older editions caused some conflicts between the installer and the system verifier. The intent of providing more detail is to eliminate any possible confusion about the proper placement of zone valves.

5.1.4.9.2 Area Alarm Sensor Location in Relation to In-Line Valves

The intent of this paragraph is to provide guidance to the installer when they are installing the area alarm sensors. Simply stated, an area alarm sensor is permitted to be on either side of the In-Line Valve.

5.1.4.10 Valves for Future Connections

Although not really a new valve, this edition provides it with an official name. These are valves installed onto the medical pipeline, which will allow for easier expansion of the medical pipeline distribution system in the future. They must conform to the same requirements as in-line and service valves except these must be locked **closed**.

5.1.6 Manufactured Assemblies

5.1.6.3 Requirement for Manufacturers to Complete Test Documentation

It is now required for the manufacturer of these assemblies to provide documentation certifying that the assemblies have been through the following tests:

1. Initial blowdown 5.1.12.2.2
2. Initial pressure 5.1.12.2.3
3. Piping purge 5.1.12.2.5
4. Standing pressure 5.1.12.2.6 or 5.1.12.2.7 using the parameter under 5.1.6.2

5.1.6.7 Outlet/Inlet Requirements for Manufactured Assemblies with Concealed Hoses

Manufactured assemblies using concealed hoses to connect a user outlet/inlet to a concealed station outlet/inlet must use DISS connectors at the concealed station outlet/inlet. These connectors are permitted to omit secondary check.

5.1.8 Pressure and Vacuum Indicators

5.1.8.1 General Requirements

An entire section, paragraph 5.1.8.1.1 through 5.1.8.1.7, provides detailed pressure and vacuum indicator requirements such as the following: cleaning, ANSI/ASME compliance, scale range, labeling, and accuracy.

5.1.8.2.3 Gas-Specific Demand Check Valve Requirements for Sensors and Gauges

The requirement for gas-specific demand check valves provides assurances that all sensors and gauges connected to the medical pipeline cannot accidentally be placed onto the wrong pipeline during testing or maintenance. Sensors and gauges, which are part of a manufactured product like zone-valves and area alarms panels, are not required to have gas-specific demand check-valves.

5.1.8.2.4 Demand Check Valves Required for Monitors

The intent of this requirement is to allow the medical air compressor system's dewpoint and carbon monoxide monitors or their sensors to be removed for inspection or replacement while the system is still providing medical air to the facility. They are not required to be gas-specific.

5.1.9 Level 1 Warning Systems

5.1.9.1 General Requirements for Master, Area, and Local Alarm Panels

All three types of alarms must be able to provide the following functions:

1. Separate indicators for each monitored condition
2. Visual alarm indicators which will remain lit until the alarm condition returns to normal
3. Audible alarm indicator, cancelable by user acknowledgement and has a minimum noise level of 80 dBA at 3 feet
4. Test button or another way to test all lamps or LEDs for proper operation
5. Indicator for when a switch or sensor becomes disconnected from the alarm panel
6. Labeling and indicators for surveillance area of the alarm panel and for each monitored condition
7. Re-activation of the audible indicator should another alarm condition occur after the original alarm was silenced
8. Connection to the life safety branch of the emergency electrical system
9. Automatic restart of the alarm panel without causing false alarms after a power loss of at least 10 seconds or until the emergency generator powers up

5.1.9.4 Local Alarms

Local alarms must meet the same requirements as master and area alarms. They are used to monitor required alarm points coming from medical air compressor, surgical-vacuum, WAGD, and instrument air systems. It is important for the installer to ensure each required local alarm point meets all of the requirements stated in 5.1.9.1.

Using table 5 on page 26 of this booklet, notice most signals originate inside the control panel. This means in order for the compressor or vacuum system's control panel to be used as a local alarm it must have the following:

- Separate indicators for each alarm signal
- Cancelable audible alarm that re-activates if another alarm condition occurs
- Test button or other means to test the lamps or LEDs for proper operation

Dewpoint and CO monitors must comply with the same requirements as listed at the bottom of page 25 of this booklet. Their alarm points must be connected to a Local Alarm panel if they cannot meet these requirements

NOTE:

Most dewpoint and carbon monoxide monitors do provide these requirements.

Table 5. Required Local Alarm Signals and Their Source

Required Local Alarm Signal	Source of Signal
Backup compressor running	Compressor's control panel
High water in the receiver	Compressor's control panel
High water in the separator	Compressor's control panel
High compressor exhaust temperature	Compressor's control panel
High dewpoint temperature	Compressor's dewpoint monitor
High carbon monoxide temperature	Compressor's carbon monoxide monitor
Backup vacuum pump running	Vacuum System's control panel

See section 5.1.9.4.4 for all of the required local alarm signals.

5.1.10 Level 1 Distribution

5.1.10.3.3 Mechanically Formed Extruded Tee-Branch Connections

Branch connections using mechanically formed and drilled extruded tee-connectors are permitted on the *vacuum* pipelines only. Installers must follow the manufacturer's instructions for brazing these connectors into the vacuum pipeline.

5.1.10.5.5 Nitrogen Purge

Paragraphs 5.1.10.5.5.1 through 5.1.10.5.5.11 provide detailed requirements for properly purging new medical pipelines with oil-free dry Nitrogen NF. Paragraph 5.1.10.5.5.2 requires the purge gas contents be monitored with an audible indicator which will alert the user when the cylinder's content becomes too low. Paragraph 5.1.10.5.5.5 requires additional equipment, like a flow meter, to be used with the purge gas cylinder regulator.

When the new pipeline's final connection is tied into an existing pipeline system without the use of purge gas, an outlet on the new pipeline and the outlet on the existing pipeline immediately downstream of this connection are required by paragraph 5.1.10.5.5.11 to have the tests conducted as stated in section 5.1.12.3.9.

5.1.10.5.8 Special Fittings

Included with the existing requirements for memory-metal couplings and metallic gas tube fittings from the 1999 edition, are new requirements for dielectric fittings for gas and vacuum pipeline systems installed in areas where there is a need to electrically isolate the pipeline, such as magnetic resonance imaging (MRI) suites. Vacuum pipelines are also permitted to use mechanically pressed joints with resilient O-rings and grooved joints. There are restrictions for the gasket or O-ring material used on these joints and minimum size allowances for grooved joints.

5.1.10.6.6 Branch Takeoffs Requirements

This new requirement ensures tee connections installed on new horizontal piping will help prevent transfer of solid debris or liquids from the primary horizontal pipe to the connected branch piping takeoff. This is accomplished by requiring the takeoff to be connected to the primary horizontal piping vertically or at an angle that is no less than 45 degrees from vertical.

5.1.10.6.10 Medical Pipeline Use-Change Requirements

The 2002 edition provides requirements for changing the use and pressure of a specific gas already in use in a positive pressure medical gas pipeline system, to a another patient related application using the same gas. An example of a gas use-change would be converting a 345 kPa (50 psi) medical oxygen pipeline to an oxygen pipeline for hyperbaric chambers, which would require a higher pipeline pressure.

5.1.10.6.11 Installer Qualifications

This is a new section providing all of the required qualifications for medical pipeline installers. A new qualification, which is important to note, is that the installer must meet all of the requirements in ANSI/ASSE Standard 6010.

5.1.11.2 Shutoff Valves Labeling

An entire section is now allocated for valve identification requirements. Labeling (paper labels, tags, etc.) is required to show the chemical name of the gas or vacuum service the valve is connected to, along with the rooms or areas covered, and cautions stating not to close or open valves except in an emergency. Also required are the substance labeling for source, main, riser, and service valves, which provides users the necessary important details of these valves.

5.1.12 Level 1 Performance Criteria and Testing

5.1.12.1.12 Testing of Source Equipment and Components When Brazing is Involved

This section provides clarification of the same requirement as written in the 1999 edition. Simply stated, when components needing to be replaced or repaired are removed from a source system by cutting into the system's piping, or when new piping is brazed onto the system's existing piping, it is required to test the source system as if it was new.

5.1.12.1.12.1 Testing of Source Equipment When There Has Been No Piping Change

Testing of existing source equipment when one of its components is replaced without the need for new piping, requires only functional tests for that component and any other components which may have been affected by the old component's faulty operation.

5.1.12.1.12.2 Additional Testing of Source Equipment When There Has Been No Piping Change

These tests are dependent on the type of source equipment involved. Perform the tests required for equipment types listed (1) through (5) in the NFPA 99 Standard under this paragraph.

NOTE:

There appears to be a misprint in (2) "Medical and Instrument Air", which refers to tests in paragraph 5.1.12.3.14.2 (A) when it should refer to paragraph 5.1.12.3.14.3 (A).

Installer Performed Test

5.1.12.2.1.1 Installer Test Result Documentation

It is required that the installer completely document all results of the tests under section 5.1.12.2 prior to the System Verification. The person performing the pipeline certification should request to see the results of all installer's performance tests before beginning their tests listed under 5.1.12.3 System Verification.

5.1.12.2.3.5 Initial Pressure Test for Vacuum

The testing pressure used during the initial pressure test for vacuum has been changed from a minimum pressure of 1034 kPa (150 psi), in the 1999 edition, to 415 kPa (60 psi).

5.1.12.2.7 Standing Pressure Test for Vacuum

The testing pressure used during the standing pressure test for vacuum has been changed from a minimum pressure of 415 kPa (60 psi), in the 1999 edition, to a minimum vacuum pressure of 300 mm Hg (12"Hg).

System Verification

5.1.12.3.1.3 Medical Pipeline Certifiers' Qualification Requirements

Medical pipeline certifiers must meet the requirements as stated in the ANSI/ASSE 6000 Standard under Section 6030 when performing pipeline certification to the 2002 edition.

5.1.12.3.1.5 In-House Medical Pipeline Certifiers' Requirements

When installation of new medical pipeline systems is performed by healthcare facility personnel, in-house personnel are no longer allowed to conduct the systems' verification tests. These tests must be performed by another party.

5.1.12.3.1.8 Using Source Gas to Test Small Projects

When the authority having jurisdiction allows their use, source gases are permitted to be used instead of test gases on small projects, such as additions or component removal, when conducting the following tests:

1. Standing pressure
2. Cross-connection
3. Alarms
4. Piping purge
5. Piping purity
6. Operational pressure

5.1.12.3.2 Standing Pressure Test

The medical pipeline certifier is now required to perform a standing pressure test at operational pressure by following the procedures listed under this paragraph in the standard.

However, this list does not provide the complete information for add-on medical pipelines to pipelines that are currently in use. Shutting off source gas valves can cause real problems unless proper notification and contingency plans are in place.

5.1.12.3.7 Piping Particulate Test

The weighted accrue particulate test is less stringent in the 2002 edition. Instead of the 0.1 mg total allowable weight of accrued particulates, as stated in the 1999 edition, a full 1 mg is now the maximum allowed.

5.1.12.3.8 Piping Purity Test

The dewpoint allowance for this test is now conducted as an absolute high limit of 12°C (53.6°F) and no longer a variance between two opposite ends of a pipeline.

5.1.12.3.9 Final Tie-in Test

There is no obvious new requirement within this section. However, it is important to note the requirements stated in section 5.1.10.5.5 (Nitrogen Purge), paragraph 5.1.10.5.5.11. This paragraph provides that the outlet locations on both new and existing systems must be tested using the requirements listed within section 5.1.12.3.9 (Final Tie-in Test).

5.1.12.3.10 Operational Pressure Test

Instead of separate tests for flow and pressure the 2002 edition now combines these two tests under one test. The test is conducted using the source gas at normal operational pressures.

5.1.12.3.14.2 (E) Testing Required after Replacement of a Bulk System's Storage Unit

Whenever a storage unit is replaced on a bulk system, it is required to test all of the associated signal devices at the bulk system to their signal indicator location at the master alarm panels for proper operation.

5.1.13 Level 1 Operation and Management

An entire section providing requirements for properly managing and maintaining components which makeup Level 1 Medical Gas and Vacuum Systems is included within this section. Special precautions for handling cylinders and source equipment along with their required maintenance is also included.

5.2.3 Level 2 Sources

There are no real changes within the requirements for Level 2 source equipment. Facilities are still allowed to have simplex medical air compressor and medical-surgical vacuum systems under certain conditions. However, the facilities where these simplex systems are installed must have an emergency plan in place to deal with the possibility of interruption of these sources.

5.3.3 Level 3 Sources

5.3.3.1 Medical Gas Supply System Identification and Labeling

The requirements for the proper labeling of cylinders and the cylinder contents, along with door warning labels, and the cylinder room or enclosure construction and ventilation requirements are the same as Level 1.

5.3.3.2 Supply System Operations

This section was added to provide the requirements for proper storage and handling of high-pressure and liquid cylinders within the healthcare facility.

5.3.3.3 Source Systems

Included within this section are requirements for rooms or enclosures where source equipment is located. Proper cylinder security and storage within the room or enclosure, along with the room or enclosure ventilation requirements, for Level 3 facilities are stated within this section.

5.3.10 Level 3 Distribution

5.3.10.2.1 Piping Material for Field-Installed Level 3 Vacuum Systems

This section permits the use of soft copper for *vacuum* only when the piping is either underground or in the floor. Also permitted in this section is the use of plastic piping systems only when the plastic piping is polyvinylchloride (PVC) plastic, Schedule 40 minimum.

5.3.10.10.1 Qualification of Installer

Installers of Level 3 medical gas and vacuum pipelines must meet the same requirements as Level 1 installers by being qualified under the requirements of ASSE 6010.

5.3.12 Level 3 Performance Criteria and Testing

5.3.12.3.1.3 Medical Pipeline Certifier's Qualification Requirements

The person conducting the system verification must be qualified under the requirements of ASSE 6030.

5.3.12.3.1.4 Additional Certifier's Requirement

A real change from the previous edition for Level 3 pipelines is that the person conducting the systems' verification must be someone *other than* the contractor or installer of the medical pipeline.

About the Author

Since my first introduction into medical pipeline systems eighteen years ago, I have seen many positive changes in regards to medical pipeline requirements. Being a primary member of the NFPA 99 Standard Technical Committee for Medical Pipelines (HEA-PIP) since 1998, has allowed me to participate in the process that ultimately improves medical pipeline safety and provides better guidance for installation, testing, and maintenance. I have also served as a member of the Canadian Standards Association (CSA) Technical Sub-committee for Medical Pipelines since 1999, and being an accredited active member in the new Medical Gas Professional Healthcare Organization (MGPHO) has broadened my horizons as to what other organizations and individuals in the medical pipeline business stress as important requirements for medical pipeline safety.

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