NFPA 99
Health Care Facilities

The Changes in Medical Gas and Vacuum Systems from the 1999 to 2002 Editions

Mark Allen
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Notes

Notes on Using this Pamphlet:

This pamphlet is presented as a service to users of the National Fire Protection Association’s Standard for Healthcare Facilities, the NFPA 99. The pamphlet seeks to simplify understanding the changes which have occurred between the document as published in 1999 and the document as published in 2002.

Users are cautioned that this pamphlet is intended to be used in conjunction with the standard, which should be obtained from:

National Fire Protection Association
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Quincy, MA  02269-9101
Phone 1-800-344-3555
Internet www.NFPA.org

This pamphlet is not intended to be exhaustive and there may be changes of significance omitted from this document.

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Comments on this booklet or on any aspect of medical gases are welcome and encouraged.
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Introduction and The Manual of Style

Introduction:

The 2002 NFPA 99, Chapter 5 deserves to be viewed as a watershed in the history of the NFPA medical gas document. From the ground up - every word, every figure, every table - has been redone. The document is in essence entirely new. The format is vastly different, but above and beyond the formatting revisions there are over 57 substantive technical changes (i.e. changes which may result in changing something we did under the 1999 version). This revision is likely to be the one that most enforcement people are going to want to see adopted, simply for the clarity of the language and format, as you immediately see when you first look at the new structure.

The Impact of the Manual Of Style:

NFPA as an organization is pursuing a strategy towards becoming a more widely recognized international standards organization. To do this, it is justifiably felt that their documents need to be written more along the lines of other international standards. These guidelines for writing all future NFPA standards are embodied in the Manual of Style (MOS), issued by NFPA in 2000 and revised at least once since then. Although this is an internal NFPA document used primarily by the committees and NFPA staff, it is available from the NFPA should you be interested in seeing a copy.

Irrespective of NFPA's reasons for issuing the MOS, following it presented the Technical Committee an appalling problem. Without a doubt, the chapter had become more cumbersome and harder and harder to understand with each revision cycle. There were paragraphs with vast numbers of requirements all choked together in a single paragraph. As a random example, here's 4-3.1.1.9 (g) from the 1999 version:

"(g) Accessories. Compressor systems for medical air shall be equipped with intake filter-mufflers of the dry type, aftercoolers or air dryers, or both, line filter(s) appropriate for the intake air conditions and compressor type, pressure regulators, and a pressure relief valve set at 50 percent above nominal line pressure to ensure the delivery of medical air (see definition of Medical Air in Section 2-2).

The medical air receiver shall be provided with a three-valve bypass to permit service to this device without shutting down the medical air system.

Dryer systems shall be, at a minimum, duplexed and valved to permit isolation of individual components to allow for maintenance or repair in the event of failure, while still continuing to adequately treat the flow of air. Under normal operation, only one dryer shall be open to airflow with the other dryer valved off. Each dryer system shall be designed to provide air at a maximum dew point of 35°F (1.7°C) at the peak calculated demand of the system. [See 4-3.1.2.2(b)3g.] System design shall preclude formation of liquid water in the air line.

Aftercoolers, where required, shall be duplexed and provided with individual condensate traps. The receiver shall not be used as an aftercooler or aftercooler trap.
Where more than two devices are provided, the peak calculated demand shall be met with the largest single unit out of service.

Final line filters located upstream of the final line regulators shall be duplexed with appropriate valves to permit service to these devices without shutting down the medical air system. Each of the filters shall be sized for 100 percent of the system peak calculated demand at design conditions and shall be rated for a minimum of 98 percent efficiency at 1 micron. These filters shall be equipped with a continuous visual indicator showing the status of the filter element life.

All final line regulators shall be multiplexed with isolating valves to permit service to the regulator without completely shutting down the gas piping system. Each of the regulators shall be sized for 100 percent of the system peak calculated demand at design conditions."

Other problems also existed and needed attention. The figures were out of sync with the text and antediluvian in presentation. Beyond that, there was a large amount of invalid appendix material which needed combing through.

Many people have lamented over the years that a rewrite was necessary, but the sheer enormity of the job shied previous committees off tackling the task (remember that all NFPA Committees are after all volunteers).

It is impossible to overstate the value of this cycle’s Chair of the Committee, Mr. Doug Erickson. Although Mr. Erickson has been a member of the committee for many years as alternate for ASHE, he was placed into the chair by a conspiracy of events late in the life of the 1999 edition. As the revision cycle kicked into high gear, it was Doug who received NFPA’s irrevocable demand that the MOS rewrite be accomplished at the same time. It was immediately apparent that no less than rewriting the chapter word for word would do, which of course would be superimposed on one of the most active revision cycles in the history of the chapter (a record 317 public proposals were received and acted on this cycle).

A crucial limitation of the rewrite was to reformat the text for clarity but ensure that no technical changes were
made which were not otherwise intended by proposals received. The process required a chair with sufficient command of the process to ensure the work was done and thoroughly done, and enough presence with NFPA to ensure the task force was allowed the time and staff support to do it. The committee was exceedingly fortunate in their Chair.

Mr. Erickson chose a small sub-group (including himself), broadly representative of the various interests on the committee as a whole. This group (with understandable reluctance) put in literally hundreds of pro bono hours under the guidance of NFPA staff to re-write the document and simultaneously to integrate the changes as they were approved. Known simply as the MOS Task Force, it is primarily their sacrifice which led to the vastly improved document you see today. The results are probably not perfect, but if you’ve ever struggled with trying to make sense of some obscure paragraph in NFPA 99 Chapter 4, you’ll have plenty of reason to thank the MOS Task Force. I take the liberty of publishing their names here by small way of thanks:

Mr. Doug Erickson, American Society for Healthcare Engineering, St. Croix, USVI
Mr. Craig Kampmeir, NFPA Staff, Providence, RI
Mr. David Mohile, Medical Engineering Services, Leesburg, VA
Mr. Dan Shoemaker, MDS Matrx, Mesa, AZ
Mr. Richard Wagner, Poole and Kent, Baltimore, MD

With grateful acknowledgement of the assistance rendered by NFPA Staff, especially:

Mr. Rich Bielan, NFPA Staff, Quincy, MA
Ms. Sylvia Dovner, NFPA Editorial Manager, Quincy, MA

What is Happening Here?:

The significant requirements of the MOS which you’ll see reflected in the final document include:

- A document must be written to be convenient for and comprehensible to enforcers.

- Each numbered paragraph has one requirement or at most a very limited number of very tightly related requirements. No longer can multiple requirements be tumbled into hodgepodge paragraphs for the user to tease apart.

- The NFPA has gone metric (english) versus english (metric).

- The definitions no longer contain enforcement criteria as such - an innocuous sounding change with important consequences.

- There is nothing in the body of the chapter which is not enforceable. The Annex therefore now contains most of the Tables and all of the Figures. Conversely, everything in the Annexes is non-mandatory and meant only to be explanatory or to expand on the text. Nothing in an Annex is enforceable.

Compare the section of the 2002 draft which is roughly equivalent to the 1999 version section shown on page 4:

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5.1.3.5.5 Aftercoolers. Aftercoolers, where required, shall be provided with individual condensate traps. The receiver shall not be used as an aftercooler or aftercooler trap.
5.1.3.5.5.1 Aftercoolers shall be permitted to be constructed of ferrous and/or non-ferrous materials.
5.1.3.5.5.2 Anti-vibration mountings shall be installed for aftercoolers as required by equipment dynamics or location and in accordance with the manufacturer’s recommendations.
5.1.3.5.6 Medical Air Receivers. Receivers for medical air shall meet the following requirements:
(1) Be made of corrosion resistant materials or otherwise made corrosion resistant.
(2) Comply with Section VIII, Unfired Pressure Vessels, of the ASME Boiler and Pressure Vessel Code
(3) Be equipped with a pressure relief valve, automatic drain, manual drain, sight glass, and pressure indicator.
(4) Be of a capacity sufficient to prevent the compressors from short-cycling.
5.1.3.5.7 Medical Air Dryers. Medical air dryers shall meet the following requirements:
(1) Be designed to provide air at a maximum dew point which is below the frost point (0°C /32°F) at any level of demand.
(2) Be sized for 100 percent of the system peak calculated demand at design conditions.
(3) Be permitted to be constructed of ferrous and/or non-ferrous materials.
(4) Be provided with anti-vibration mountings installed as required by equipment dynamics or location and in accordance with the manufacturer’s recommendations.
5.1.3.5.8 Medical Air Filters. Medical air filters shall meet the following requirements:
(1) Be appropriate for the intake air conditions.
(2) Be located upstream of the final line regulators.
(3) Be sized for 100 percent of the system peak calculated demand at design conditions and shall be rated for a minimum of 98 percent efficiency at 1 micron or greater.
(4) Be equipped with a continuous visual indicator
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Major Changes

showing the status of the filter element life.
(5) Be permitted to be constructed of ferrous and/or non-ferrous materials.
5.1.3.5.8.1 Compressors complying with 5.1.3.5.4.1(2) shall be provided with:
(1) Coalescing Filters with element change indicators.
(2) Charcoal absorbers with colorimetric hydrocarbon indicators.
5.1.3.5.9 Medical Air Regulators. Medical air regulators shall meet the following requirements:
(1) Be sized for 100 percent of the system peak calculated demand at design condition.
(2) Be permitted to be constructed of ferrous and/or non-ferrous materials.
(3) Be equipped with a pressure indicator indicating delivery pressure.

You will quickly see that the resulting rewrite of the 99 is vastly more clear and leaves many fewer ambiguities than any NFPA med gas document you’ve ever seen. While it can never be without “room for interpretation” and there undoubtedly remain loopholes and flaws, the general feeling is that the document is going to be vastly easier to understand and apply.

Most significantly, this document is as “enforcer friendly” as a specialist document can ever be. That means that even an enforcer who is not especially expert in medical gas should generally be able to read and understand the requirements. Since they are now arranged one paragraph, one requirement, there is less of the “three paragraphs and a figure that bear” problem which plagued earlier versions. State inspectors and others responsible for the inspection of these systems will find their jobs eased greatly when this new standard is adopted in their jurisdictions.

Finding your way:

The MOS had impact beyond the new medical gas chapter - it also altered the entire order of the document. Some of the things you’ll want to note:

• Look for the definitions in Chapter 3 instead of 2.

• Look for the medical gas section in Chapter 5 instead of Chapter 4.

• Look to find the Occupancy Chapters (formerly 12 for Hospitals, 13 for “Other” Health care Facilities, 16 for Nursing Homes, 17 for Limited Care Facilities and 20 for Freestanding Birthing Centers moved to 13, 14 17, 18 and 21 respectively.

• Don’t look for any Appendix - they’re renamed “Annexes”.

• Don’t look for a separate vacuum section. Vacuum and pressure gases are tightly integrated on the premise that they’ve more in common than they have differences.

• To find Level 1 requirements, look in sections numbered 5.1. Level 2 will be found in 5.2, and Level 3 in 5.3. Similar requirements across levels will generally be found in similarly numbered paragraphs, so for example, to find outlets requirements for Level 1 application, look in 5.1.5. For Level 2, go to 5.2.5 and Level 3 go to 5.3.5.

A Quick Find Index:

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5.(x).2 Nature of Hazards
5.(x).3 Sources
5.(x).4 Cylinder and Bulk gas
5.(x).5 Medical Air
5.(x).6 Medical Vacuum
5.(x).7 WAGD
5.(x).8 Instrument Air
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5.(x).13 Operation and Management
An Overview of Major Changes:

While the document was being revised to the MOS, the usual revision cycle was underway. Some 317 comments were received and many were incorporated into the document, several of them of substantial importance.

5.1.3
The source sections for manifolds and bulk stations were extensively re-written, adding some requirements and reorganizing for clarity.

5.1.3.3.2(7)
Cylinders must be individually secured.

5.1.3.3.3.1 (2)
Indoor locations for manifolds are to be ventilated by fans or blowers and those are to draw from 300 mm (1 foot) of the floor.

5.1.3.3.3.1 (3)
Fans or blowers used for gas system ventilation must be powered from the Essential Electrical System.

5.1.3.3.3.1 (5)
Locations with natural ventilation must have two openings - one near the floor and one near the ceiling.

5.1.3.4.3 (1)
Oxygen systems operating above 300 psig may not contain polymers.

The most important changes are listed on the following pages in two column format. The change and reference is in the left column, and our reflections on the possible consequences and implementation of the change in the right column.

These changes are in addition to the reorganization required by the MOS.

Cylinders have always had to be secured. The requirement for individually securing them is new. The idea is to prevent a “domino” effect when changing or manipulating cylinders.

The gases of greatest concern are the gases with inherent toxicity (N\textsubscript{2}O, CO\textsubscript{2}). Since these gases are heavier than air, they tend to sink to the floor. Locating an intake duct anywhere else may not adequately remove the gas from the room.

Air manifolds are obviously not toxic by definition and don’t increase the oxygen in the room, so they are exempted.

The standard does not state which branch (equipment, life safety or critical). The equipment branch is probably most appropriate.

The most important result being that flexible pigtails lined with polytetrafluoroethylene (e.g. Teflon™) or the like are no longer permitted on cylinder oxygen manifolds. They are still permitted on liquid oxygen cylinders which operate at pressures below 2,070 kPa (<300 psig) and on all other gases.

This results from incidents reported to manufacturers of these leads spontaneously bursting. These incidents appear to be the result of ignitions in the linings of these pigtails caused by adiabatic compression in the presence of 100% oxygen.

Any material in the high pressure oxygen stream must be regarded as potential fuel, and it is wise to avoid any such materials if possible.

This problem is so serious that this should be considered a threat to life, and facilities having these
Major Changes

5.1.3.4.5.1
All Relief valves for all gases must be piped to the outside of the building (with an exception for small air manifolds (<84,950 liters(3,000 ft³))).

5.1.3.4.5.1(7)
Relief valves may be piped into a common line, but that line must have a cross sectional area equal to the sum of the cross sectional areas of the valve outlets.

No reference - deleted requirement
Relief valves no longer have “to close automatically”.

5.1.3.4.5.1(8)
The location for the relief line discharge is specified.

5.1.3.4.5.2
Relief valve vent lines must be made of copper.

5.1.3.4.9.1(1)
Outdoor manifolds and bulk systems both need to be sited in accordance with NFPA 50’s table of dimensions.

5.1.3.3.1
What source can be located with what other source has been strictly defined.

5.1.3.3.1.8
Locations for Nitrous or Carbon Dioxide must be kept above -7°C (20°F).

5.1.3.3.2(8)
Electrical power for all source systems must be supplied from the Essential Electrical systems.

5.1.3.3.3.2
Locations containing motor-driven equipment must be ventilated to prevent accumulation of heat.

Changes NFPA 99 1999 to 2002, Medical Gases
Major Changes

5.1.3.3.3
Outdoor locations must also be ventilated.

5.1.3.4.2
All medical gases are limited to medical applications, not just Medical Air and Oxygen.

5.1.3.4.4.2
A pressure indicator must be provided for each final line regulator.

5.1.3.4.11.3
Reserve headers for bulk oxygen systems can no longer be installed without check valves in the individual cylinder leads.

5.1.3.4.7
There is a new quasi-alarm called a Local Signal defined.

5.1.3.4.8
Manifolds are comprised of “Headers”, whose construction is defined in the standard.

5.1.3.4.10.2, .3
It will be permissible to locate a manifold and its reserve header in separate locations.

5.1.3.4.10.6
Liquid manifolds will be required to have an economizer.

5.1.3.4.11.2
There is a whole new set of requirements regarding the siting and equipment pad for bulk oxygen systems.

Changes NFPA 99 1999 to 2002, Medical Gases

It used to be rare to see the condition which would invoke this new requirement. It applies for instance to a bulk system enclosed in a solid enclosure such as a brick or block wall. However, with security generally becoming a big issue, these kind of enclosures are sure to become more common. The standard does not state how big these openings must be. Size should be determined after consultation with the supplier of the bulk system.

Always intended, the 2002 is the first edition in which this requirement is clearly stated.

The Local Signals are the indicators you would expect to see for instance when standing at the manifold. They would allow the operator to diagnose and fix problems with the manifold. They are required for all sources for the first time in this edition.

Hard to believe, but they weren’t required previously. Believe it or not this is a NEW requirement.

This will affect liquid manifolds and little else. It allows a reserve header to be located separately from the rest of the manifold. Labelling is critical in these cases, because it’s not the usual thing to have these manifold parts separated.

These are optional under the 1999.
Major Changes

5.1.3.4.11.6 (1)

Bulk oxygen systems will be required to have a liquid level low local signal and a master alarm for the main tank - not just the reserve or secondary as now.

5.1.3.4.12.1(1)

An Emergency Oxygen Inlet (EOSC) will need to be placed on each building of a multi-building campus.

5.1.3.4.13

... but there is another way to meet the EOSC requirement - an In-Building Emergency Reserve.

5.1.3.4.12 (1)

EOSC are only needed now when cryogenic bulk systems are employed - this is a clarification of the earlier text which implied that any remote oxygen source needed an EOSC.

5.1.3.5.1

Medical Air purity is specified in the body of the text.

5.1.3.5.2

Medical Air can be used for supplied air respiration (e.g., for hoods and masks for the medical staff in isolation rooms).

Although most facilities have these already, they have not been mandatory.

This reflects the simple logic: if the line between the source and Building “A” is at risk from being torn up by a backhoe, etc., are you not equally vulnerable in the line between Building “A” and Building “B”?

EOSC connections are problematic for many facilities. They may have no good site, their supplier may not be ready to service them in an emergency, or any of many other issues may be present which make these connections problematic. The In Building Emergency Reserve is a new allowance which allows a facility to forgo the EOSC in favor of a reserve permanently installed in the building. In addition, this provision helps define how to install a local reserve for areas with very high criticality.

This seemingly subtle change is huge in its potential consequences. Under the 1999 version a medical air compressor system was required in the text to “not add contaminants in the form of particulate matter, odor or other gases”. In the 2002 version it is required to produce air of a specific quality. In this NFPA has now fallen into line with other major international standards in requiring a medical air system to produce air to a pharmacopial grade. Medical air can no longer simply be air drawn in from outside, compressed, dried and delivered to the patient, but now should be viewed as the oxygen would be viewed - a drug whose purity must be assured.

Medical Air in 1999 was not permitted to be used for any non-patient purpose. This excluded use by staff for applications like decontamination, isolation rooms etc. where the staff needs a breathing air source for their own protection. Medical air is therefore now usable for an occupational safety application, and as such overlaps with the requirements for breathing air from the Occupational Safety and Health Administration (OSHA) in 29 CFR 1910.134(i)(1)(ii). The practical effect for the typical facility is likely to be small. Fortunately, for most of the U.S., most of the time (per the Environmental Protection Agency), ambient air meets or exceeds the requirements set forth by USP and OSHA, and a medical air system provided with an intake, dryers and filters as specified in this section of NFPA 99 will be able to provide air of this quality without additional apparatus. However, where the quality of local ambient air is suspect, known or suspected to vary outside USP limits.

Changes NFPA 99 1999 to 2002, Medical Gases
5.1.3.5.3.2
Piping within the medical air compressor system (upstream of the source valve) will need to be cleaned and suitable for oxygen.

5.1.3.5.7(1)
Medical Air sources will need to be designed to provide a dew point below 0°C (32°F) at any level of demand.

or otherwise not perfectly reliable, additional purifiers may be advised.

This will be an important specification point - ASTM B-819, brazed and purged is the right way to assemble a medical air system.

Water in medical air remains the single most common flaw in medical gas systems overall. Among other reasons, it continues so because of a continuing failure of design. Many engineers prefer refrigerant dryers because of their low cost and because they are “used” to them. However, these dryers have a fundamental limitation in the fact that they are subject to reentrainment of the water and thus to a “bathtub” shaped performance curve (see the figure below).

This edition of the standard has acknowledged this potential problem by changing the dew point limits in two fundamental ways: the design criteria is reduced from 1.7°C to “below frost point” or less than 0°C; and that performance is required across the entire range of operation, not just at peak demand.

In effect, the standard now requires the use of dryers without a bathtub shaped performance curve and insists they be operated totally in accordance with manufacturer’s specification. A refrigerant dryer can achieve these results - the criteria has been chosen specifically to permit their continued use - but the onus is heavily on the designer to ensure that they can in fact perform and that they are operated exactly per their design criteria. It has been proven over and over that the average off the shelf refrigerant dryer cannot perform adequately.
Major Changes

5.1.3.5.11.1(1)
The new standard explicitly notes the principle of single fault for medical air component arrangement.

5.1.3.5.11.7
Three way valves are permitted to isolate or select components. There are some limits: they must be full port and indexed-to-flow (e.g. indicating handles).

5.1.3.5.11.10
If the air relief valve can be isolated by the valves used to create redundancy, then a second relief valve would be mandated.

5.1.3.6.1.2 (5)
Piping within the medical vacuum pump system (downstream of the source valve) will need to be copper.

5.1.10.5.8(3)
Dielectric couplings are permitted in specialized locations

5.1.3.7.1.2
When med-surg vacuum in used for WAGD, the Medical-surgical vacuum system must be up-sized to compensate for the additional volume.

5.1.3.7.3
A dedicated WAGD System will need a lag alarm.

5.1.3.8
A whole new system, “Instrument Air” is defined. Instrument Air is designed to mimic nitrogen. It has defined filtration, the compressor must produce 200 psi or more, the air must meet the Instrument Society of America’s criteria for cleanliness and purity and the air must be dried to -40°.

Instrument air systems may be duplex compressors

A typical application of these valves is shown below.

This is an issue only when the configuration demands two valves. It is however not uncommon as a design feature.

See also the new requirement for vacuum systems to be piped in copper (5.1.10.2.1). This impacts vacuum pipelines generally, vacuum exhausts, and air intakes (through the linkage in 5.1.3.5.13.4).

The use of these fittings has been vigorously debated over several cycles. Installing one will inevitably reduce the overall resistance of the medical gas systems to fire, and thus they have been resisted. However, the specialized imaging equipment being installed simply cannot have the medical gas lines acting as antennae into the room. In this edition, dielectric couplings are permitted. No other information on the devices is available, and we recommend you consult with your imaging vendor for sources.

Obvious enough you might think it could go without being stated in the standard, however, it is a requirement.

Instrument Air is air primarily for running tools as a substitute for Nitrogen. There is a critical distinction between Instrument and Medical air: Instrument air is an alternate for nitrogen used to drive tools, power columns, dry glassware, etc. Medical air is a pharmaceutical used for life support. Instrument Air may therefore be used for any purpose,
or simplex compressors with a high pressure cylinder backup.

There is a whole section on these systems in the proposed standard in 5.1.3.8.

5.1.10.5.5

A whole set of procedures for operating a nitrogen purge during brazing would be included.

5.1.10.6.11.2

Installers must qualify through a procedure as contained in ASSE/ANSI 6010.

5.1.12.3.1.3

Verifiers must now be qualified to ASSE/ANSI 6030.

5.1.10.5.8

The use of “roll grooved” and gasketed jointing methods will be permitted in vacuum only.

Major Changes

unlike medical air which must be limited to respiratory applications.

Instrument Air may also have a unique configuration: a simplex compressor backed up by a high pressure gas manifold. This configuration will be the least expensive installation, but duplexed compressors are also acceptable.

This is related to the installer qualification and in fact is the same procedure a brazor should be using to qualify under 5.1.10.6.11 and 5.1.10.6.12.

The references to the ASSE document in this edition is one of the more controversial actions the committee took, but reflects the gradual move from a simple and unsatisfactory requirement that an installer be “qualified” toward defining what “qualified” means.

There are issues with this qualification, the greatest being that as of this writing, no one issues such a qualification. The nearest approach is the PIPE school in Los Angeles (affiliated with NITC) which does have a “verifiers” qualification, but which is not explicitly a qualification to the 6030 standard.

The Medical Gas Professional Healthcare Organization (MGPHO), the verifier’s voluntary professional organization, has already gone beyond the 6030 to create an additional qualification for verifiers which is intended to be somewhat more meaningful, the CMGV (Credentialled Medical Gas Verifier). This credential is awarded and managed by the MGPHO. NFPA does not however recognize that credential in the 2002 version.

The ASSE document can be obtained from the American Society of Sanitary Engineering, 28901 Clemens Rd., Westlake, OH 44145.

At the annual meeting, Victaulic made a presentation from the floor and was accepted as a jointing method for vacuum service only. There are several limitations, but essentially the roll grooving systems and pressfit systems are permitted in some cases. This allowance for alternative jointing methods does not relieve the requirement that vacuum be piped in copper (5.1.10.2.1) but it permits a jointing method not previously permitted as such. This allowance is particularly opportune for large lines and exhausts, where the problems of brazing and purging large copper lines is at its greatest.
Major Changes

5.1.10.6.6
Branches shall take off at an angle of 45° or more above the pipe.

Taking a branch off the top of a pipeline should reduce the possibility of debris or water passing from that line into the branch, which is what this new provision aims to promote. A takeoff under the 2002 might look as illustrated in the two figures below.

5.1.12.1.12
An important qualification regarding repair work has been made: where such work involves cutting and brazing, it must be treated as new work for the purposes of testing. Otherwise, specific tests are required which are a limited subset of the larger testing regime.

This change is aimed at avoiding a misinterpretation encountered with the earlier edition that ended up forcing facilities who simply performed maintenance to re-verify their whole system.

5.1.12.3
Testing can now be performed using the system gas.

Largely beneficial to the verifier working on a small project, the change allows them to perform most of their testing using the gas the facility intends to use. It is a problematic change, as certain tests are difficult to perform on the system gas and require special instruments or modifications to standard instruments. The change reflects a valid need, but in practice (particularly given the specialized knowledge required of the verifier) could result in testing being performed in ways which are not valid. The owner must take pains to ensure their verifier is competent in gas analysis.

5.1.12.3.7
Particulate testing is now less stringent. Instead of the 0.1 mg previously allowed, the standard now permits up to 1 mg of matter in the weighed filter test.

The ability of a verifier to accurately measure to the lower limit and the relevance of that lower limit were debated and it was determined to increase the accumulation which represented failure. The practical effects of this change are likely to be small.

5.1.12.3.8(e)
Dew point in the piping purity test has changed from a differential dew point (source to last outlet) of 5°C to an absolute maximum dew point of 500 ppm (12°C).

Making the dew point absolute makes the test much easier to perform but reduces its sensitivity. In practice, since the test is there to detect wet pipe, either test (properly performed) is likely to achieve the desired result. The exception is medical and instrument air, in those two systems, if the allowance for performing the tests in system gas is also used, this test becomes absolutely pointless.

5.1.13.8.4
Carbon Monoxide monitors must be tested and calibrated at least annually.

Regrettably, this is likely to be an oft ignored requirement, because these monitors are usually ignored now, and these requirements are in a section of the standard few people ever read. The intent is to ensure the monitors are operational (as many now are not). In light of the changes in the requirements
Level 3 Medical Gas Systems
Changes to Level 3 oxygen and nitrous oxide bring them into line with Level 2 for installation and testing.

5.3.10.2.3
Plastic vacuum lines are explicitly permitted in Level 3 Vacuum.

5.3.10.3, .4, .5, .6
Rules have been defined for vacuum pipeline assembly in Level 3 which allows a variety of methods to be used.

Level 4
All laboratory requirements have been removed to Chapter 11 - where whatever laboratory requirements NFPA has will now be found.

Figures A5.1.3.4 - A5.1.6
All the Figures have been revised

1999 Appendix C
The NFPA Vacuum sizing methodology previously found in Appendix C has been removed.

Major Changes

for medical air (see 5.1.3.5), this requirement, along with the requirement for the CO monitor in general, is particularly important.

Medical gases for Level 3 will need to be installed with the same care that these systems are handled in larger facilities. This effects installation, the qualifications for installers, testing and the qualifications for verifiers (among other effects). Note that these requirements are limited to the Medical Gases (oxygen and nitrous oxide only in most Level 3 facilities) and they do not apply to the other gas systems in a Level 3 facility (typically vacuum and compressed air). This will have it’s most dramatic effect on dentists, who have acquired some notoriety for being indifferent to the systems they install and the way those systems are installed.

But beware - many local jurisdictions do not permit plastic in commercial occupancies, whatever NFPA permits. Local rules govern.

Chapter 4 never had many Lab requirements anyway. The best known was the requirement for Lab vacuum, when connected to a medical-surgical vacuum source, to be run through a separator upstream of the receiver. This requirement remains.

The revisions make the Figures more friendly for the non-specialist and bring them more in line with the standard itself. They are all moved to the Annex, reflecting the fact the Figures have never been and are not in this edition, mandatory or enforceable.

The NFPA sizing methodology has been controversial since it was introduced to the document with the integration of the NFPA 56K. It’s removal is unfortunate, since it leaves us without the only sizing methodology that actually had a research history.
Occupancy Chapters

The Occupancy Chapters

In NFPA parlance, the place to start using the standard is in the back - Chapters 13-21, the so-called Occupancy Chapters. It is there that the user will find the information which allows them to select a Level for the facility before they move to Chapter 5 to find out the technical requirements to implement that level.

A very common complaint is that the standard has been very thin on guidance with respect to these levels requirements, and thus there was too much latitude given to “choose your own”.

NFPA has set the requirements with two important ideas: first, it is not reliable to determine a facility’s level by simply reading the name over the door, so a more fine-grained system based on the actual procedures being performed is required. Second, that the owner cannot shirk the responsibility to make that determination, because the owner is the only person who knows what they will be doing.

This is of course anathema to the enforcer, who wishes to be able to tell which requirement to enforce by the simplest method possible. Regrettably, developments in health care simply confetti any neat formula, and thus we fall back on the next best thing - a set of rules.

In the 1999 edition, the rules were obscure and scattered, which made even starting the decision process difficult. A major change in the 2002 is the creation of a clear “decision tree”, which is duplicated for each of the occupancy chapters where it is relevant. Since the decision tree is the same for all the occupancies, it is clear that the Level of medical gas systems to be installed becomes entirely dependant on the work being performed, as is the intent. It is therefore possible to have a “nursing home” with a Level 1 system, and a “hospital” with a Level 3 system, despite the fact that their “name” would imply otherwise.

It is prudent and highly recommended that these rules be interpreted very conservatively. Given what little it costs to put in a better Level of system versus the risks and liability implied in the use of medical gases and vacuum, it is a foolish way to save a very few dollars.

The decision tree is summarized overleaf. (Note this is a paraphrase of the exact language in the standard. Please refer to the actual standard prior to any real decision.)

BeaconMedæs also makes available a specific guide for medical gases in small facilities. Please contact us and request a copy of the “Small Facilities Guide”
Gas and Vacuum System Requirements

General
Where medical gas, instrument air, vacuum and WAGD systems are installed they shall conform to the requirements for the appropriate Level. Systems conforming to different Levels within the same building are permitted.

The Level is determined by following the appropriate rules stated below:

All systems are Level 1 if any part of the systems are Level 1, unless:

The system(s) is (are) entirely separate from the Level 1 system(s) (ie. are stand alone) and are not connected to Level 1 sources or distribution pipelines (e.g. systems cannot be “mixed” from a single source).

and the occupancy to be served and the function of that occupancy is distinct from other occupancies in the building.

Medical gas and vacuum systems shall be permitted to be Level 2 systems only where:
The system(s) is (are) entirely separate from the Level 1 system(s) (ie. are stand alone) and are not connected to Level 1 sources or distribution pipelines

and the occupancy to be served and the function of that occupancy is distinct from other occupancies in the building

and patients served by the system(s) are not dependant on mechanical ventilation or assisted mechanical ventilation at any time, including during administration of anesthesia.

Medical gas and vacuum systems shall be permitted to be Level 3 systems only where:
The system(s) is (are) entirely separate from the Level 1 system(s) (ie. are stand alone) and are not connected to Level 1 sources or distribution pipelines

and the occupancy to be served and the function of that occupancy is distinct from other occupancies in the building

and patients served by the system(s) are not dependant on mechanical ventilation or assisted mechanical ventilation at any time, including during administration of anesthesia

and the patient population, during or subsequent to treatment are not dependant for life on the gases or vacuum system(s), and the treatment(s) which the facility will perform can be completed without detrimental effect on patient outcomes in the event of sudden loss of the gas or vacuum system(s)

and the total of all gases in cylinders or containers, except nitrogen, connected and in storage at one time does not exceed 3,000 ft3 (85 m3) at standard temperature and pressure (STP), except that 5,000 ft3 (143 m3) at standard temperature and pressure (STP), shall be permitted if oxygen is stored in a DOT Specification 4L (cryogenic liquid) cylinder

and the system(s) supply not more than two adjoining single treatment facilities.

Gas and vacuum systems are to be treated as Laboratory systems only where:
The system(s) is (are) entirely separate from the Level 1 system(s) (ie. are stand alone) and are not connected to Level 1 sources or distribution pipelines

and the occupancy to be served and the function of that occupancy is distinct from other occupancies in the building

and patients served by the system(s) are not dependant on mechanical ventilation or assisted mechanical ventilation at any time, including during administration of anesthesia

and the patient population, during or subsequent to treatment are not dependant for life on the gases or vacuum system(s), and the treatment(s) which the facility will perform can be completed without detrimental effect on patient outcomes in the event of sudden loss of the gas or vacuum system(s)

and the total of all gases in cylinders or containers, except nitrogen, connected and in storage at one time does not exceed 3,000 ft3 (85 m3) at standard temperature and pressure (STP), except that 5,000 ft3 (143 m3) at standard temperature and pressure (STP), shall be permitted if oxygen is stored in a DOT Specification 4L (cryogenic liquid) cylinder

and the system(s) supply not more than two adjoining single treatment facilities and the pipeline system serves only laboratories, except that Instrument air systems used for medical support may also serve laboratories.
Links

Links to Relevant Organizations

*American Society for Sanitary Engineering*
28901 Clemens Road
Suite 100
Westlake, OH 44145
[www.asse-plumbing.org](http://www.asse-plumbing.org)

*BeaconMedaes*
[www.beaconmedaes.com](http://www.beaconmedaes.com)

*Compressed Gas Association*
Jefferson Davis Hwy,
Alexandria, VA 22202
[www.CGAnet.com](http://www.CGAnet.com)

*National Fire Protection Association*
Batterymarch Park
Quincy, MA 02269
[www.NFPA.org](http://www.NFPA.org)

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