NFPA 99
Health Care Facilities

The Changes in Medical Gas and Vacuum Systems Requirements from the 2002 to 2005 Editions

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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 2002 and the document as published in 2005.

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

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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. Please send to mallen@beaconmedaes.com

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Contents & Introduction

Introduction

The 2005 edition will initially appear to be mostly a continuation of the work begun and far advanced in the 2002 edition. While the 2002 edition involved the prodigious work of rewriting and reorganization, the 2005 involves more refining of the document, smoothing some of the rough sections and addressing many of the oversights and residual issues.

Which is not to imply that major changes have not been introduced. New allowances in the standard permit the use of oil-free screw compressors, computers as alarms, new liquid manifold configurations, new jointing techniques and others. These changes hold the potential to save money, but equally a facility may find their costs increase. The changes in this edition can improve patient and staff safety but equally they can make the systems less safe and place patients and staff at greater risk.

Which they will achieve in practice will depend entirely on the facility and their construction professional’s ability to understand and properly implement what are complex changes.

It is fair to say that the 2005 edition is in many respects is less stringent than the edition before. In the past, it would be fair to say that an implementation following a more recent edition of the standard would generally be compliant with any earlier edition, and would simply add additional safeguards. Thus, it was common for engineers in particular to use the “most recent edition” and generally local authorities would accept such a decision. The 2005 edition, however, contains several allowances which were not - and very explicitly not - allowed under earlier editions. Thus, a facility choosing to implement the 2005 may find themselves in trouble with regulatory officials who are following the edition listed in local statutes. It is essential therefore that you reach an understanding with the local authorities at the design stage which permits you to follow the 2005. If the allowances are disallowed after the fact, the costs of change can be enormous.

This booklet will attempt to present these changes in detail. We will particularly attempt to detail the entire scope of a change as well as some of the justification behind the change, and where a particular risk of implementation exists, we will attempt to describe the risk and some ideas on management.

There is one piece of unfinished business which may have considerable impact in future revisions. There is general dissatisfaction with the present way the Levels...
are implemented and particularly with the difficulty of practically using them.

At the moment, determining which level a facility can implement is left (intentionally) in the hands of the owner and the medical staff. Engineers, who are the primary user of the document, loathe the lack of hard facts this implies, and the difficulties it places in the way of decision making.

There is also a general perception that harder criteria are required than the present “risk of morbidity or mortality” of the present test.

The committee discussed in detail the problems, but were unable in the time available and with the resources at hand to evaluate other criteria. Therefore, this subject has been “held for further study” and will be the first proposal for the 2008.
5.1.1.3 New
Medical surgical vacuum and WAGD scope statement.

5.1.3.1.3 New
Liquid container labelling.

5.1.3.1.4 New
Requires liquid container outlets be non-interchangeable via use of V-1 (high pressure) or V-5 (low pressure) connectors.

5.1.3.1.5 New
Permanent fixing of connector to containers.

5.1.3.1.6 New
The contents of containers and cylinders must be checked prior to use.

5.1.3.1.8 Term Changed
Medical Gases has been changed to Positive Pressure Gases.

5.1.3.2.3 Cylinder/Container Editorial Change

5.1.3.2.4 Cylinder/Container Editorial Change

5.1.3.2.10 Cylinder/Container Editorial Change

5.1.3.2.11 Cylinder/Container Editorial Change

5.1.3.2.12 Cylinder/Container Editorial Change

5.1.3.3.1.3 New
Allowance for other machinery.

5.1.3.3.1.4 Reinforced
Cylinder headers, such as the Instrument Air reserve header permitted in 5.1.3.8.5 should never be placed in enclosures which will exceed 54°C (130°F).

5.1.3.3.1.8 Cylinder/Container Editorial Change

5.1.3.3.1.11 New.
Large (container based) Carbon Dioxide systems were not considered in the 2002 edition.

5.1.3.3.1.12 New.
See 5.1.3.3.1.11.

5.1.3.3.2 Term “positive pressure gases” as used here implies this paragraph applies to both Medical Gases

Limits the scope of requirements which are intended to apply only to vacuum or WAGD.

Liquid container safety has been the subject of much discussion following a particularly unfortunate incident in 2000 involving cross connection of containers of oxygen and nitrogen. Because of this incident, NFPA issued a Tentative Interim Amendment (TIA) to the 2002 edition. These requirements come from that action and from similar action by the CGA.

The terms cylinder and container were used almost interchangeably throughout the document. The intended change was to make cylinders apply only to high pressure gas cylinders and containers apply only to low pressure cryogenic containers. This was done editorially.

The editorial change has eliminated the term “container” from several places where it belongs. For instance, in 5.1.3.2.3 and 5.1.3.2.4 it would be entirely acceptable to store containers with cylinders in these locations, but the wording would prohibit this.

Other machinery has always been allowed in the same space as medical air plant and vacuum plant. The 2002 made it appear this might not be true. This change seeks to correct this misinterpretation.

There is nothing new in this requirement, it is simply reinforced by this rewrite.
Changes by Paragraph

and Medical Support Gases.

5.1.3.3.2 (1) Reinforced.
Requirement for the use of hand trucks for moving cylinders and containers is now found in Chapter 9, but should not be ignored.

5.1.3.3.2 (7) Change.  {ref 5.1.3.3.2 (7)}
Cylinders must be secured.

This is a return to previous requirements. In the 1999 and earlier editions, the requirement was as now revised - a single chain of cable was adequate. In the 2002 edition, for the first time, each cylinder had to have its own chain or cable. This was found to be onerous, and what is difficult often does not get done, so the requirement has been returned to its earlier form.

5.1.3.3.3 New Allowance.
Common walls do not have to have openings.

The need for a way to replace the air being exhausted was always obvious, and it has now been added to the paragraph.

5.1.3.3.4.2 Clarification.
Cylinders may not be stored in rooms containing medical air compressors, vacuum pumps, etc. This paragraph is related to 5.1.3.3.1.4.

This addition eliminates that narrow (and irresponsible) interpretation.

5.1.4.1 Clarification.  {ref. 5.1.3.4.1}
The paragraph has been reworded to change the emphasis and to place the responsibility on the manufacturer.

5.1.3.4.2 Change.  {ref. 5.1.3.4.2}
Nitrogen has been eliminated from this list. The exclusions for medical air, also found in 5.1.3.5.2 are now repeated here.

This may appear to be a very minor change, but in fact is of very great significance. It goes to heart of the question “who do you call?” The earlier wording simply mentions a “supplier” who could be argued to be the contractor, a dealer, a middleman. The new version places responsibility on the manufacturer and also insists the manufacturer’s instructions be followed.

5.1.3.4.3 New.
These are now the exclusions for medical support gases.

This is part of an overall rework of the bulk system requirements.

5.1.3.4.5.2 New.
Regulators for bulk cryogenic systems must be of a specific design.

A global editorial change has been made to add the term “patient of use side” or “source side” to every

Changes NFPA 99 2002 to 2005, Medical Gases
5.1.3.4.6.1 (3) New.
The relief valve setting is now defined based on the components to be protected. But see 5.1.3.4.6.3 (2)

5.1.3.4.6.1 (4) New.
A diffuser on an air relief valve must not restrict flow.

5.1.3.4.6.1 (5) Reword. {ref. 5.1.3.4.5.1 (6)}

5.1.3.4.6.1 (6) Change. {ref. 5.1.3.4.5.1 (7)}
“Two or more” has been substituted for “multiple”.

5.1.3.4.6.1 (7) Reword. {ref. 5.1.3.4.5.1 (8)}

5.1.3.4.6.1 (8) New and Reword {ref. 5.1.3.4.5.1 (9)}
“Snow” and “rain” have been substituted for “Water”.

5.1.3.4.6.1 (9) New.
A reference standard (ASME B31.3) has been incorporated.

5.1.3.4.6.2 Reword. {ref. 5.1.3.4.5.2}

5.1.3.4.6.3 Reword. {ref. 5.1.3.4.5.1 (3) and 5.1.3.4.5.1 (4)}
Requirements have been moved and regrouped.

5.1.3.4.6.4 New.
Relief valve piping must be labelled.

5.1.3.4.7 Clarification. {ref. 5.1.3.4.6}
Multiple pressure redundancies are now very specific.

5.1.3.4.9 (5) Change. {ref. 5.1.3.4.8 (5)}
The gauge must indicate header pressure only.

5.1.3.4.9 (8) Change. {ref. 5.1.3.4.8 (8)}
The pressure previously stipulated was removed.

5.1.3.4.9 (10) New.
An allowance for a “header vent valve” is added.

The new requirement is superior engineering and better enables the use of alternate materials and methods in these systems.

The reworded requirement narrowly defines the elements which must be redundant for systems supplying multiple systems at different pressures and eliminates some unnecessary duplication.

This very minor rewording is significant because in certain gases and with liquid containers, a gauge cannot indicate contents other than “empty”.

Header vent valves are required only for systems which contain toxic gases as a way to reduce header pressure safely during cylinder change. No medical gas in common use will require such a device, but it might be seen on nitric oxide or ethylene oxide manifolds (neither of which is a medical gas as defined by this chapter).
Changes by Paragraph

5.1.3.4.10.4 (2) New.
See 5.1.3.4.9 (10)

5.1.3.4.11 New.
This allows for a cylinder manifold with reserve, e.g.:
(see also 5.1.3.4.12.10)

This is a rare configuration but one which might be useful particularly for high volume users of nitrous oxide or carbon dioxide.

5.1.3.4.12 (4) Change. {ref. 5.1.3.4.10 (1)}
Container manifolds may now be fitted with any number of containers per side.

This change permits the use of container manifolds with one or two containers, whereas the 2002 edition explicitly limited these to two containers. Theoretically, it would also permit three or more, but in fact manifolds of that size typically fall under the requirements of 5.1.3.4.13 (ref 5.1.3.3.1.9 - 5.1.3.3.1.12).

5.1.3.4.12.4 (3) Change. {ref. 5.1.3.4.10.4 (3)}
Relief valve set point is redefined.

5.1.3.4.12.5 (2) New.
This allows for a hybrid manifold arrangement, e.g.:

Unlike other manifolds which are best operated by rotating the primary and secondary headers, hybrid container x cylinder manifolds are designed to always draw from the liquid when gas is available.

5.1.3.4.12.7 Change. {ref. 5.1.3.4.10.7}
An allowance recognizes the different operating characteristics of a liquid x gas hybrid manifold.

The new alarm recognizes that a container x cylinder manifold, in favoring the liquid side, creates a unique hazard in that the gas cylinders on the secondary can run empty as a side effect of normal operation. They must be changed prior to running completely empty. The alarm helps the operator realize when this change must occur.

5.1.3.4.12.9 New.
New alarm required “Secondary Low” for hybrid container x cylinder manifolds.
5.1.3.4.12.10 New.
See 5.1.3.4.11

5.1.3.4.13 New, Change, Reword. {ref. 5.1.3.4.11}
The entire Bulk oxygen section has been rewritten.
New and Changed:
• reference to NFPA 55. (5.1.3.4.13.1 (1))
• requirement for visual layout. (5.1.3.4.13.1 (5))
• overpressure protection during filling. (5.1.3.4.13.1 (6))
• installation to meet pipeline requirements in 5.1.10. (5.1.3.4.13.1 (7))
• installation to meet requirements in CGA M-1. (5.1.3.4.13.1 (7))
• installation per FDA Good Manufacturing Practice requirements. (5.1.3.4.13.1 (9))
• requirement for access to components during filling. (5.1.3.4.13.2)
• requirements for the foundations, mountings and enclosure as well as the vehicle pad. (5.1.3.4.13.3 and 5.1.3.4.13.4)
• system elements. (5.1.3.4.13.5)
• reserve elements. (5.1.3.4.13.6)
• fill circuit elements. (5.1.3.4.13.7)
• vaporizer elements. (5.1.3.4.13.10 and 5.1.3.4.13.11)

Reworded:
• operation. (5.1.3.4.13.8)

Unchanged:
• alarms. (5.1.3.4.13.9)

5.1.3.5.3.2 Deletion. {ref 5.1.3.5.3.2 (6)}
The requirement for piping within a medical air plant to be cleaned for oxygen service has been withdrawn.

5.1.3.5.3.2 Changed.
Materials and devices in the air plant may be as deemed suitable by the manufacturer.
See also 5.1.3.5.4.3, 5.1.3.5.5.1, 5.1.3.5.7(3), 5.1.3.5.8 (5), 5.1.3.5.9 (2)

5.1.3.5.4.1 (3) New.
Rotating element compressors are permitted for medical air service if they comply with specific requirements:
• separation of oil containing sections from oil free sections by seal(s) with atmospheric vent(s).
• visualization of the vent(s) without disassembly of the compressor.
• pressurization where the shaft enters the compression chamber.
• a procedure for the operator to inspect the vent(s). (see also 5.1.3.5.14.4)

The 2005 is the first edition of NFPA 99 which explicitly defines the unique requirements for a medical bulk system as opposed to the more general requirements for bulk systems which have previously been found in NFPA 50 or CGA documents. In this, an important gap in the medical gas source requirements has been filled.

This new allowance recognizes that there are a small number of facilities whose air demand is so high that oil less technologies are hard pressed to serve them well. If looking to use this allowance, remember that all the other provions for medical air sources still apply, and a medical plant is much more than a compressor. In particular, note the requirements under 5.1.3.5.14.4, which do apply to these compressors. Rotating element compressors of this construction have implicitly been prohibited under earlier editions and it would be wise to obtain the concurrence of local regulatory officials prior to selecting such a machine. Full compliance with all the paragraphs of
5.1.3.5.11.3 Changed. {ref 5.1.3.5.11.3}
Aftercoolers may be arranged per compressor or as a
duplexed set.

5.1.3.5.11.4 Changed. {ref 5.1.3.5.11.4}
Receiver piping must ensure air enters and exits
through different receiver ports.

5.1.3.5.11.7 New.
The allowances for three port valves is widened.

5.1.3.5.12.3 New
Compressors must restart without manual intervention
following power loss.

5.1.3.5.13.4 Changed. {ref. 5.1.3.5.13.4}
Medical air intakes may now be made of copper in any
of several grades.

5.1.3.5.13.6 New.
Air intakes must be protected, and that screen, filter etc.
must be of a non-corroding material.

5.1.3.5.14.4 Changed. {ref. 5.1.3.5.14.4}
This section also applies to rotating element
compressors. (see also 5.1.3.5.4.1 (3))

5.1.3.5.15 (3) New.
When power to the dew point of CO monitors fails,
they must activate their respective alarm(s) at the master
panels.

5.1.3.6.1.2 (6) New.
Materials and devices in the vacuum plant may be as
deemed suitable by the manufacturer.
See also 5.1.3.6.2.1

5.1.3.6.5.2 (3) New.
The three valve bypass method for isolating a receiver
is added.

the air system section is essential (see in particular
5.1.3.5.14.4).

This eliminates a configuration often used with vacuum
receivers where there is a single line used to connect
the receiver to the system and thus a single valve
can be used to isolate the receiver. While perfectly
acceptable for vacuum under some circumstances,
such a configuration is not appropriate for air systems.
In air systems, the receiver performs a useful role in
cooling the air and thus it is desirable for the air to pass
through it under normal operation.

This is a problem often observed with rotating element
compressors, which are subsceptible to failure if
stopped and restarted too quickly (e.g. following power
drop out for the generator test). In order to protect
the machine, the manufacturer prevents the machine
from restarting until after a timed cool down period
or appropriate manual intervention. Clearly, this is
entirely unsuitable for medical applications, and thus
this new requirement has been added.

This is a long time requirement which was lost in the
2002 cycle and is now restored. (see NFPA 99 1999
4-3.1.1.9)

Note that this only requires the master alarms to be
activated. In most cases it would be impossible to
operate the local alarms, since the monitors have no
power.
5.1.3.6.6.3 (6) New.
Vacuum pumps must restart without manual intervention following power loss.

5.1.3.6.8 New.
Lag alarms must latch (i.e. require manual reset at the vacuum plant site)

5.1.3.7.1.2 Change. (ref. 5.1.3.7.1.2 (2))
Where dilution cannot be assured, pumps must be safe with waste anesthesia.

5.1.3.7.1.3/4 New.
Requirements for small local WAGD producers have been established.

5.1.3.7.1.7 New.
Water is permitted as a power source for WAGD venturis.

5.1.3.7.2.1 New.
Pumps used for WAGD service shall be safe in for use with oxygen and other waste anesthetic components.

5.1.3.7.2.2 New.
Requirements for low vacuum WAGD producers are now included here.

5.1.3.7.2.3 New.
A minimum distance between the inlet and the point at which dual use systems tie together is established.

5.1.3.7.5.3 (6) New.
WAGD producers must restart without manual intervention following power loss.

The many changes in the WAGD section reflect concern that newer WAGD interfaces may be changing some of the conditions in the systems, which in turn may have resulting in an increase in the associated risk. In addition, there has long been unease about mixing waste anesthetic gas and oil inside the pumps. The 2005 edition is the first to absolutely require that WAGD producers be inert in the presence of oxygen.

5.1.3.8.7.1 (3) New.
Materials for the elements of the instrument air plant may be as deemed suitable by the manufacturer. See also 5.1.3.8.7.2 (5)

5.1.3.8.10.1 New.
Lag alarms must latch (i.e. require manual reset at the plant site)

5.1.3.8.11 New.
Instrument air compressors must have the same basic electrical controls as other critical use compressor systems.

5.1.4.5 Change. (ref. 5.1.4.5 and 5.1.4.5.4)
Main line shutoff valves may now be omitted when a source is:
• within the building.
• physically against the outside wall of the building.

The new requirements and allowances also reflect and allow additional technologies for dealing with WAGD.

To obtain more information on WAGD and the associated issues, please contact BeaconMedaes to request our paper on WAGD systems.
5.1.5.3 Change. (ref. 5.1.5.3)
Vacuum inlets may now have a secondary check as an option.

5.1.5.16 Change. (ref. 5.1.5.16)
Wording defining the required location for WAGD inlets has been made more specific and no longer relies on definition of “anesthetizing location”.

5.1.5.16.1 Restatement. (ref. 5.1.5.1, 5.1.5.9, 5.1.5.13)
The requirements in this paragraph are already covered elsewhere, but have not previously specifically referenced WAGD. (see also 5.1.5.16.1 (3) below)

5.1.5.16.1 (3) New.
WAGD inlets must be appropriate for the vacuum levels in the systems and the interfaces on which they will operate.

5.1.6.7. (3) Change. (ref. 5.1.6.7)
Vacuum connections (e.g. at the ceiling) may now be open (i.e. have no check valve).

5.1.8.2.3.1 Clarification.
Gauges in valve boxes or on alarms do not need to be mounted on demand checks.

5.1.9.1 (10) Clarification.
CO and dew point alarms may be electrically fed from the medical air or instrument air systems with which they are mounted.

5.1.9.2.2 New.
A computer may substitute for one of the two required master alarm panels under certain circumstances. (see 5.1.9.4)

5.1.9.2.3.3 New.
Master alarms may, where appropriate, monitor a single device (e.g. the same switch).

5.1.9.2.4 (4) & (5) New.
The reserve in use and reserve low alarms, required for some manifolds (see 5.1.3.4.11.10, 5.1.3.4.12.9) are added.

Changes by Paragraph

This change should finally resolve one of the more pointless debates in the industry regarding the design of inlets which used a single valve with two functions (e.g. the Diamond II/III) versus designs which used two valves. Since the single valve designs had the positive characteristic that they did not roar when disassembled for maintenance at the bedside. However, they were argued not to comply with the letter of this paragraph as written in earlier editions.

WAGD systems operate at different pressures depending on the producer, interface, etc. Use of the wrong type can create a hazard to the patient and the equipment.

The manufacturers of manufactured assemblies found the requirement made meeting the flow requirements for these products very difficult. Since they often rely on very long lengths of small bore hose internally, elimination of every possible restriction is the only way adequate flow can be obtained.
5.1.9.2.4 (10) Change. (ref. 5.1.9.2.4 (9))
The alarm set point for the dew point alarm is changed to 2°C (35°F).

5.1.9.3.1 Change. (ref. 5.1.9.3.1)
The words “continuous responsible surveillance” has been reduced to “surveillance”.

5.1.9.3.4 (2) Change. (ref. 5.1.9.3.4 (2))
Alarm sensors for anesthetizing locations may now be either on the source or the patient side of the valve.

5.1.9.4 New.
Computers may be used to substitute for one of the two required master alarms if the computer can be demonstrated to comply with all the requirements in this section:
• continuous uninterrupted operation.
• continuously attended or providing remote signaling.
• supervised signal interface devices.
• power for the signaling switches/sensors from the computer or the life safety branch.
• wiring from the computer to the signaling switches or sensors same as an alarm panel.
• provided with an audio alert.
• compliance with labelling.
• the operating program(s) includes allocate the highest priority to medical gas alarms.
• medical gas alarms interrupt any other activity of the computer.
• activation of an audible alert, activation of any remote signaling protocol and display of the specific condition in alarm.
• provide for compliance with all other general alarm requirements.
see also 5.1.12.3.5.1

5.1.9.5.2 Rewrite.
The rewrite should make more clear the intent of having at least one master alarm signal for each plant.

5.1.9.5.4 (5) New.
The requirement for the WAGD lag alarm is here instead of in 5.1.3. The latching requirement is new.

5.1.10.2.1 (1) Reword.
The references to the various standards are more explicit and complete.

5.1.10.2.1 (2) New.
Stainless is now permitted as a vacuum piping material.
5.1.10.2.2 New. During installation, tubing for vacuum which is not the same as that used for medical gases (i.e. ASTM B-819) must be marked to prevent mixing it into the medical gas pipeline.

5.1.10.2.2 New. Marking is not required where vacuum is installed per the requirement for medical gas.

5.1.10.2.3 New Allowance. WAGD systems operated at low vacuum (<130 mmHgV (<5 inHgV)) may be made of any material suitable to the service. See also 5.1.10.9.

5.1.10.4 (1) New Allowance. Check valves (which are used only on the Emergency Oxygen Connection piping (ref 5.1.3.4.14.2 (4)) may be threaded.

5.1.10.5.1.6 New Allowance. Brazing on cryogenic piping may be done with flux and BAg alloy.

5.1.10.5.1.8 Reinforcement. See 5.1.10.5.5.1

5.1.10.5.3.5 New. Abrasive pads used to clean tubing must be non-shedding.

5.1.10.5.3.13 Change. Cleared joints can sit for eight hours prior to brazing.

5.1.10.5.5.5 New. Oxygen analyzers are required to ensure all air is cleared from the pipeline prior to brazing.

These requirements for properly marking vacuum tubing during installation are the result of the allowance for the use of any of several materials, most of which will not be cleaned for oxygen. They are intended to prevent mixups where the wrong tube is installed into the medical gas pipeline.

This allowance is very helpful for the installer who does go through the extra effort to install vacuum in the same manner as medical gas.

An important step forward, allowing WAGD systems to be constructed in the least expensive manner possible. Low vacuum systems (130 mmHgV (5 inHgV)) of course do not require the same strength of materials as a system operating at 304 mmHgV (12 inHgV) or greater. Note that materials requirement for high vacuum systems have not changed see 5.1.10.2.3 (1).

This allowance is NOT permitted in earlier editions, where WAGD systems must be piped as per Vacuum, irrelevant of the vacuum level.

This is a recognition that these checks, which under the 2002 edition had to be brazed with factory installed tubing extensions, were unobtainable at any reasonable price premium over standard checks. Therefore the requirement was being ignored.

This is in direct contravention of earlier editions since 1999, and although the requirement has been widely ignored, be aware that it did exist and may remain enforceable by local authority.

The suppliers of these systems have discovered that BCuP alloys are inferior to BAg alloys when exposed to cryogenic temperatures.

The change is from one to eight hours.
5.1.10.6 New.
A new process for joining pipe, Gas Tungsten Arc Autogenous Welding (GTAW) has been added to the standard.

GTAW is a process for orbital welding of copper. The method is technologically elegant and yields an excellent joint. But it is tricky, requires a specially trained operator, a special machine, a specific purge gas mixture and very tight quality control.

@ This jointing method is NOT permitted in earlier editions. Paradoxically, the use of the technique when properly used is almost undetectable after the fact, as the resulting joint is nearly invisible.

5.1.10.7 (4) New.
A new fitting type, the axially swaged fitting has been added to the standard.

This fitting is likely to become very popular. Unlike brazing or the new GTAW method, the device is simple, the method of installation is simple, there is no purge required, and there is no flame involved. This will be of particular value for work involving a small number of joints. There are specific limitations on the connector and not all axially swaged connectors will be suitable. The tests to be applied are:

• Does the completed joint have the same thermal integrity (538°C (1,000°F) or better) as a brazed joint?
• Is the completed joint good for the pressure (150 psi or 1.5 times working pressure (whichever is higher) as a minimum?)
• Is the connector metal to metal only? Connectors which contain gaskets, o-rings or other seals are not permissible.
• Is the joint permanent (i.e. cannot be disassembled)?

@ This fitting is NOT permitted in earlier editions, as it would have to be viewed as a compression fitting. Use of these fittings should be pre-approved by local authorities prior to use.

5.1.10.7 Deleted {ref. 5.1.10.5.8 (4) - (8)}
Permission to use gasketed type fittings for vacuum has been withdrawn.

Among these fittings are gasketed clamp fittings (i.e. Victaulic style), which were briefly permitted in the 2002 edition and then withdrawn under a T.I.A.

5.1.10.8 (3) New.
Crimpers, if used to permanently stop the flow of gas, are prohibited.

These crimping tools are sometimes used in emergency situations to shut off flow from a line which might be cut or broken. Such use is not prohibited, but the use of such a tool to permanently terminate a line instead of a proper cap is what this provision ends to prevent.

5.1.10.9 New.
WAGD piping is to be joined like vacuum above 320 mmHgV (12 inHgV) but may be joined using other methods suitable to the materials and the service when under 130 mmHgV (5 inHgV).

NFPA 99 has long referred to “electrical switchgear rooms” as a prohibited location for medical gases. However, no definition for such a room exists in any NFPA document. In this edition, a more usable set of requirements has replaced the term.

5.1.10.10.3.2 Reword.
The location of medical gases relative to “electrical switchgear” has been clarified to be rooms with gear 600 volts and over. Two specific exemptions are made.
Changes by Paragraph

5.1.10.5.2 Change. {ref. 5.1.10.6.5.2}
Piping no longer required to be buried in a continuous split enclosure if another way to protect it during burial can be found. See 5.1.10.5.3.

5.1.10.5.3 New.
If a continuous split conduit is employed, it must drain and permit access to the joints during testing.

5.1.11.1.1 Rewrite. {ref. 5.1.11.1.1-.3}

5.1.12.2.5.2 Change {ref. 5.1.12.2.5.2}
A more exact description of the purge procedure is provided.

5.1.12.2.7.3 Reword.
The requirement is defined differently, but is not changed.

5.1.12.3.1.8 Change {ref. 5.1.12.3.1.8}
The system gas may now be used for the listed tests without prior authorization of the authority having jurisdiction.
See also 5.1.12.3.8.1, 5.1.12.3.10.1 and 5.1.12.3.5.1(E)

5.1.12.3.5.1(G) New.
This paragraph includes a computer (if used) in the alarm test procedures.
see 5.1.9.4.

5.1.12.3.8.2 Reword {ref 5.1.12.3.8.2}
The new word added “nonmethane” does not change the meaning.

5.1.12.3.8.4 Change {ref. 5.1.12.3.8 (Di)}
The limits are changed to 5 ppm for hydrocarbons and also for halogenated hydrocarbon.

5.1.12.3.9.2 New.
Vacuum joints may be tested with an ultrasonic leak detector.

5.1.12.3.10.3 New.
Support gases are now called out as their own category, and the flow test is that previously specified for nitrogen.

Table 5.1.12.3.11 Change.
Oxygen concentration is now >=97%, reflecting the accuracy of the oxygen analyzer.

5.1.13 Removal.
A large section of the text previously here has been moved to Chapter 9 Gas Equipment.

These tests are part of what will make implementing a computer as an alarm panel difficult. These test may require coordination between the computer programmer/manufacturer, gas supplier and verifier, and can result in some surprises (see Annex A).

This is not a reduction in the quality of the oxygen but an adjustment based on the required accuracy of the instrument.
5.1.14 New.
These sections define the applicability of all requirements relating to medical support gases (At present, nitrogen and instrument air).

5.3.3.4.4 Reword.

5.3.3.4.5.2 Reword.

5.3.3.6.3 New.
Proviso added here to remind the user that local codes have precedence in the arrangement of drains.

5.3.5.2 Change. [ref. 5.3.5.2]
The limitation for interchangeability of medical gas outlets in Level 3 is expanded from only air to all other services, including water.

5.3.9.1 New and Changed.
Paragraph (5) is revised, paragraphs (6) and (7) are new. The rewriting makes the description of the intended function of the alarms more complete, and corrects for the fact that changeover alarms are not required in every case.

5.3.10.9 (3) New.
The axially swaged fittings allowed in level 1 and 2 are also permitted here. (see commentary for 5.1.10.7 (4))

5.3.10.10.3.1 New.
A requirement for oxygen pipes to be larger than Nitrous Oxide pipes is introduced.

5.3.10.10.3.2 New.
Nitrous oxide piping now has a defined minimum size.

5.3.10.10.3.3 New.
Piping for other service (e.g. device air, vacuum must be of a different size than oxygen and nitrous oxide.

5.3.10.10.3.4 Changed. [ref 5.3.10.10.3.3]
Runouts for alarms, etc. are now permitted to be 8mm (1/4 in.) OD

5.3.10.10.4.2 Changed. [ref 5.3.10.10.4.2]
This requirement now only applies to medical gas tubing.

5.3.10.5 Changed. [ref 5.3.10.5 (A)]
Piping does not have to be run overhead, but it may be run that way if preferred.

This is a highly significant change. It was demonstrated to the committee that a manufacturer has in fact made a water outlet which can be accessed with a gas adapter. A more disastrous scenario can scarcely be imagined.

The old wording, which some would call an error in the 2002, has given installers of dental systems nightmares. It is actually very difficult and undesirable to run vacuum piping overhead, yet the wording of the 2002 required that be done. The problem has been corrected here in the 2005.
Changes by Paragraph

5.3.10.10.5.2 New.
Requirements for the piping of systems other than medical gases has been added.

5.3.10.10.7 Reword and Deletion.
Redundant text was deleted.

5.3.10.10.7.1 The allowance for soft tubing was moved and limited to gas powered devices and vacuum. See also 5.3.10.1.2 and 5.3.10.2.

5.3.10.10.8 Change.
The requirements for underground piping from Level 1/2 systems were changed for level 3 as well. See 5.1.10.10.5.

5.3.10.10.10.3 Change [ref. 5.3.10.10.10.3]
Cleanouts are limited to vertical piping.

5.3.12.3.1.1 New.
Verifier tests are only required for medical gases in Level 3.

5.3.12.3.2 and 3 Deletion.
Requirements for testing vacuum are deleted except for a basic cross connection test.

5.3.12.3.4.1 Change [ref. 5.3.12.3.5.1]
All warning systems for medical gases now must be tested.

5.3.12.3.8.3 Change. [ref 5.3.12.3.9.3]
Only Level 3 medical gases must now be tested.

5.3.12.3.11 Change. [ref 5.3.12.3.12]
Only Level 3 medical gases labelling must now be checked.

5.3.12.3.12.1 Change. [ref 5.3.12.3.13.1]
Only Level 3 medical gas sources must now be checked.

5.3.12.3.12.3 New.
Level 3 medical gas sources must now be checked.

5.3.12.4 New.
This section now details the testing requirements for non-medical gas systems. See 5.3.12.3.13.3 in the 2002 edition.

5.3.13 Removed. [ref 5.3.13.1, .2 and .3]
This section and others in the Administration section have been removed to Chapter 9 Gas Systems.
Annex A
Notes on Computers as Substitute Alarms

One of the changes to the 2005 which has been greeted with general acclaim has been the change which allows a computer to act as one of the two master alarm panels. While this is clearly a useful change and will improve the surveillance of medical gases in some facilities, it is a complex change, easily misunderstood and easy to implement badly. To assist with implementation of the change, we offer some general observations and guidance.

It is essential to begin with the understanding that this change is not intended to diminish in any way the ultimate level of surveillance or safety which is the role of the medical gas alarm system. In this, all the elements of the alarm system which are present when a panel is installed must be present when a computer is used, and one additional safeguard is required.

First question: Is the computer you are contemplating for this application suitable? The one requirement in which the computer must be superior to a panel is that a computer must be under continuous supervision (5.1.9.4.1 (2)). To be acceptable, the computer must be continuously supervised or equipped to remotely advise the responsible person(s) through pagers, etc. An installation where this requirement may be met might be a central Building Automation System (BAS) where an attendant is present 24 hours, or which is equipped to page the engineer on duty when certain programmed events occur. An unsuitable computer would be the P.C. on the chief engineers desk, which is turned off at night and locked in the office.

Once the supervision of the computer is evaluated and agreed to be suitable, the next question is how to get the signals into the computer and the other alarm panel. This is more tricky than it sounds, because of the way alarm panels are designed to be wired and the fact that computers work differently.

A quick brief on alarm wiring (ref Fig A1.):
An alarm panel sends out a current on the wires to the switch and detects the returning current. If the switch opens or the wire is cut, the alarm detects the circuit is broken and signals the fault. (Incidentally, this is why alarms do not detect shorts in the wiring.)

Fig A2. shows the switch/sensor wiring as required by 5.1.9.2.3. To make this operate, the alarms must be able to cooperate to the extent necessary to prevent the two power supplies from “bucking” one another. This is a minor trick as long as the same design has been employed for both power sources. However, a computer substituting for an alarm must also perform this trick, and it is extremely unlikely that the same design will have been used for the computer’s power supply (in fact, it is often difficult simply to get a computer power supply with the same voltage).

To get a computer to work with a panel, several strategies can be employed, all of which must be evaluated in light of the requirements of 5.1.9.4.1(3) through (5). This gets to be extremely tricky because there is a problem which can be created which can go undetected until a critical moment when suddenly the facility has no alarms.

One trick is to install a relay or a signal interface. The difficulty with these is that they are not typically arranged to power the switch but commonly only read the presence of power on the line. Essentially they will therefore depend on the other panel to power the
switch and simply read the presence of the signal from that panel. Fig. A3 illustrates this effect.

This is a subtle flaw which will be detected only when the alarm panel is shut off. Unlike two alarms, where the second alarm will simply carry on as if it had always been alone, in this case the computer will fail as well, since it will presume the switch has opened because of the absence of current.

This is a fault the verifier should test by shutting down the alarm panel and checking that the computer continues to monitor all signals correctly, and then disconnecting the computer and ensuring the alarm panel continues to monitor all signals correctly.

Another method (often the easiest of all) is to simply install two switches. This will work in any case where this facility exists (i.e. line pressure switches) but it is not a realistic option for the dew point monitor, inside the control cabinets of air or vacuum plant, etc. where a single contact is all that is available.

It is the complexity of solving this issue which may in fact make the elimination of an alarm so problematic that the anticipated savings for the panel disappears in additional interfaces, switches, wiring and programming.

There is a workaround, which has been available to any facility forever. The rules are that two panels are required, and the wiring between them and their switches is tightly prescribed for absolute safety. However, it has always been true that a facility can go beyond the standard and monitor the medical gases at as many additional points as they desire. There are no limits on the wiring of the third panel, fourth panel, etc.

Modern alarms like the Total Alert or the MEGA II provide a direct digital communications path which can easily be read into any computer system which is programmed to interpret the signal. If the two alarm panels are installed as required, it becomes very easy to use the digital output to read into a computer as a “third panel”. Figure A4 shows this configuration.

Before letting enthusiasm for this new allowance in the standard induce you to take on a project which requires struggling with all the complexities of the wiring as described above, don’t forget that this older but proven option is still available and may in fact prove quicker, cheaper and less trouble to implement.