Committee on NFPA 99

MEMORANDUM

TO: NFPA Technical Committee on Piping Systems

FROM: Jeanne Moreau-Correia

DATE: March 3, 2010

SUBJECT: NFPA 99 A11 ROP Letter Ballot

The ROP letter ballot for NFPA 99 HEA-PIP is attached. The ballot is for formally voting on whether or not you concur with the committee’s actions on the proposals. Reasons must accompany all negative and abstention ballots.

Please do not vote negatively because of editorial errors. However, please bring such errors to my attention for action.

Please complete and return your ballot as soon as possible but no later than Tuesday, March 16, 2010. As noted on the ballot form, please submit the ballot to Jeanne Moreau-Correia, e-mail to jmoreaucorreia@nfpa.org or fax to 617-984-7110.

The return of ballots is required by the Regulations Governing Committee Projects.

Attachment: Proposals
99-1     Log #11  HEA-PIP
(Entire Document)       Final Action: Reject

Submitter: David Escherick,
Recommendation: Include the examples of Level 3 occupancies.
Substantiation: See my comment on Comment 99-18 (Log #164).
Committee Meeting Action: Reject
Committee Statement: Examples are not needed as the definitions will be revised.

99-3     Log #109  HEA-PIP
(Entire Document)       Final Action: Reject

Submitter: Fred Petito, Medical Technology Associates, Inc.
Recommendation: During the National MGPHO meeting in Indianapolis, the members had an interesting discussion regarding frequency of testing for Medical Gas and Vacuum systems. NFPA 99C provides a thorough review of the elements of testing for Level 1, 2 and 3 piped gas and vacuum systems, but does not establish planned testing/inspection frequency. Many sections of Chapter 5 state "periodic testing procedure", "periodically tested" and "regular preventive maintenance schedule" must be completed without reference to specific timing. Facilities that are governed by NFPA 99C will be better served if the language provided a defined frequency of testing (e.g., alarms should be tested annually to assure they are functioning properly, etc.). Annual testing/inspection would assist the hospital in maintaining compliance with NFPA 99C.
Substantiation: A defined testing system will eliminate confusion regarding frequency of testing and improve proper operations of alarms, outlets and other components of the medical gas pipeline system.
Committee Meeting Action: Reject
Committee Statement: The submitter did not propose any specific recommendation for change. Also see action on proposal 99-341 (Log #CP251).

99-4     Log #255  HEA-PIP
(Entire Document)       Final Action: Accept

Submitter: Keith Ferrari, Praxair
Recommendation: Replace all references to "NFPA 50" with "NFPA 55".
Substantiation: This is an editorial change.
NFPA 55 incorporated all instances of NFPA 50, 2001 into the 2005 edition of NFPA 55 and should now be used in its place.
This is not original material; its reference/source is as follows:
NFPA 55, 2005
Committee Meeting Action: Accept
Technical Committee on Piping Systems,

99-5 Log #CP250 HEA-PIP

Submitter: Technical Committee on Piping Systems,
Recommendation: Update references as follows:

ASME BPV, VIII, IX 2007
ASME B 31.3 2002 2008
ASME B 40.100 2005
ASSE 6010 2006
ASSE 6030 2004 2006
ASTM B 32 2008
ASTM B 88 2002 2003
ASTM B 280 2002 2008
ASTM E 84 2009
ANSI/AWS A5.8 2004
CGA C-7 2004 Ed.8, 2004
CGA G-4 1990 Ed.10, 2008
CGA G-4.1 2004 Ed.4, 2004
CGA G-6.1 2002 Ed.6, 2005
CGA G-6.5 2004 Ed.5, 2007
CGA G-8.1 1990 Ed.4, 2001
CGAM-1 (add space after CGA)
CGA M-1 2005 Ed.2, 2007
CGA O2-DIR Ed.4, 2000
CGA V-1 2009 Ed.12, 2005
CGAV-5 (add space after CGA)
CGA V-5 2000 Ed.6, 2008
MSS SP-69 2002 2003

Substantiation: The references were updated to current editions.
Committee Meeting Action: Accept

99-6 Log #CP5 HEA-PIP

Submitter: Technical Committee on Piping Systems,
Recommendation: Review entire document to: 1) Update any extracted material by preparing separate proposals to do so, and 2) review and update references to other organizations documents, by preparing proposal(s) as required.
Substantiation: To conform to the NFPA Regulations Governing Committee Projects.
Committee Meeting Action: Accept
99-7 Log #CP210 HEA-PIP
(Entire Document)
Final Action: Accept

Submitter: Technical Committee on Piping Systems,
Recommendation: Make the nominal units first, followed by Imperial units, followed by metric. For pressures, have Imperial units first followed by metric. For example section 5.1.10.1.4 would read "...NPS 3, (3 1/8 in. O.D.), DN80)." Also pressures would be "...gauge pressure of 185 psi (1275 kPa)."
Substantiation: Domestic users of this document continue to prefer the Imperial measurement unit.
Committee Meeting Action: Accept

99-14 Log #CP214 HEA-PIP
(Chapter 2)
Final Action: Accept

Submitter: Technical Committee on Piping Systems,
Recommendation: Add the following references to Chapter 2.
ASSE 6040, Professional Qualification Standard for Medical Gas Maintenance Personnel, 2006
ASTM F 441, Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80, 2009.

Substantiation: References need to be added to standard as they are not presently listed in Chapter 2.
Committee Meeting Action: Accept

99-24 Log #266aa HEA-PIP
(3.3.x Proportioning System for Medical Air (New))
Final Action: Accept in Principle

Submitter: Keith Ferrari, Praxair, Tamara Brown
Recommendation: Add a definition of Proportioning System for Medical Air to the definitions section of NFPA 99.
Substantiation: Section 3.3.106 Medical Air Definition and Section 5.1.3.5 Level 1 Medical Air Supply Systems refer to Medical Air USP reconstituted from oxygen USP and oil free, dry Nitrogen NF. Currently, NFPA 99 does not define a system that reconstitutes Medical Air USP from Oxygen USP and Nitrogen NF. Also, additional proposals defining a Proportioning system, if accepted, will need a definition for a Proportioning System.
Definition needed: Section 3.3.x Proportioning System for Medical Air USP (Proportioning System): a central supply that produces medical air (USP) reconstituted from Oxygen USP and Nitrogen NF as in by the means of a mixer or blender.
This will clarify the definition of the word – Proportioning System.
This is not original material; its reference/source is as follows:
References to International Standard ISO 7396-1 and CSA A305.1
Committee Meeting Action: Accept in Principle
This proposal will be sent to the HEA-PIP committee as it is in their jurisdiction.
Section 3.3.x Proportioning System for Medical Air USP. A central supply that produces medical air (USP) reconstituted from oxygen USP and nitrogen NF by means of a mixer or blender. (PIP)

Committee Statement: A definition was provided per the request of the submitter.
99-25  Log #267  HEA-PIP
(3.3.x Proportioning System for Medical Air USP (New))

Submitter: Keith Ferrari, Praxair, Tamara Brown
Recommendation:  Add a definition of Proportioning System for Medical Air to the definitions section of NFPA 99 as follows:
Section 3.3.X Proportioning System for Medical Air USP : a central supply that produces medical air (USP) reconstituted from Oxygen USP and Nitrogen NF as in by the means of a mixer or blender.
Substantiation: Section 3.3.106 Medical Air Definition and Section 5.1.3.5 Level 1 Medical Air Supply Systems refer to Medical Air USP reconstituted from oxygen USP and oil free, dry Nitrogen NF. Currently, NFPA 99 does not define a system that reconstitutes Medical Air USP from Oxygen USP and Nitrogen NF. Also, additional proposals defining a Proportioning system, if accepted, will need a definition for a Proportioning System.

This will clarify the definition of the word – Proportioning System.

This is not original material; its reference/source is as follows:
References to International Standard ISO 7396-1 and Canadian Standards CSA – Z305.1
Committee Meeting Action: Accept in Principle
Committee Statement: See Committee Action on Proposal 99-24 (Log #266aa)

99-46  Log #174  HEA-PIP
(3.3.80 Instrument Air)

Submitter: Dale Woodin, ASHE-American Society for Healthcare Engineering of the American Hospital Association (AHA)
Recommendation:  Revise text to read as follows:
3.3.80 Instrument Air. For the purposes of this standard, instrument air is air intended for the powering of medical devices unrelated to human respiration and where the air comes in direct contact with patients in an invasive setting (e.g., surgical tools, ceiling arms). Medical air and instrument air are distinct systems for mutually exclusive applications. Instrument air is a medical support gas that falls under the general requirements for medical gases. (PIP)
Substantiation: Provide a more specific definition that limits the application directly to invasive procedures.
This is not original material; its reference/source is as follows:
I am proposing this revision on behalf of the ASHE Medical Gas Workgroup chaired by Ed Tinsley
Committee Meeting Action: Reject
Committee Statement: Instrument air and nitrogen are support gases that should be used for these purposes.

99-48  Log #2  HEA-PIP
(3.3.90 Level 1 Medical Piped Gas and Vacuum Systems)

Submitter: James Everitt,
Recommendation:  Reconsider the original proposal and place the text as an annex note.
Substantiation: The annex note will meet the submitter’s intent and will provide clarity to the user of the document.
Committee Meeting Action: Reject
Committee Statement: Examples are not needed as the definitions will be revised.
99-49  Log #4  HEA-PIP
(3.3.90 Level 1 Medical Piped Gas and Vacuum Systems)
Final Action: Reject

Submitter: Peter Esherick,
Recommendation: I agree with Mr. Mohile.
Substantiation: I agree with Mr. Mohile. Further, the committee statement is ridiculous. Anyone who interprets the statement to be “all inclusive” is not thinking very well.
Committee Meeting Action: Reject
Committee Statement: The submitter has not offered any recommended change.

99-50  Log #8  HEA-PIP
(3.3.90 Level 1 Medical Piped Gas and Vacuum Systems)
Final Action: Reject

Submitter: David B. Mohile,
Recommendation: Accept proposal as written.
Substantiation: I disagree with the TC’s action on this proposal.
There continues to be a great amount of confusion out in the industry regarding what level a facility is.
Mr. Wagner is correct that we use examples in several other places in the document. Perhaps we can change the words “an example” to the term “e.g.”.
And although we do list wording such as “eminent danger of morbidity or mortality” in the document, this is very difficult for the average engineer or contractor to understand and interpret.
This would not be an all inclusive statement, but would merely give an example.
Committee Meeting Action: Reject
Committee Statement: Examples are not needed as the definitions will be revised.

99-51  Log #1  HEA-PIP
(3.3.92 Level 2 Medical Piped Gas and Vacuum Systems)
Final Action: Accept in Part

Submitter: James Everitt,
Recommendation: Reconsider the original proposal and place the text as an annex note.
Substantiation: The annex note will meet the submitter’s intent and will provide clarity to the user of the document.
Committee Meeting Action: Accept in Part
Delete 5.3.12.3.7 (2) and (4) only and renumber the remaining sections.
Committee Statement: b. The items were deleted previously in level 1 by the committee. The committee feels the remaining tests are still valid and should not be deleted.

99-52  Log #5  HEA-PIP
(3.3.92 Level 2 Medical Piped Gas and Vacuum Systems)
Final Action: Reject

Submitter: Peter Esherick,
Recommendation: I agree with Mr. Mohile.
Substantiation: I agree with Mr. Mohile. Further, the committee statement is ridiculous. Anyone who interprets the statement to be “all inclusive” is not thinking very well.
Committee Meeting Action: Reject
Committee Statement: The submitter has not recommended any changes.
99-53  Log #9  HEA-PIP
(3.3.92 Level 2 Medical Piped Gas and Vacuum Systems)

Final Action: Reject

Submitter: David B. Mohile,
Recommendation: Accept proposal 99-40 (Log #107) as written.
Substantiation: I disagree with the TC's action on this proposal.
I agree with Mr. Wagner's comments.
We are merely giving examples and not an all-inclusive list. Confusion between Level 2 and 3 is the biggest problem in the field for engineers, contractors, and end users. We need to give an easier to understand definition other than "manageable risk of morbidity and mortality".
By using terms such as "...but not be limited to."
This would also permit considerable cost savings for construction material for Level 2 facilities since they could go to simplex compressors, dryers, filters, alarms, etc., which are currently permitted by the Standard but frequently overlooked by design engineers due to confusion.
Committee Meeting Action: Reject
Committee Statement: Examples are not needed as the definitions will be revised.

99-54  Log #12  HEA-PIP
(3.3.92 Level 2 Medical Piped Gas and Vacuum Systems)

Final Action: Reject

Submitter: David Esherick,
Recommendation: Include the examples listed in proposal.
Substantiation: See my comment on 99-18 (Log #164).
Committee Meeting Action: Reject
Committee Statement: Examples are not needed as the definitions will be revised.

99-55  Log #3  HEA-PIP
(3.3.94 Level 3 Piped Gas Systems)

Final Action: Reject

Submitter: James Everitt,
Recommendation: Reconsider the original proposal and place the text as an annex note.
Substantiation: The annex note will meet the submitter's intent and will provide clarity to the user of the document.
Committee Meeting Action: Reject
Committee Statement: Make up air has been added to the document and the ventilation requirements have been requested to be transferred to the TC MEC.

99-56  Log #6  HEA-PIP
(3.3.94 Level 3 Piped Gas Systems)

Final Action: Reject

Submitter: Peter Esherick,
Recommendation: I agree with Mr. Mohile.
Substantiation: I agree with Mr. Mohile. Further, the committee statement is ridiculous. Anyone who interprets the statement to be "all inclusive" is not thinking very well.
Committee Meeting Action: Reject
Committee Statement: The submitter has not recommended any changes.
### 99-57  Log #10 HEA-PIP  
**Final Action: Reject**  

**(3.3.94 Level 3 Piped Gas Systems)**  

**Submitter:** David B. Mohile,  
**Recommendation:** Accept proposal 99-41 (Log #106) as written.  
**Substantiation:** I disagree with the TC’s action on this proposal.  
I agree with Mr. Wagner’s comments.  
We are merely giving examples and not an all-inclusive list. Confusion between Level 2 and 3 is the biggest problem in the field for engineers, contractors, and end users. We need to give an easier to understand definition other than “not place patients at risk of morbidity and mortality”.  
By using terms such as “...but not be limited to.”  
There are a lot of Level 3 facilities that should be Level 2 due to the nature of the procedures being performed.  
**Committee Meeting Action:** Reject  
**Committee Statement:** Examples are not needed as the definitions will be revised.

### 99-58  Log #28 HEA-PIP  
**Final Action: Reject**  

**(3.3.95 Level 3 Vacuum System)**  

**Submitter:** Burton R. Klein, Burton Klein Associates  
**Recommendation:** Revise the definition for Level 3 Vacuum System to read:  
A Level 3 vacuum distribution system that can be is either a wet system designed to remote liquids, air-gas, or solids from the treated area; or a dry system designed to trap liquid and solids before the service inlet and to accommodate air-gas only through the service inlet.  
**Substantiation:** Editorial.  
**Committee Meeting Action:** Reject  
**Committee Statement:** Level 3 is a term that will no longer be used in the document. Also see action on Proposal 99-117 (Log# 277) where Level 3 Vacuum Systems was deleted.

### 99-60  Log #175aa HEA-PIP  
**Final Action: Reject**  

**(3.3.111 Medical Support Gas)**  

**Submitter:** Dale Woodin, ASHE-American Society for Healthcare Engineering of the American Hospital Association (AHA)  
**Recommendation:** Revise text to read as follows:  
3.3.111 Medical Support Gas. Piped gases such as nitrogen and instrument air that are used to support medical procedures by operating medical–surgical tools, equipment booms, pendants, and similar medical support applications and/or where the gas comes in direct contact with patients in an invasive setting.  
**Substantiation:** Provide a more specific definition that limits the application directly to invasive procedures.  
This is not original material; its reference/source is as follows:  
I am proposing this revision on behalf of the ASHE Medical Gas Workgroup chaired by Ed Tinsley  
**Committee Meeting Action:** Reject  
**Committee Statement:** Instrument air and nitrogen are support gases that should be used for these purposes.
99-69 Log #106aa HEA-PIP
(3.3.162 Scavenging)

Submitter: Burton R. Klein, Burton Klein Associates

Recommendation: Add at the end of definition the following "piped vacuum systems", so that definition reads:
3.3.162 Scavenging. An alternate term for WAGD often applied in Level 3 piped vacuum systems. (PIP)

Substantiation: Clarify what is meant by "in Level 3."

Committee Meeting Action: Accept in Principle

Committee Statement: This definition coordinates with the OSHA definition.

99-70 Log #348aa HEA-PIP
(3.3.163 SCFM)

Submitter: Marcelo M. Hirschler, GBH International

Recommendation: Revise text to read as follows:
3.3.163 SCFM. Abbreviation of flow rate units of standard cubic feet per minute.

Substantiation: The existing definition in NFPA 99 is simply an abbreviation. This should be explained. The NFPA preferred definition, contained in NFPA 1901, as follows, does not recognize that SCFM is simply an abbreviation.
SCFM. (preferred) NFPA 1901-2003
An expression of airflow rate in which the airflow rate is corrected to standard temperature and pressure.

I am the chairman of the NFPA Advisory Committee on the Glossary on Terminology. The committee was created by NFPA Standards Council to provide consistency in terminology throughout the NFPA documents. The committee has not had time to review all of my recommendations on definitions of terms. Therefore, this proposal is being submitted in my own name only.

Committee Meeting Action: Accept

99-71 Log #CP245 HEA-PIP
(3.3.174)

Submitter: Technical Committee on Piping Systems,

Recommendation: Modify definition to read as follows:

3.3.174 Support Gas. Nitrogen or instrument air used for any medical support purpose (e.g., to remove excess moisture from instruments before further processing, or to operate medical-surgical tools, air-driven booms, pendants, or similar applications) and, if appropriate to the procedures, used in laboratories and are not respired as part of any treatment.

Substantiation: To clarify misperception throughout the industry that Support Gas is required to power booms, pendants and similar devices and make clear that any type air that can accomplish this equipment type’s needs is acceptable. Also to clarify that support gas is permitted to be used to blow dry medical instruments in Central Service and Surgical Instrument Processing departments.

Committee Meeting Action: Accept
Richard Knieriem, Praxair Healthcare

Proposal to NFPA 99 committee for the purpose of including facility wide, annual medical gas
inspection/testing in the NFPA 99, 2005, Chapter 5.

Proposal: Include under Section 5.1.13 Level 1 Operation and Management of NFPA 99 2005 the following: annual
inspection/testing of all medical gas components including source supplies, control valves, monitoring alarms and
patient outlets shall be inspected, tested, and documented by credentialed personnel meeting the minimum
requirements of ASSE 6030.

Annual inspection/testing of valves shall include as listed under 5.1.4, 5.1.12.3.4.1, 5.1.12.3.4 where correlation is
compromised, 5.1.12.3.13 and Section 5.1.11.2.

Annual inspection/testing of warning alarms/signals shall include specifications listed under 5.1.9 except testing of area
alarms high pressure activation point due to accessibility.

Annual inspection/testing of pressure/vacuum indicators shall include the specifications of 5.1.8.

Annual inspection/testing of station outlets/inlets shall include the specifications of 5.1.5 through 5.1.12.3.10,
5.1.12.3.11.

Annual inspection/testing of the source equipment shall include as listed under 5.1.3, 5.1.12.3.14.2 with exception to
5.1.12.3.14.3(D, E, F).

Annual inspection/testing of warning signs shall include as listed under 5.1.13.2.

Annual inspection/testing of support gases shall include as listed under 5.1.14.

Substantiation: Due to the ongoing lack of enforcements of states, municipalities, etc., the verification process does
not meet minimum standards. The inconsistencies are often identified by inspectors (not associated with the verifier)
during periodic systemic inspections of the medical gas system. The inconsistencies commonly identify issues which
vary in concern from minimal to severe. These issues commonly compromise patient safety. The NFPA 99 standard
incorporates redundancies from equipment to testing to ensure patient safety. The periodic inspection is often a critical
action which captures items that compromise patient safety.

The periodic inspection is a homogeneous action which focuses on the entire medical gas utility system, whereas
verification often is a snapshot of a local area in the facility. These snapshots may also deny the facility of consistencies
with regards to equipment, i.e.: Outlet/inlet connections (DISS, QC, etc), manufacturer, alarm types, etc. The periodic
inspector is responsible to communicate to facility personnel on the specific and overall performance of the medical gas
utility system. The communication, or annual inspection report, often identifies equipment that may meet minimum
requirements but may soon fail. This potential failure is attributed to equipment life expectancies, frequency of use,
abuse, obsolescence, etc. Actions taken often prevent injury to patients and staff.

The medical gas utility system is often neglected until an emergency arises. At that time, patient safety is most
compromised. These emergencies often cause the temporary absence of a critical life support gas/vacuum system.

Moving from periodic to *annual inspection will prevent many accidents and emergencies.

Annual inspections shall include all components of a medical gas utility system.

Source equipment varies from cryogenic storage/distribution of gases, high pressure storage/distribution of gases,
manufacturing of pressure/vacuum. All source systems provide many opportunities to fail, especially if neglected.

Medical gas alarm systems shall include the master, area and local alarm systems. These systems vary from digital to
analog to visual indicators, all providing opportunities for failure due to calibration neglect, power failure, sensor failure
etc.

*Annual is a minimum recommendation. There are many types of equipment that require more frequent inspection and
should be identified during an inspection.

Medical gas control valves including source, main, riser, service and zone (provided accessibility and existence).
Verifications in existing facilities often only account for the proper identification of the associated zone valve, often
neglecting the re-identification of the service, riser and source or main valves. All valves need to be identified for proper
signage. Existing valves need to be exercised to assure competence. Gauge inspections are necessary to assure
accuracy and competency. Accessibility to critical valves by unauthorized personnel must be identified as well as valves
that need to be accessible at all times.

Outlet/inlet performance and condition must be tested. Vacuum inlet performance degrades rapidly with any misuse
(body fluids, floor debris, etc); positive pressure gases begin to fail due to internal component failure as well. This failure
can be attributed to various types of debris including particulate and water, misuse, abuse (often outlets are used to
support patient equipment), and product life expectancy.
All performance requirements specified in NFPA 99 Chapter 5 should be applied to the identified components during the annual inspection.

Purity testing of all medical gasses by use of off site or on site laboratory. Analysis results should be compared to the appropriate CGA of USP criteria.

Committee Meeting Action: Accept in Principle

Change the term “Level “1” to “Category 1” throughout chapter 5 and delete definitions 3.3.90, 3.3.91, 3.3.92, 3.3.93, 3.3.94, 3.3.95. In addition change the term “Level “2” to “Category 2” throughout chapter 5.

Change the term “Level “3” to “Category 3” throughout chapter 5.

Committee Statement: Changing the “Levels” to “Categories” is consistent with the direction of the Technical Correlating Committee and consistent with the defined risk categories in the new Chapter 4, Fundamentals. Also see Committee Action on Proposal 99-341 (CP#251).

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Submitter: Technical Committee on Piping Systems,

Recommendation: Make the following editorial changes:

5.1.1.1 These requirements shall apply to health care facilities that require Category 1 systems as referenced in Chapters 13 through 15 of the draft.

5.2.1* Applicability. These requirements shall apply to health care facilities that qualify for Category 2 systems as referenced in Chapters 13 through 15 of the draft.

Substantiation: Changes are editorial. Chapters 13-15 no longer exist and Categories will now be defined in Chapter 4 of the draft.

Committee Meeting Action: Accept
99-119 Log #CP226 HEA-PIP
(Chapter 5) Final Action: Accept

Submitter: Technical Committee on Piping Systems,
Recommendation: Add/Revise the following Section Titles and make the following editorial changes.
- 5.1.3.3.1 General.
- 5.1.3.3.1(A) Ventilation of Relief Valves.
- 5.1.3.4.1 General.
- 5.1.3.4.2 Medical Gases.
- 5.1.3.5.2 Uses of Medical Air.
- 5.1.3.5.3.1 Location.
- 5.1.3.5.3.2 Required Components.
- 5.1.3.5.3.3 Air Drying Equipment.
- 5.1.3.7.3 WAGD Connections to Vacuum Piping.
- 5.1.8.1 Quality of Instrument Air.
- 5.1.4.8 Zone Valves.
- 5.1.4.9 In-Line Shutoff Valves.
- 5.1.5 Station Outlets/Inlets Outlets and Inlets.
- 5.1.9.4 Master Alarms by Computer Systems.
- 5.1.11.1.3 Medical gas pipeline piping shall not be painted.
- 5.1.12.2.4 Initial Cross-Connection Test.
- 5.1.12.2.5 Initial Piping Purge Test.
- 5.1.12.2.7 Standing Vacuum Test for Vacuum System Piping.
- 5.1.12.3.3.1 By Individual Pressurization.
- 5.1.12.3.3.2 By Pressure Differential.
- 5.1.12.3.12 Medical Air Purity Test for Compressor Sources (Compressor System).
- 5.2.5 Station Outlets/Inlets Outlets and Inlets.
- 5.2.10 Level 2 Category 2 Distribution.

Substantiation: All of these changes are either editorial or provide Section Titles to comply with the NFPA MOS.
Committee Meeting Action: Accept

99-120 Log #41 HEA-PIP
(Chapter 5 and 9.8) Final Action: Reject

Submitter: Burton R. Klein, Burton Klein Associates
Recommendation: 1. Delete 5.1.13, 5.2.13 and 5.3.13 from Chapter 5.
2. Delete Section 9.8 from Chapter 9.
3. Create a new Chapter 6 titled, "Piped Gas and Vacuum System Requirements for Existing Facilities."
4. Insert 5.1.13, 5.2.13, 5.3.13, and Section 9.8 into new Chapter 6, renumbered as Sections 6.1, 6.2, 6.3, and 6.4 respectively.
5. Revise title of Chapter 5 to "Piped Gas and Vacuum Requirements for New Facilities."
6. Renumber current Chapters 6 to 21 as 7 to 22, respectively.
Substantiation: Make it easier for users and enforcers of this document to see which requirements are applicable to new facilities, and which are applicable to existing facilities. (In the similar fashion to arrangement in NFPA 101.)
Committee Meeting Action: Reject
Committee Statement: The risk based approach of specifying the level of system will address both new and existing systems. A separate chapter is not needed.
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**Submitter:** Craig B. Williams, Life Medical Networks  
**Recommendation:** Revise text to read as follows:  
Wherever the terms medical gas or vacuum occur, the provisions shall apply to all piped systems for oxygen, nitrous oxide, medical air, carbon dioxide, helium, medical surgical vacuum, waste anesthetic gas disposal, and mixtures thereof. Wherever the name of a specific gas or vacuum occurs, the provision shall apply only to that gas.

**Substantiation:** This paragraph should be used only to define the term medical gases. The following paragraph (5.1.1.3) is used only to define vacuum systems.

**Committee Meeting Action:** Accept in Principle  
**Committee Statement:** See Committee Action on Proposal 99-124 (Log #220).

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**Submitter:** Thomas J. Mraulak, Metropolitan Detroit Plumbing Industry  
**Recommendation:** Revise text to read as follows:  
Wherever the terms medical gas or vacuum occur, the provisions shall apply to all piped systems for oxygen, nitrous oxide, medical air, carbon dioxide, helium, medical surgical vacuum, waste anesthetic gas disposal, nitrogen, instrument air, and mixtures thereof. Wherever the name of a specific gas or vacuum service occurs, the provision shall apply only to that gas.

**Substantiation:** 5.1.1.3 covers medical-surgical vacuum and waste anesthetic gas disposal. Medical support gases need to be inserted here so that they are covered in this document.

**Committee Meeting Action:** Accept

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**Submitter:** David D. Eastman, Metro Detroit Plumbing Industry Training Center  
**Recommendation:** Revise text to read as follows:  
Wherever the terms medical gas or vacuum occur, the provisions shall apply to all piped systems for oxygen, nitrous oxide, medical air, carbon dioxide, helium, medical surgical vacuum, waste anesthetic gas disposal, and mixtures thereof. Wherever the name of a specific gas or vacuum service occurs, the provision shall apply only to that gas.

**Substantiation:** The standard as currently written often refers to simply "vacuum," rather than the specific vacuum system. Under section 5.1.1.2 as currently written, the provisions of these references must also apply to positive pressure gases. Eliminating the references to "vacuum" in this section eliminates this confusion, especially since 5.1.1.3 makes a similar provision for vacuum only.

**This is not original material; its reference/source is as follows:**  
NFPA 99, Section 5.1.1.2

**Committee Meeting Action:** Accept in Principle  
**Committee Statement:** See Committee Action on Proposal 99- (Log #220).
99-126  Log #34  HEA-PIP  (5.1.1.4)  Final Action: Reject

Submitter: Burton R. Klein, Burton Klein Associates

Recommendation: 1. Move 5.1.1.4: "An existing system that is not in strict compliance with the provisions of this standard shall be permitted to be continued in use as long as the authority having jurisdiction has determined that such use does not constitute a distinct hazard to life," to 5.1.13, and designate it as 5.1.13.1.

2. Renumber existing 5.1.13.1 and 5.1.13.2 as 5.1.13.2 and 5.1.13.3, respectively.

Substantiation: Sections 5.1.1 through 5.1.12 apply to new piped systems. Section 5.1.13 applies specifically to existing systems.

Committee Meeting Action: Reject

Committee Statement: The current location is more appropriate than under operations and management.

99-127  Log #403  HEA-PIP  (5.1.3.x and A.5.1.3.x (New))  Final Action: Reject

Submitter: Joshua W. Elvove, Aurora, CO

Recommendation: Add a new provision in 5.1.3.x and a corresponding annex note A.5.1.3.x as follows:

5.1.3.x Medical gas piping shall correspond with smoke compartment zoning in new health care and ambulatory health care occupancies. Zoned shutoff valves shall be provided such that it is not possible to shut off the medical gas supply to more than one smoke compartment from a zoned shutoff valve.

A.5.1.3.x This doesn't preclude installing another valve upstream of the smoke compartment zone valve that is arranged to shut off multiple zones.

Note: feel free to relocate the proposed text where best suited in the new standard.

Substantiation: In health care occupancies (including nursing homes) and ambulatory health care occupancies, medical gas piping should be arranged so it is not possible to shut off a zone valve and have it impact on more than one smoke compartment. Should medical gas not be configured in this manner, it is possible that more than one smoke compartment will be effected when a zone shut off valve is closed which defeats the concept of relocating patients from one smoke compartment to an adjacent smoke compartment during a fire emergency. The annex note is provided to clarify that it is ok to have other valves (e.g., service valves, riser valves) upstream of the smoke compartment that shut off more than one zone in the event there is a need to secure the flow of medical gas in a larger part of the building, that this action will not be common and should not be done without the knowledge of clinical staff since it has a greater impact on patients facility-wide.

Committee Meeting Action: Reject

Committee Statement: Smoke compartment zoning is not consistent with medical gas zoning and therefore does not form a sufficient criteria for valve placement. The second proposed wording is in conflict with the basic principle of medical gas zoning.

Printed on 3/3/2010
99-128     Log #238 HEA-PIP
(5.1.3.1.1) Final Action: Accept in Principle

Submitter: Keith Ferrari, Praxair
Recommendation: Revise text to read as follows:
5.1.3.1.1* Only cylinders and containers constructed, tested, and maintained in accordance with U.S. Department of Transportation specifications and regulations shall be permitted to be used. Cylinders and containers shall be designed, constructed, and maintained in accordance with NFPA 55.

Substantiation: There is no mention of building bulk cryogenic storage tanks to ASME Section VIII.

NFPA 55 description:
Containers employed for the storage or use of cryogenic fluids shall be designed, fabricated, tested, marked (stamped), and maintained in accordance with DOT regulations; Transport Canada (TC) Transportation of Dangerous Goods Regulations; the ASME Boiler and Pressure Vessel Code, "Rules for the Construction of Unfired Pressure Vessels"; or regulations of other administering agencies.

This is not original material; its reference/source is as follows:
NFPA 55

Committee Meeting Action: Accept in Principle
Revise 5.1.3.1.1 as follows:
Design and Construction. Containers, cylinders, and tanks shall be designed, fabricated, tested, and marked (stamped) in accordance with regulations of DOT, Transport Canada (TC) Transportation of Dangerous Goods Regulations, or the ASME Boiler and Pressure Vessel Code, "Rules for the Construction of Unfired Pressure Vessels, " Section VIII. [NFPA 55, 7.1.2.1]

Committee Statement: This material was extracted from NFPA 55, Compressed Gases and Cryogenic Fluids Code as they have the expertise with this subject.

99-129     Log #369 HEA-PIP
(5.1.3.2.2) Final Action: Accept in Principle

Submitter: David D. Eastman, Metro Detroit Plumbing Industry Training Center
Recommendation: Delete text as follows:
5.1.3.2.2 Cylinders and containers shall be handled in strict accordance with 5.1.13.

Substantiation: Section 5.1.3 no longer has provisions for handling cylinders and containers.

This is not original material; its reference/source is as follows:
NFPA 99, Section 5.1.3.2.2

Committee Meeting Action: Accept in Principle
Revise text as follows:
5.1.3.2.2 Cylinders and containers shall be handled in strict accordance with Chapter 9, Gas Equipment, Section 9.7.2.

Committee Statement: The committee corrected the reference.
99-130  Log #237  HEA-PIP
(5.1.3.2.5) Final Action: Accept

Submitter: Keith Ferrari, Praxair
Recommendation: Delete the following text:
5.1.3.2.5 Wooden racks for cylinder storage shall be permitted.
Substantiation: It conflicts with 5.1.3.2.9 that states that racks shall be constructed of noncombustible or limited-combustible materials.
This is not original material; its reference/source is as follows:
NFPA 55
Committee Meeting Action: Accept

99-131  Log #143  HEA-PIP
(5.1.3.2.7) Final Action: Accept

Submitter: Craig B. Williams, Life Medical Networks
Recommendation: Delete the following text:
Cylinders not in use shall have their valve protection caps secured tightly in place.
Substantiation: This requirement is stated again with paragraph 5.1.3.1.12.
Committee Meeting Action: Accept

99-132  Log #176  HEA-PIP
(5.1.3.2.12) Final Action: Reject

Submitter: Dale Woodin, ASHE-American Society for Healthcare Engineering of the American Hospital Association (AHA)
Recommendation: Revise text to read as follows:
5.1.3.2.12 When cylinder valve protection caps shall be supplied. They shall be secured tightly in place unless the cylinder is connected for use.
Substantiation: Cylinders should have caps affixed to the cylinders until that cylinder has been secured in the rack.
This is especially true now that individual securing has been deleted.
This is not original material; its reference/source is as follows:
I am proposing this revision on behalf of the ASHE Medical Gas Workgroup chaired by Ed Tinsley
Committee Meeting Action: Reject
Committee Statement: Smaller cylinders can be protected by means other than a protective cap.

99-133  Log #370  HEA-PIP
(5.1.3.3.1(2)) Final Action: Reject

Submitter: David D. Eastman, Metro Detroit Plumbing Industry Training Center
Recommendation: Add new text to read as follows:
(2) Manifolds for gas cylinders with reserve supply. (See 5.1.3.4.11)
Substantiation: I presume that the omission of the reference to 5.1.3.4.11 was an editorial error; nevertheless, its omission leaves the installer or facility with a mandate for behavior without any specific guidance on that behavior.
Including this section reference clears up that omission.
This is not original material; its reference/source is as follows:
NFPA 99, Section 5.1.3.3.1.1(2)
Committee Meeting Action: Reject
Committee Statement: Paragraph 5.1.3.4.11 is no longer in the standard. See Committee Action on Proposal 99-168 (Log #148).
(2) Manifolds for gas cylinders with reserve supply. *(See 5.1.3.4.11)*

I presume that the omission of the reference to 5.1.3.4.11 was an editorial error; nevertheless, its omission leaves the installer or facility with a mandate for behavior without any specific guidance on that behavior. Including this section reference clears up that omission.

This is not original material; its reference/source is as follows: NFPA 99, Section 5.1.3.1.2(2)

**Committee Meeting Action:** Reject

**Committee Statement:** Paragraph 5.1.3.4.11 is no longer in the standard. See Committee Action on Proposal 99-168 (Log #148).

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Any system listed under 5.1.3.3.1.3 shall not be located in the same room with any system listed under 5.1.3.3.1.1 or 5.1.3.3.1.2, except instrument air reserve headers complying with 5.1.3.3.1.7 and 5.1.3.8.5 shall be allowed to be in the same room as an instrument air compressor when the instrument air system is the only motorized equipment located within the room.

This paragraph is confusing and sometimes interpreted to mean that cylinders can be stored in the same room as any motorized equipment as long as they are intended to be used as the reserve of an instrument air system.

**Committee Meeting Action:** Reject

**Committee Statement:** The contents of the cylinders are not hazardous to anything in the room.

---

Indoor locations for oxygen, nitrous oxide, and mixtures of these gases shall not communicate with or be adjacent to the following:

Cylinders of oxygen and nitrous should not be located in the room adjacent to an anesthetizing location. There should be at least one room between the two. If a patient is under anesthesia and the procedure has begun, this would allow the surgeon extra time to close and move the patient, should an emergency condition occur at the source.

This does not provide any additional protection.

99-137  Log #CP249  HEA-PIP  
(5.1.3.3.1.8, 5.1.3.3.1.9)  

Final Action: Accept  

Submitter: Technical Committee on Piping Systems,  
Recommendation: Revise to read as follows:  
5.1.3.3.1.8 Central supply systems for nitrous oxide and carbon dioxide using cylinders or portable containers shall be prevented from reaching temperatures lower than the recommendations of the central supply system's manufacturer, but shall never be lower than -12°C (10°F) or greater than 54°C (130°F).  
5.1.3.3.1.9 Central supply systems for oxygen with a total capacity connected and in storage of 566,335 L (20,000 ft³) or more outside of the facility at standard temperature and pressure.  

Substantiation: 20 degrees F was changed to 10 degrees F because it is more reasonable. The change to 5.1.3.3.1.9 was editorial clarification.  
Committee Meeting Action: Accept  

99-138  Log #261  HEA-PIP  
(5.1.3.3.1.13 (Central Supply System Locations) (New))  

Final Action: Reject  

Submitter: Keith Ferrari, Praxair  
Recommendation: Add new text as follows:  
Central Supply Systems for Bulk Inert Gases (examples include Nitrogen, Helium) with a total capacity connected and in storage of 20000 ft³ or more of compressed gas or cryogenic fluid at standard temperature and pressure, shall comply with CGA P-18 Standard For Bulk Inert Gas Systems.  
Substantiation: The current edition of NFPA 99 includes requirements for the individual bulk gas storage for Oxygen, Nitrous Oxide and Carbon Dioxide, but no storage guideline for Bulk Inert Medical Gases such as Nitrogen NF and Helium USP.  
This is not original material; its reference/source is as follows:  
CGA P-18 Standard for Bulk Inert Gas Systems  
Committee Meeting Action: Reject  
Committee Statement: See the Committee Action on Proposal 99-139 (Log #260).
Central Supply Systems for Non Flammable Medical Gases, Oxidizing Medical Gases, and Inert Medical Gases with a combined total capacity connected and in storage of 20000 ft³ or more at standard temperature and pressure shall be installed outdoors and the individual gas shall comply with the applicable installation standard as stated below:

- Oxygen: NFPA 55 as defined in section 5.1.3.3.1.9
- Nitrous Oxide: CGA 8-1 as defined in section 5.1.3.3.10
- Nitrogen: CGA P-18 as defined in section 5.1.3.3.1.13
- Carbon Dioxide: CGA G-6.1 or G-6.5 as defined in sections 5.1.3.3.1.11 and 5.1.3.3.1.12.

Substantiation: The current edition of NFPA 99 includes requirements for the individual bulk gas storage, but no storage guideline for when multiple gases are stored together.

Example: If we have 16,000 cubic ft of oxygen inside a building's storage room with 5000 cubic ft of nitrous oxide inside the same room (A combined 21,000 cubic ft of non flammable and oxidizing medical gas), the standard does not clearly define a max. level of storage for combined gases that can be stored inside, or a combined level of gas when they need to be stored outside.

Committee Meeting Action: Reject
Committee Statement: The submitter's intent is not clear and he is encouraged to submit a public comment to further explain his proposed change.

Electrical devices located at or above 1520 cm (5 ft) above finished floor to avoid physical damage if oxygen equipment used by SWF stands higher than 44 in.

Skilled care nursing homes used to use H cylinders and M cylinders of oxygen years ago to use on their residents. These cylinders were tall enough to cause damage to light switches. Light switches are approximately 47 in. off floor, ninety percent of nursing homes in Wisconsin do not use the outdated cylinder today. They use liquid or tank which only stand 42 - 44 in. high. Well below light switches.

Committee Meeting Action: Accept in Principle
Committee Statement: See Committee Action/Statement on Proposal 99-142 (Log #239).
99-141     Log #278  HEA-PIP
(5.1.3.3.2(3)) Final Action: Accept

Submitter: Keith Ferrari, Praxair
Recommendation: Revise text to read as follows:

5.1.3.3.2* Design and Construction. Locations for central supply systems and the storage of positive pressure gases shall meet the following requirements:

(3) If outdoors, be provided with an enclosure (wall or fencing) constructed of noncombustible materials with a min. of two entry/exits.

Substantiation: This is an employee safety issue. In the case of a bulk cryogenic supply source, you could have a valve rupture or fill line leak or any other number of failure scenarios occur. If the outdoor storage location only has one entry/exit and an employee is inside the fence or enclosure performing maintenance or testing and a failure occurs blocking the only exit (for example liquid oxygen streaming through the gate opening blocking the exit), the employee will need another way out of the enclosure.

This is not original material; its reference/source is as follows:
NFPA 99, 2005 handbook, Praxair site survey guides
Committee Meeting Action: Accept

99-142     Log #239  HEA-PIP
(5.1.3.3.2(5)) Final Action: Accept in Principle

Submitter: Keith Ferrari, Praxair
Recommendation: Revise text to read as follows:

5.1.3.3.2* Design and Construction. Locations for central supply systems and the storage of positive pressure gases shall meet the following requirements:

(5) Be compliant with NFPA 70, National Electrical Code, for ordinary locations, with electrical devices located at or above 1520 mm (5 ft) above finished floor to avoid physical damage.

(10) Electrical devices shall be protected from physical damage.

Also, add detailed explanation/examples to the annex: Electrical devices shall be protected by physical protection (such as protective barrier around the electrical devices, or location of the electrical device such that it will avoid physical damage with the cylinders or containers, such as located at or above 5 ft above finished floor or other location that will not allow the possibility of the cylinders or containers to come in contact with the electrical device.

Substantiation: The requirement to have electrical devices 5 ft from floor finish applies only to sources that have cylinders or moveable containers. Also, there is new technology which allows for the electrical devices to be protected from physical damage as an alternative method from locating the electrical device 5 ft from finished floor.

Committee Meeting Action: Accept in Principle

Revise text to read as follows:

5.1.3.3.2* Design and Construction. Locations for central supply systems and the storage of positive pressure gases shall meet the following requirements:

(5) Be compliant with NFPA 70, National Electrical Code, for ordinary locations, with electrical devices located at or above 1520 mm (5 ft) above finished floor to avoid physical damage.

(10) Electrical devices shall be protected from physical damage.

Also, add detailed explanation/examples to the annex:

A.5.1.3.3.2(5) Electrical devices should be protected by physical protection (such as protective barrier around the electrical devices, or location of the electrical device such that it will avoid physical damage with the cylinders or containers, such as located at or above 5 ft above finished floor or other location that will not allow the possibility of the cylinders or containers to come in contact with the electrical device.

Committee Statement: Editorial changed "shall" to "should" for the annex material.
99-143     Log #240  HEA-PIP
(5.1.3.3.2(8))
Final Action: Accept in Principle

Submitter: Keith Ferrari, Praxair
Recommendation: Revise text to read as follows:
(8) Be supplied with electrical power compliant with the requirements for essential electrical systems as described in
Chapter 4 of this document.
Substantiation: Chapter 4 defines that medical gas equipment that needs to be powered by the essential electrical
systems. Removing the words “compliant with the requirements” clarifies the intent of the standard and allows chapter
4 to define the equipment necessary to be on the EES. Electrical equipment that is not essential for the operation of the
supply system can be powered by non-essential power (e.g.: telemetry).
Committee Meeting Action: Accept in Principle
Do not accept the proposed change but add the following annex material:
A.5.1.3.3.2(8) Chapter 4 defines that medical gas equipment that should be powered by the essential electrical
systems. Electrical equipment that is not essential for the operation of the supply system can be powered by
non-essential power (e.g.: telemetry, site lighting, etc).
Committee Statement: The proposal was not clear. The new annex material clarifies the intent of the requirement.

99-144     Log #CP213  HEA-PIP
(5.1.3.3)
Final Action: Accept

Submitter: Technical Committee on Piping Systems,
Recommendation: Add new 5.1.3.3.3.1, 5.3.3.6 to read as follows:
Ventilation requirements for manifold rooms shall be in accordance with 9.3.7.5.2 or 9.3.7.5.3.
Substantiation: Ventilation is now in the new Chapter 9.
Committee Meeting Action: Accept
Committee Statement: Referenced sections 9.3.7.5.2 and 9.3.7.5.3 are sections as they will appear in draft and not the
references from the 2005 edition.

99-145     Log #131  HEA-PIP
(5.1.3.3.1)
Final Action: Accept

Submitter: David B. Mohile, Medical Engineering Services, Inc.
Recommendation: Delete this section from Chapter 5 and send to the new Technical Committee on Mechanical
Systems.
Renumber the remaining paragraphs.
Substantiation: The section of the standard which sets the requirements for ventilation of manifold storage rooms
belongs more properly under the control of the Mechanical Systems TC personnel who are designers of these systems.
Committee Meeting Action: Accept
Renumber accordingly.
Where the total volume of medical gases connected and in storage is greater than 84,950 L (3000 ft$^3$) at STP, indoor supply locations shall be provided with dedicated mechanical ventilation systems that draw air from within 300 mm (1 ft) of the floor and operate continuously. Mechanical ventilation shall be at a rate of not less than $0.3048\m^3/min/m^2$ ($1\text{ ft}^3/\text{min}/\text{ft}^2$) of floor area over the area of storage or use. A means of makeup air shall be provided.

Substantiation: Mechanical ventilation for medical gas storage is extremely important. And also as important is the mechanical ventilation rate that removes asphyxiant gasses that can displace oxygen in the room due to the low ventilation rate. When mechanical ventilation was added to the NFPA 99 standard, no reference to ventilation rates was defined. We find 10 ft x 10 ft storage rooms with the same ventilation designs as 50 ft by 50 ft storage rooms. The mechanical rate listed above is listed in the national and local mechanical and building codes as well as NFPA 55.

This is not original material; its reference/source is as follows:
NFPA 99, 2005 handbook; NFPA 55; IMC, IBC, NFPA 5000

Committee Meeting Action: Accept in Principle
See Committee Action on Proposal 99-145 (Log #131). This proposal will be given to the TC on MEC.

Committee Statement: This proposal will be given to the TC on MEC for action. The TC on PIP recommends this proposal be accepted.

Where natural ventilation is permitted, it shall consist of two louvered openings, each having a minimum free area of 46,500 mm$^2$ (72 in.$^2$), with one located within 300 mm (1 ft) of the floor and one located within 300 mm (1 ft) of the ceiling. Natural venting shall be to outside atmosphere.

Substantiation: Natural venting should be to outside atmosphere to avoid oxygen deficient or enriched atmospheres inside the building. What good does it do to vent leaking nitrous oxide cylinders to the adjacent lunchroom or patient holding area?

Committee Meeting Action: Accept in Principle
See Committee Action on Proposal 99-145 (Log #131). The recommendation of the PIP committee is accept this proposal.

Committee Statement: The committee agrees with the proposal but is moving the proposal to the MEC committee as they will have jurisdiction for ventilation.
5.1.3.3.3 Ventilation for Outdoor Locations. Outdoor locations surrounded by impermeable walls shall have protected ventilation openings located at the base of each wall to allow free circulation of air within the enclosure. Walls that are shared with other enclosures or with buildings shall be permitted to not have openings.

Outdoor installations for Central Supply System(s) that are installed within enclosed courts or fire barriers shall be installed and ventilated per NFPA 55.

Also, an annex should be attached that reads:

Systems installed in areas with limited air flow or inadequate ventilation are subject to hazards such as oxygen-enriched or oxygen-deficient atmospheres and excessive icing of ambient vaporizers and cryogenic piping.

And, two definitions should be added:

Fire Barriers: A 2-hour fire barrier wall without openings or penetrations, and extending not less than 762 mm (30 in.) above and to the sides of the storage or use area.

Court. An open, uncovered, unoccupied space, unobstructed to the sky, bounded on three or more sides by exterior building walls.

Enclosed Court. A court bounded on all sides by the exterior walls of a building or by the exterior walls and lot lines on which walls are permitted.

Substantiation: 5.1.3.3.3 Should reference NFPA 55 for walled in areas. Current text is in contradiction with NFPA 55.

A problem arises when structures (courtyards or firewalls) are configured so as to interrupt the free movement of air around a tank where an asphyxiation hazard, a flammable hazard, or an oxygen-enriched environment can be created.

When additional walls encroach on the installation to form a walled enclosure, the focus of concern shifts away from the exposure hazards associated with the building itself to the hazards associated with personnel due to hazardous atmospheres that can be created due to the lack of free air movement and ventilation.

By specifying the minimum distance between the tank and the encroaching walls, the circulation of adequate air is ensured.

This is not original material; its reference/source is as follows:
NFPA 55, NFPA 101, and NFPA 5000
Committee Meeting Action: Accept in Principle
Committee Statement: See Committee Proposal 99-174 (Log #130).
### 99-156 Log #372 HEA-PIP

**Final Action:** Reject

**Submitter:** David D. Eastman, Metro Detroit Plumbing Industry Training Center

**Recommendation:** Add new text to read as follows:

(8) Cylinder manifolds for gas manifolds with reserve per 5.1.3.4.11

**Substantiation:** In Section 5.1.3.4, the standard as written does not allow the use of cylinder systems with reserve as a central supply system, yet in 5.1.3.4.11, it prescribes requirements for the system. In short, it provides requirements for the installation of a system that it doesn't allow, including the above text (renumbered, most likely) would eliminate this paradox.

**Committee Meeting Action:** Reject

**Committee Statement:** Paragraph 5.1.3.4.11 is no longer in the standard. See Committee Action on Proposal 99-168 (Log #148).

### 99-157 Log #CP206 HEA-PIP

**Final Action:** Accept

**Submitter:** Technical Committee on Piping Systems

**Recommendation:** Revise existing 5.1.3.4.2 as follows:

5.1.3.4.2 Central supply systems such as oxygen, medical air, nitrous oxide, carbon dioxide, and all other patient medical gases shall not be piped to, or used for, any purpose except:

1) Patient respiratory applications.

2) Patient clinical applications such as the use of insufflator to inject carbon dioxide directly into patient body cavities during laparoscopic surgery, etc.

3) Patient medical device applications such as using carbon dioxide to purge ambient air from heart-lung machine patient bloodflow ways before cardiac procedures, etc.

4) Calibration of medical devices for respiratory application.

Add to the end of existing A.5.1.3.4.2 as follows: It is the intent of this standard that patient medical gases can be cross-connected and blended only downstream of station outlets (externally of the piping distribution system) by connections to patient medical devices such as anesthesia machines, ventilators, heart-lung machines, etc. by licensed medical professionals such as anesthesiologists, respiratory therapists, perfusionists, etc.

**Substantiation:** This clarifies what is allowed for central supply systems and pipelines for medical gases.

**Committee Meeting Action:** Accept

### 99-158 Log #CP209 HEA-PIP

**Final Action:** Accept

**Submitter:** Technical Committee on Piping Systems

**Recommendation:** Add a new 5.1.3.4 as follows:

5.1.3.4 Control Equipment. For control equipment that is physically remote from the supply system, the control equipment shall be installed within a secure enclosure to prevent unauthorized access in accordance with 5.1.3.3.2(2).

5.1.3.4.1 The enclosure shall provide enough space to perform maintenance and repair.

5.1.3.4.2 The location of the enclosure for control equipment other than for medical air shall not communicate with combustible or flammable materials.

Renumber the existing 5.1.3.4 as 5.1.3.5 and renumber accordingly its subsections

**Substantiation:** These requirements were added because there are some remote control cabinets in health care facilities with insufficient safeguards.

**Committee Meeting Action:** Accept
99-160 Log #CP248 HEA-PIP  
(5.1.3.4.4)  
Final Action: Accept  

Submitter: Technical Committee on Piping Systems, 
Recommendation: Revise to read as follows:  
5.1.3.4.4* Materials. Materials used in central supply systems shall meet the following requirements:  
(1) In those portions of systems intended to handle oxygen at gauge pressures greater than 2413 kPa (350 psi), interconnecting hose shall contain no polymeric materials.  
(2) In those portions of systems intended to handle oxygen or nitrous oxide, material construction shall be compatible with oxygen under the temperatures and pressures to which the components can be exposed.  
(3) If potentially exposed to cryogenic temperatures, materials shall be designed for low temperature service.  
(4) If intended for outdoor installation, materials shall be installed per the manufacturer's requirements.  

Substantiation: The safety relief valves are rated at 350 psi and not 300 psi.  
Committee Meeting Action: Accept

99-161 Log #367 HEA-PIP  
(5.1.3.4.4(1))  
Final Action: Reject  

Submitter: John M. Skinner, Medical Equipment Technology, Inc.  
Recommendation: Delete text as follows:  
5.1.3.4.4(1) In those portions of systems intended to handle oxygen at gauge pressure greater than 2070 kPa (300 psi), interconnecting hose shall contain no polymeric materials.  
Substantiation: Building constraints this is not always a proper solution. 
Committee Meeting Action: Reject  
Committee Statement: The committee is aware of many instances of adiabatic heating in polymeric materials within pigtails, causing leakage and resulting in fires and personnel injuries.

99-162 Log #19 HEA-PIP  
(5.1.3.4.5)  
Final Action: Reject  

Submitter: Frank DaCato, Plumbers and Pipefitters Local 777 JATC  
Recommendation: When vented outside, all relief lines shall be labeled as to gas and source location.  
Substantiation: If a relief valve begins to develop a slow leak due to a weak spring, this may not cause an alarm condition. If the leak is discovered on a relief line outlet that is labeled it will be easy to locate and to replace the faulty valve.  
Committee Meeting Action: Reject  
Committee Statement: The relief valves are already required to be labeled. This would be redundant. The proposal is to the wrong section.
All positive pressure central supply systems shall be provided with duplex line pressure regulators, installed with duplex final line regulators, installed in parallel with isolation valves before each regulator, installed in parallel with isolation valves before each regulator, and isolation valves or check valves after each regulator permitting service to either regulator without interruption supply and meet the following requirements:

1. Be sized for 100 percent of the system peak calculated demand at design condition
2. Be designed and constructed of materials deemed suitable by the manufacturer
3. Be equipped with a pressure indicator indicating regulated pressure.

This revised text is intended to simplify and provide a consistent statement for final line regulators used for all positive pressure central supply systems by eliminating the need for section 5.1.3.4.5.2 (bulk systems, final line regulator requirements) and 5.1.3.5.9 (regulators used for medical air compressor systems).

Committee Meeting Action: Accept in Principle

Revise to read as follows:

All positive pressure supply systems shall be provided with duplex line pressure regulators piped in parallel with the following characteristics:

1. Provided with isolation valves on the source side of each regulator
2. Provided with isolation or check valves on the patient side of each regulator
3. Provided with a pressure indicator indicating regulated pressure on or near each regulator and between the regulator and the patient side isolation valve
4. Piped to permit either regulator to be serviced without interrupting supply.
5. Each regulator shall be sized for 100% of the peak calculated demand
6. Constructed of materials deemed suitable by the manufacturer.

Substantiation: The text was revised to provide consistency between regulators.

Submitter: Craig B. Williams, Life Medical Networks
Recommendation: Revise text to read as follows:

Substantiation: This revised text is intended to simplify and provide a consistent statement for final line regulators used for all positive pressure central supply systems by eliminating the need for section 5.1.3.4.5.2 (bulk systems, final line regulator requirements) and 5.1.3.5.9 (regulators used for medical air compressor systems).

Committee Meeting Action: Accept in Principle

Revise to read as follows:

All positive pressure supply systems shall be provided with duplex line pressure regulators piped in parallel with the following characteristics:

1. Provided with isolation valves on the source side of each regulator
2. Provided with isolation or check valves on the patient side of each regulator
3. Provided with a pressure indicator indicating regulated pressure on or near each regulator and between the regulator and the patient side isolation valve
4. Piped to permit either regulator to be serviced without interrupting supply.
5. Each regulator shall be sized for 100% of the peak calculated demand
6. Constructed of materials deemed suitable by the manufacturer.

Committee Statement: The text was revised to provide consistency between regulators.

Submitter: Mark W. Allen, BeaconMedaes
Recommendation: 5.1.3.4.5.4 Control equipment (e.g. regulator sets, relief valves, etc.) shall be physically located within the same enclosure as the supply system.

Substantiation: An increasing number of questions are being asked regarding the permitted location of the final line regulating sets, particularly where multiple pressure systems are contemplated. Having the regulation at the conventional location makes it easy to access this equipment, to understand that it exists, and to monitor it. A hazard which is created when a single high pressure line is separated into two or more pipelines at different pressures at some remote location is thus avoided.

Committee Meeting Action: Accept in Principle

Committee Statement: See Committee Action on Committee Proposal 99-158 (Log #CP209).
Relief Valves.
All pressure relief valves shall meet the following requirements:
(1) Be of brass, bronze, or stainless steel construction
(2) Be designed for the specific gas service
(3) Have a relief pressure setting not higher than the maximum allowable working pressure (MAWP) of the component with lowest working pressure rating in the portion of the system being protected.
(4) Be vented to the outside of the building, except that relief valves for compressed air systems having less than 84,950 L (3000 ft$^3$) at STP shall be permitted to be diffused locally by means that will not restrict the flow
(5) Have a vent discharge line that is not smaller than the size of the relief valve outlet
(6) Where two or more relief valves discharge into a common vent line line, its internal cross-sectional area shall be not less than the aggregate cross-sectional area of all relief valve vent discharge lines served
(7) Shall not discharge into locations creating potential hazards
(8) Have the discharge terminal turned down and screened to prevent the entry of rain, snow, or vermin
(9) Shall be designed in accordance with ASME B31.3, Pressure Process Piping

Three requirements are new in this section of the 2005 edition:
1. The relief valve must relieve at or below the maximum working pressure.
2. The relief vent line must not be smaller than the relief valve outlet.
3. The relief valve must comply with ASME B31.3, Pressure Process Piping[6].

These are all primarily related to bulk gas installations, but they apply to all relief valves used with medical gases.

The location of the pressure relief valve in relation to shutoff valves is important. No shutoff valve should be positioned in a location that would allow pressure to build up in the supply portion of a system if the shutoff valve were closed.

Although the hazards vary, any release of gas(es) in an enclosed area could be hazardous to persons inside or around the immediate area. All gases, except medical air, should be vented to the outside and into a safe location, as required by 5.1.3.4.6.1(4) and (7).

Vent lines are intended to be short, to discharge outdoors, and to discharge where they will not be a hazard either to the building or to anyone who might be nearby. Specific hazards of concern are the gas (e.g., nitrous oxide could be hazardous if discharged into any occupied space or drawn into the building), aggravation of a fire hazard (e.g., oxygen could cause a severe fire if discharged anywhere near an ignition source), and the pressure (e.g., a sudden discharge of high pressure gas could be noisy and very frightening to passerby and might physically blow dirt, stones, or other items near the discharge toward people).

Relief valve vent lines are permitted to be tied together (e.g., to allow a single penetration of the wall). In this case, line size is determined by calculating the areas of each of the individual vent connections (e.g., a valve with a ½ in. NPT outlet will have an area of 0.196 in.$^2$) and summing them (e.g., four ½ in. valves will have an aggregate area of 0.785 in.$^2$, indicating a line size of 1 in.).

5.1.3.4.6.1(10) Relief valve lines (the actual piping) need to be labeled, as there has been at least one report of a person tying into a relief line under the assumption that it was the system pipeline, which is an easy mistake to make since the pipe material is the same and it connects to the same equipment.

Substantiation: None.

Committee Meeting Action: Reject
Committee Statement: Relief lines are already required to be labeled 5.1.3.4.6.4.
When vented outdoors, materials and construction of relief valves discharge lines shall be the same as required for positive pressure gas medical-surgical vacuum distribution (see 5.1.10.42).

There is no reason to require oxygen cleaned piping to be used as vent piping since it will be exposed to containments from ambient air eventually by being open at one end.

Committee Meeting Action: Reject
Committee Statement: There could be oil in the tubing if tubing that is not cleaned for oxygen use is installed.

(1) If located outdoors, be installed in an enclosure used only for this purpose and sited to comply with minimum distance requirements in Figure 5.1.3.4.10.1 NFPA 55.

NFPA 99 should not add siting distances but should reference NFPA 55 for siting requirements.

Accept the proposal. In addition move Figure 5.1.3.4.10.1 to the annex as A.5.1.3.4.13.

The committee agrees that the figure should come from NFPA 55, Compressed Gases and Cryogenic Fluids Code. The material was moved to the annex with expectations to extract the figure from NFPA 55, Compressed Gases and Cryogenic Fluids Code when it becomes available.

There is no reason to have this possible configuration placed into this standard since it would be allowed anyway as an enhancement of the minimum requirement of a manifold without reserve.

Committee Meeting Action: Accept
Committee Statement: See Committee Action on Proposal 99-168 (Log #148). The Committee accepted the deletion of the whole paragraph.

See Committee Action on Proposal 99-168 (Log #148). The Committee accepted the deletion of the whole paragraph.
99-170  Log #242  HEA-PIP
(5.1.3.4.11.1(1))
Final Action: Accept in Principle

Submitter: Keith Ferrari, Praxair
Recommendation: Revise text to read as follows:
(1) If located outdoors, be installed in an enclosure used only for this purpose and sited to comply with minimum
distance requirements in Figure 5.1.3.4.10.1 NFPA 55.
Substantiation: NFPA 99 should not add siting distances but should reference NFPA 55 for siting requirements.
This is not original material; its reference/source is as follows:
NFPA 55
Committee Meeting Action: Accept in Principle
Accept the proposal. In addition move Figure 5.1.3.4.10.1 to the annex as A.5.1.3.4.13.
Committee Statement: The committee agrees that the figure should come from NFPA 55, Compressed Gases and
Cryogenic Fluids Code. The material was moved to the annex with expectations to extract the figure from NFPA 55,
Compressed Gases and Cryogenic Fluids Code when it becomes available.

99-171  Log #244  HEA-PIP
(5.1.3.4.12.1(1))
Final Action: Accept in Principle

Submitter: Keith Ferrari, Praxair
Recommendation: Revise text to read as follows:
(1) If located outdoors, be installed in an enclosure used only for this purpose and sited to comply with minimum
distance requirements in Figure 5.1.3.4.10.1 NFPA 55.
Substantiation: NFPA 99 should not add siting distances but should reference NFPA 55 for siting requirements.
This is not original material; its reference/source is as follows:
NFPA 55
Committee Meeting Action: Accept in Principle
Accept the proposal. In addition move Figure 5.1.3.4.10.1 to the annex as A.5.1.3.4.13.
Committee Statement: The committee agrees that the figure should come from NFPA 55, Compressed Gases and
Cryogenic Fluids Code. The material was moved to the annex with expectations to extract the figure from NFPA 55,
Compressed Gases and Cryogenic Fluids Code when it becomes available.

99-172  Log #192  HEA-PIP
(5.1.3.4.12.4)
Final Action: Reject

Submitter: Dale Woodin, ASHE-American Society for Healthcare Engineering of the American Hospital Association
(AHA)
Recommendation: Revise text to read as follows:
5.1.3.4.12.4 The manifolds in this category shall consist of the following:
(1) Two equal headers, per 5.1.3.4.9, each having sufficient number of liquid container connections for an average
day’s supply, but not fewer than two cylinders, and with the headers connected to the final line pressure regulator
assembly in such a manner that either header may supply the system.
Substantiation: This is currently confusing to installers and owners. Two is the required minimum for all manifolds.
This is not original material; its reference/source is as follows:
I am proposing this revision on behalf of the ASHE Medical Gas Workgroup chaired by Ed Tinsley
Committee Meeting Action: Reject
Committee Statement: Requiring two connections will lead to unnecessary waste of product.
A variant on the cryogenic liquid container manifold shall be permitted having three headers of cylinders. Such a variant shall comply with all requirements of 5.1.3.4.12 except:

1. The minimum number of cylinder connections required for each header under 5.1.3.4.12.4 (1) shall be two.
2. Paragraph 5.1.3.4.12.6 shall not apply.

Substantiation: There is no need to place this variant into the standard. It is confusing, nobody understands what it means, it most likely would be allowed since it appears to suggest a central supply system that exceeds the minimum requirements already stated for other cylinder or cryogenic container central supply systems.

Committee Meeting Action: Accept
Delete all of this section and move it to the Technical Committee for NFPA 55.

This material more properly belongs in the document that controls the installation and service of bulk oxygen equipment at consumer sites. The installation and monitoring of this equipment is handled by personnel who have an ASSE 6015 designation.

Revise 5.1.3.4.13 to read as follows:

5.1.3.4.13* Bulk Cryogenic Liquid Systems.

5.1.3.4.13.1 Bulk cryogenic liquid storage systems shall be in accordance with NFPA 55, Compressed Gases and Cryogenic Fluids Code.

5.1.3.4.13.2 Bulk cryogenic liquid systems shall have the following protections:

1. Be installed in accordance with NFPA 55, Compressed Gases and Cryogenic Fluids Code
2. Meet the requirements of 5.1.3.3.2(1)
3. Meet the requirements of 5.1.3.3.2(8)
4. Meet the requirements of 5.1.3.3.2(10)
5. Be installed meeting the requirements in 5.1.10.1 through 5.1.10.4.7
6. Have a minimum clearance of 3 ft (1 m) around the storage container, vaporizer(s), and pressure regulating manifold for system maintenance and operation
7. 5.1.3.4.13.3 Bulk cryogenic liquid sources shall include automatic means to provide the following functions:

1. When the main supply is supplying the system, the reserve supply shall be prevented from supplying the system until the main supply is reduced to a level at or below the reserve activation pressure.
2. When the main supply cannot supply the system, the reserve supply shall automatically begin to supply the system.
3. Where there is more than one main supply vessel, the system shall operate as described in 5.1.3.5.12 for primary, secondary, and reserve operation.
4. Where there are two or more cryogenic vessels, they shall be permitted to alternate (e.g., on a timed basis) in the roles of primary, secondary, and reserve, providing an operating cascade (primary–secondary–reserve) as required in 5.1.3.5.12.4 is maintained at all times.
5. Where a cryogenic vessel is used as the reserve, the reserve vessel shall include a means to conserve the gas produced by evaporation of the cryogenic liquid in the reserve vessel and to discharge the gas into the line upstream of the final line regulator assembly as required by 5.1.3.5.12.6.

5.1.3.4.13.4* The bulk systems shall have a local signal that visibly indicates the operating status of the equipment and an indicator at all master alarms under the following conditions:

1. When or at a predetermined set point before the main supply reaches an average day's supply, indicating low contents
2. When or at a predetermined set point before the reserve supply begins to supply the system, indicating reserve is in use
3. When or at a predetermined set point before the reserve supply contents fall to one day's average supply, indicating reserve low
4. If the reserve is a cryogenic vessel, when or at a predetermined set point before the reserve internal pressure falls too low for the reserve to operate properly, indicating reserve failure
5. Where there is more than one main supply vessel, when or at a predetermined set point before the secondary vessel begins to supply the system, indicating changeover

Committee Statement: In response to the joint effort of the NFPA 99 PIP TC and the NFPA 55 TC to coordinate their respective documents, a public comment was submitted to the NFPA 55 committee and accepted by the committee during the recent ROC meeting. The proposal was designed to address the issues raised in NFPA 99 ROP Item 99-174 (Log #130) to establish generic requirements for all bulk cryogenic fluid systems used in medical gas applications. As accepted by the NFPA 55 committee the provisions are applicable to all cryogenic fluids including those that are inert such as nitrogen and helium. Compliance with ANSI/CGA P-18 Standard For Bulk Inert Gas Systems is also a requirement for inert gas systems. Additional specific requirements for the installation of bulk oxygen systems specified in NFPA 55 Chapter 9 remain in place as has been past practice.
It is proposed that Sections 5.1.3.4.13.8 and 5.1.3.13.9 remain with the content shown, but that the sections be renumbered to reflect necessary change in numbering after the preceding sections are deleted.

99-175 Log #179 HEA-PIP
(5.1.3.4.13.1)
Final Action: Accept in Principle

Submitter: Dale Woodin, ASHE-American Society for Healthcare Engineering of the American Hospital Association (AHA)
Recommendation: Delete the following text:
   (6) Protection against overpressurization of the pressure vessel during filling operations.
Substantiation: This requirement is redundant – it is already addressed in NFPA 55 section 8.2.4.1.1 and 8.3.6.
This is not original material; its reference/source is as follows:
I am proposing this revision on behalf of the ASHE Medical Gas Workgroup chaired by Ed Tinsley
Committee Meeting Action: Accept in Principle
Committee Statement: See Committee Action on Proposal 99-174 (Log #130).

99-176 Log #235 HEA-PIP
(5.1.3.4.13.1)
Final Action: Accept in Principle

Submitter: Keith Ferrari, Praxair
Recommendation: Revise text to read as follows:
   5.1.3.4.13* Bulk Cryogenic Liquid Systems.
   5.1.3.4.13.1 Bulk cryogenic liquid systems shall have the following protections:
      (2) Location in an enclosure constructed per 5.1.3.3.2(1) through 5.1.3.3.2(3) and 5.1.3.3.2(5), 5.1.3.3.2(8), and 5.1.3.3.2(9)
      (3) Location in an enclosure ventilated per 5.1.3.3.3
      (4) Location in compliance with CGA M-1, \textit{Guide for Medical Gas Installations at Consumer Sites}
      (5) Design such that the items noted in 5.1.3.4.13.2 and items located in trailer unloading area are readily visible to delivery personnel during filling operations
      (6) Protection against overpressurization of the pressure vessel during filling operations.
      (7) Installation per 5.1.10.1 through 5.1.10.5.7
      (8) Installation by personnel qualified to meet CGA M-1, \textit{Guide for Medical Gas Installations at Consumer Sites}
      (9) Installation in compliance with Food and Drug Administration (FDA) Current Good Manufacturing Practices as found in 21 CFR 210 and 21 CFR 211.
Substantiation: Remove 5.1.3.4.13.1(6) because it is redundant to NFPA 99 5.1.3.4.13.1(1).
NFPA 55 already states in sections:
   8.2.4 Pressure-Relief Devices.
   8.2.4.1 General.
   8.2.4.1.1 Pressure-relief devices shall be provided to protect containers and systems containing cryogenic fluids from rupture in the event of overpressure.
   8.3 Pressure-Relief Vent Piping.
   8.3.5 Overfilling. Controls shall be provided to prevent overfilling of stationary containers.
This is not original material; its reference/source is as follows:
NFPA 55
Committee Meeting Action: Accept in Principle
Committee Statement: See Committee Action on Proposal 99-174 (Log #130).
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**Submitter:** Keith Ferrari, Praxair

**Recommendation:** Revise text to read as follows:


**Substantiation:** Text is too confusing with references to NFPA 50, 55, and 1996 edition of NFPA 50. Use the latest edition of NFPA 55.

**Committee Meeting Action:** Accept in Principle

**Committee Statement:** See Committee Action on Proposal 99-174 (Log #130).

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**Submitter:** Bruce Gane, United States Welding

**Recommendation:** Add new text to read as follows:

Installers of Bulk Cryogenic Systems shall meet the requirements of ASSE 6015 Professional Qualifications Standard for Bulk Medical Gas System Installers.

**Substantiation:** The NFPA 99 standard requires installers of medical gas piping to meet the requirements of ASSE 6010 (section 5.1.12.3.1.3). Since the series 6000 standards now contain a section of qualifications for bulk medical gas system installers they should also be included. Setting minimum qualification standards for installers of bulk systems is a method to help insure the quality and reliability of the medical gas source equipment and supply.

**Committee Meeting Action:** Accept in Principle

**Committee Statement:** See Committee Action on Proposal 99-174 (Log #130).

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**Submitter:** Keith Ferrari, Praxair

**Recommendation:** Revise text to read as follows:

2. Location in an enclosure constructed per 5.1.3.3.2.2(1) through 5.1.3.3.2.2(3) and 5.1.3.3.2.2(5), 5.1.3.3.2.2(6), and 5.1.3.3.2.2(9). Design and Construction.

**Substantiation:** Bulk cryogenic liquid systems can have cylinders as a backup. Those cylinders should be supported by racks/chains/etc., as referenced in 5.1.3.3.2.2(7). Bulk cryogenic liquid systems define the locations for central supply systems and the storage of positive pressure gases requirements that shall be met. No need to list each section number.

**Committee Meeting Action:** Accept in Principle

**Committee Statement:** See Committee Action on Proposal 99-174 (Log #130).
99-180 Log #183 HEA-PIP

(5.1.3.4.13.4) Final Action: Accept in Principle

Submitter: Dale Woodin, ASHE-American Society for Healthcare Engineering of the American Hospital Association (AHA)

Recommendation: Revise text to read as follows:

5.1.3.4.13.4 The equipment pad and vehicle pad shall:

1. Be sloped to provide that all drainage run away from any building, parked vehicles, or combustible materials.

Substantiation: The pads should be level to allow any spillage of the cryogenic fluid to absorb heat from the pad and to vaporize.

This is not original material; its reference/source is as follows:

I am proposing this revision on behalf of the ASHE Medical Gas Workgroup chaired by Ed Tinsley

Committee Meeting Action: Accept in Principle

Committee Statement: This material will be sent to the TC on IMG for processing in NFPA 55. See Committee Proposal 99-174 (Log #130).

99-181 Log #247 HEA-PIP

(5.1.3.4.13.4) Final Action: Accept in Principle

Submitter: Keith Ferrari, Praxair

Recommendation: Delete the following text:

5.1.3.4.13.4 The equipment pad and vehicle pad shall:

1. Be sloped to provide that all drainage run away from any building, parked vehicles, or combustible materials.

2. Have no drain located within the pad or closer than 2450 mm (8 ft) from the edge of the pad.

Add new section

5.1.3.4.13.3 (7) The equipment pad shall be sited per NFPA 55.

Substantiation: 5.1.3.4.13.3 has the siting references. No need to have a separate section for equipment and vehicle pad siting. Vehicle was already sited in 5.1.3.4.13.3 (5). (Should change NFPA 50 to NFPA 55).

Also, No need to provide slope to the equipment pad. This requires equipment to be shimmed up which introduces possibility of corrosion under CS tank legs if not grouted properly which could lead to a hazardous condition.

The text should have read:

The vehicle pad shall be sloped to provide that all drainage run away from any building, parked vehicles, or combustible materials.

The equipment pad and vehicle pad shall have no drain located within the pad or closer than 2450 mm (8 ft) from the edge of the pad.

This is not original material; its reference/source is as follows:

NFPA 55

Committee Meeting Action: Accept in Principle

Committee Statement: This will be sent to the TC on IMG for processing in NFPA 55, Compressed Gases and Cryogenic Fluids Code. See Committee Proposal 99-174 (Log #130).
99-182  Log #390 HEA-PIP
(5.1.3.4.13.5(1))

Submitter: Jan Ehrenwerth, Yale University School of Medicine
Recommendation: Add new text to read as follows:
Bulk cryogenic liquid sources shall consist of the following: (1) One or more main supply vessel(s), whose capacity shall be determined after consideration of delivery schedules, proximity of the facility to alternate supplies, and the emergency plan. *The primary supply vessel shall be sized to provide no less than a one week supply.*
Substantiation: Due to the critical nature of an institution's oxygen supply a minimum vessel that will hold a one week supply is essential. Although supply schedules and proximity of alternate sources is important, in a disaster situation the institution may have to function for a prolonged period without access to refills. Therefore a one week main supply is an important safety measure.
Committee Meeting Action: Reject
Committee Statement: This is a minimum requirement and the facility should perform a risk analysis to determine the amount of oxygen that is needed for their facility. This proposal could be very costly for the small facilities.

99-183  Log #389 HEA-PIP
(5.1.3.4.13.5(3))

Submitter: Jan Ehrenwerth, Yale University School of Medicine
Recommendation: Revise text to read as follows:
A reserve supply sized for greater than an average *four* day's supply, with the appropriate size of the vessel or number of cylinders being determined after consideration of delivery schedules, proximity of the facility to alternate supplies, and the facility's emergency plan.
Substantiation: Due to the critical nature of an institution's oxygen supply a minimum vessel that will hold a four day reserve supply is essential. Although supply schedules and proximity of alternate sources is important, in a disaster situation the institution may have to function for a prolonged period without access to refills. Therefore a four day reserve supply is an important safety measure.
Committee Meeting Action: Reject
Committee Statement: This is a minimum requirement and the facility should perform a risk analysis to determine the amount of oxygen that is needed for their facility. This proposal could be very costly for the small facilities.

99-184  Log #251 HEA-PIP
(5.1.3.4.13.7)

Submitter: Keith Ferrari, Praxair
Recommendation: Change 5.1.3.4.13.7 (3) to read:
5.1.3.4.13.7 Bulk cryogenic liquid sources shall include a fill circuit consisting of the following components:
(3) A strainer with a minimum 100 mesh screen **strainer** with a body and screen both of Monel® or brass construction.
Substantiation: Clarification of material requirements for both body and screen.
This is not original material; its reference source is as follows:
Manufacturers descriptions of materials
Committee Meeting Action: Accept in Principle
Committee Statement: See Committee Action on Proposal 99-174 (Log #130).
The bulk systems shall actuate a local signal that visibly indicates the operating status of the equipment and an indicator at all master alarms under the following conditions:

Note: Anywhere in NFPA 99, please delete the word “actuate” when it is associated with the local signal and replace with the words above.

Substantiation: The current section 5.1.3.4.13.9 has caused a great deal of confusion & misconception as to the purpose & meaning of the local signal requirement. The word “actuate” misleads the reader to interpret the standard on local signals to require, as a minimum, a local alarm or other electronic device when a gauge or flag appropriately indicating the conditions of the source is sufficient to meet the requirement. The 2002 NFPA 99 explained the intent of the local signal as "The local signal was a new requirement in the 2002 edition and arose from the simple need of a maintenance person to know what is going on with any given piece of source equipment. Note that it is not an alarm in the sense of a local or master alarm. It is simply an indicator, which might be a gauge, a flag, a light, or some other possible manifestation that allows a maintenance person to stand at the equipment and know what conditions are present (e.g., which header of cylinders is in service). The elements to be displayed are typically those that will also be monitored at the master alarm, but the local signal is visible at the equipment rather than remotely" (Health Care Facilities Handbook - 2002, page 133).

Accept the revised text.

Also please delete the word “actuate” when it is associated with the local signal and replace with the words in the proposal as it appears in the standard in sections 5.1.3.4.10.6, 5.1.3.4.11.10, 5.1.3.4.12.9, 5.1.3.4.15.5.

Committee Meeting Action: Accept in Principle
Accept the revised text.

Committee Statement: The note should be mandatory and the committee agrees with this change.

The bulk systems shall have a local signal that visibly indicates the operating status of the equipment and an indicator at all master alarms under the following conditions:

Examples of a local signal are gauges with labels indicating the operating condition of the Bulk Gas Supply such as the fill to point or low level point.

The term actuate which is defined as putting into mechanical action or motion, does not meet the intent of the definition. Confusion as to an acceptable local signal has arisen from the placement of the word “actuate” in the standard.

Committee Meeting Action: Accept in Principle
Committee Statement: See Committee Action on Proposal 99-185 (Log #249).
Where a permanently installed cryogenic vessel is used as the reserve, the primary supply system shall have piping and manual/automatic valving configured in such a manner that operating vaporizer(s) or sections of the vaporizer can be switched to nonoperating vaporizer or section of the vaporizer to de-ice through a valving configuration that assures continuous flow to the facility through either or both vaporizers and/or sections of the vaporizer if valving switchover partially hangs up or fails.

Substantiation: The original requirement was added to address the icing problems that occur at health care facilities due to their flow rates and continuous product use. Health care facilities with cryogenic primary supply systems using high pressure cylinders as the reserve supply do not have the higher cryogenic product flow rates which can cause damage to the system, pad or equipment.

Committee Meeting Action: Reject
Committee Statement: This issue is addressed in Committee Proposal 99-188 (Log #248).

Where vaporizers are required to convert cryogenic liquid to the gaseous state, the vaporizer units shall conform to the following:

(1) Be permitted to operate by either ambient heat transfer or external thermal source (e.g. electric heater, hot water, steam)

(2) Be designed to provide adequate capacity for the customer's peak and average flowrates under local conditions, seasonal conditions for weather and humidity, and structures that obstruct air circulation flow and sunlight

(3) If switching is required as part of the system design, have piping and manual/automatic valving configured in such a manner that operating vaporizer(s) or sections of the vaporizer can be switched to nonoperating vaporizer or section of the vaporizer to de-ice through a valving configuration that assures continuous flow to the facility through either or both vaporizers and/or sections of the vaporizer if valving switchover partially hangs up or fails.

Substantiation: Vaporizer switching should not be mandatory for all medical systems. CGA M-1 allows both switching and non switching vaporizers. CGA requires that the "Primary vaporizers sized by site engineer to meet consumer consumption requirements and local weather conditions. This may include systems to alternate vaporizers for defrost cycle. The reserve vaporizer sized by site engineer to meet consumer consumption requirements and local weather conditions for a maximum continuous duty cycle of 96 hours." If the systems and vaporizers are designed correctly, switching vaporizers are not necessary. As a minimum requirement, switching vaporizers should not be required. Switching vaporizers are costly to implement that aren't designed as such and switching is not an industry standard.

This is not original material; its reference/source is as follows:
CGA M-1

Committee Meeting Action: Accept in Principle
Committee Statement: See Committee Action on Proposal 99-174 (Log #130).
99-189  Log #374  HEA-PIP
(5.1.3.4.14)
Final Action: Accept

Submitter: David D. Eastman, Metro Detroit Plumbing Industry Training Center
Recommendation: Revise text to read as follows:
5.1.3.4.14 Emergency Oxygen Supply Connection (EOSC) EOSC’s shall be installed to permit connection of a temporary auxiliary source of supply for emergency or maintenance situations under ANY of the following conditions:...
Substantiation: As written, Section 5.1.3.4.14 seems to state that all three conditions must exist before an EOSC is required. Strict interpretation of this section would leave many large facilities without an EOSC, if all three provisions must apply, then no large facility that doesn’t consist of multiple free-standing buildings would require an EOSC, even if it was supplied from a bulk cryogenic system and did not have an indoor oxygen reserve connected.
This is not original material; its reference/source is as follows:
NFPA 99 Section 5.1.3.4.14
Committee Meeting Action: Accept

99-190  Log #299  HEA-PIP
(5.1.3.4.14(3))
Final Action: Reject

Submitter: Mark W. Allen, BeaconMedaes
Recommendation: Reword to read:
5.1.3.4.14(3) Where multiple freestanding buildings are served from a single oxygen source such that damage to the interconnecting... a separate emergency connection. For this purpose, two buildings connected by a tunnel, skybridge or corridor through which the oxygen line runs are not freestanding if the passage is large enough to access and repair the piping if needed.
Substantiation: This requirement was originally intended to apply to campuses of widely separated buildings where multiple lines run underground. It is clearly not necessary where the piping is accessible from within the connecting passage and could be repaired like any other length of piping in the building(s). This revision attempts to clarify.
Committee Meeting Action: Reject
Committee Statement: The existing location for EOSC’s are appropriate.

99-191  Log #180  HEA-PIP
(5.1.3.4.14.1)
Final Action: Reject

Submitter: Dale Woodin, ASHE-American Society for Healthcare Engineering of the American Hospital Association (AHA)
Recommendation: Revise text to read as follows:
5.1.3.4.14.1 EOSCs shall be located as follows:
(1) On the exterior of the building being served in a location accessible by emergency supply vehicles at all times in all weather conditions
(2) Connected to the main supply line immediately downstream of the main shutoff valve, and connected to piping sized to accept the required flow.
Substantiation: The use of the EOSC is an emergency condition at which the demand should be reduced, and is not expected to support a full operational load demand of a facility. The normal hose connection from the supply truck is 1in.
This is not original material; its reference/source is as follows:
I am proposing this revision on behalf of the ASHE Medical Gas Workgroup chaired by Ed Tinsley
Committee Meeting Action: Reject
Committee Statement: Sizing of the pipeline should be based on facility's intent and is covered in section 5.1.10.10.1.
99-192 Log #280 HEA-PIP  
(5.1.3.4.14.2(7) (New) )  
Final Action: Accept in Principle

Submitter: Keith Ferrari, Praxair

Recommendation: Add text to read as follows:
(7) Allowance for at least 1 m (3 ft) of clearance around the EOSC for connection of temporary auxiliary source of supply or maintenance situations.

Substantiation: Hospital facilities and bulk gas suppliers need the EOSC's area to be free of hazardous conditions when temporary oxygen lines are connected to the EOSC box. Too many EOSC's are installed next to natural gas manifolds, rapidly burning solids or slow burning solids, parked vehicles, inlets to sewers or drains, electrical hazards,...

To comply with NFPA 55 Table 9.3.2 would not be possible or necessary, a min. distance required would be prudent and safe.

This is not original material; its reference/source is as follows:
NFPA 99, 2005 handbook; Praxair site survey guides.

Committee Meeting Action: Accept in Principle

Add text to read as follows:
(7) A minimum of 1 m (3 ft) of clearance around the EOSC for connection of temporary auxiliary source.

Committee Statement: Editorial.

99-193 Log #150 HEA-PIP  
(5.1.3.4.15.2)  
Final Action: Accept in Principle

Submitter: Craig B. Williams, Life Medical Networks

Recommendation: Revise text to read as follows:

# When a reserve is provided inside the building as a substitute for the EOSC or for other purposes, it shall be located in accordance with 5.1.3.3 as follows:

(1) In a room or enclosure constructed per 5.1.3.3.2.

(2) In a room or enclosure ventilated per 5.1.3.3.3.

Substantiation: Current wording can be misinterpreted to mean that construction and ventilation requirements for the enclosure of an in-building reserve supply would not need to meet the requirements when it is not used as a substitute of an EOSC.

Committee Meeting Action: Accept in Principle

Revise text to read as follows:

# When a reserve is provided inside the building as a substitute for the EOSC or for other purposes, it shall be located in accordance with 5.1.3.3 as follows:

(1) In a room or enclosure constructed per 5.1.3.3.2.

Committee Statement: Ventilation is now under the responsibility of the new TC on MEC.
Submitter: Dale Woodin, ASHE-American Society for Healthcare Engineering of the American Hospital Association (AHA)

Recommendation:  Revise text to read as follows:

5.1.3.4.15.3 In-building emergency reserves shall consist of either of the following:

1) A gas cylinder header per 5.1.3.4.9 with sufficient cylinder connections to provide for at least an average day’s supply, if the supplier cannot replenish the reserve cylinders within one day, then the number of cylinders shall be increased to the required delivery schedule.

Substantiation:  If the Hospital is remote, one day’s supply may not be adequate. The number of cylinders shall be increased to meet the supplier’s delivery schedule, so that the Facility does not deplete its supply.

This is not original material; its reference/source is as follows:

I am proposing this revision on behalf of the ASHE Medical Gas Workgroup chaired by Ed Tinsley

Committee Meeting Action: Accept in Principle

Revise text to read as follows:

5.1.3.4.15.3 In-building emergency reserves shall consist of either of the following:

1) A gas cylinder header per 5.1.3.4.9, with sufficient cylinder connections to provide at least an average day’s supply, with the appropriate number of connections being determined after consideration of delivery schedule, proximity of the facility to alternate supplies, and the facility’s emergency plan.

Committee Statement: The revised language is consistent with other requirements and language of the standard.
Add a new Medical Air Supply Section – 5.1.3.5.4 Proportioning Systems for Medical Air USP
(NFPA will need to change section numbers 5.1.3.5.3.2 – 5.1.3.5.15 to reflect a new section under Medical Air. The sections will be changed to 5.1.3.5.3.1.1 – 5.1.3.5.3.3.14).

5.1.3.5.4.1 Medical air produced using a Proportioning System shall conform to the following:
(1) Medical air produced by the Proportioning System shall have oxygen content of 19.5-23.5%.
(2) Medical air produced by the Proportioning System shall meet the quality requirements per 5.1.3.5.1 and shall be capable of supplying this quality of medical air over the entire range of flow.
(3) Medical air produced by the Proportioning System shall be exempt from the requirements of 5.1.3.5.15 (Medical Air Quality Monitoring).

5.1.3.5.4.2 The Proportioning System for medical air shall conform to the following:
(1) Proportioning System shall be cleared for marketing by the FDA or approved by the FDA
(2) Supply of oxygen USP and supply of nitrogen NF conforming to the applicable requirements of 5.1.3.4.13 (Bulk Cryogenic Liquid Systems), shall be regulated to the supply pressure required for the proportioning system. The supply systems for oxygen USP and nitrogen NF shall be filtered to prevent particulate from entering the Proportioning System.
   a. It is preferable that dedicated sources of oxygen USP and nitrogen NF supply the Proportioning System.
   b. Where dedicated bulk systems for oxygen and nitrogen are dedicated for the Proportioning System, reserve sources for the oxygen and nitrogen are not required; these systems cannot be used as the reserves for oxygen and nitrogen systems supplying the pipelines of the healthcare facility.
   c. Sources of oxygen and nitrogen may be the same sources as those supplying the oxygen and nitrogen pipelines of the healthcare facility. When sources of oxygen USP and nitrogen NF are the same sources as those supplying the oxygen and nitrogen pipelines of the healthcare facility, controls shall be provided to prevent cross-contamination of oxygen and nitrogen supply lines, as provided in 5.1.3.5.4.2(3).

(3) Integration of Sources of Supply and the Proportioning System: The following engineering controls shall be in place when the sources of oxygen USP and/or nitrogen NF are the same sources as those supplying the oxygen and nitrogen pipelines of the healthcare facility, controls shall be provided to prevent cross-contamination of oxygen and nitrogen supply lines, and/or Medical Air oxygen concentration.
   a. In cases where a new supply system is installed or in cases where the one or more bulk supplies are used to supply the mixer, bulk systems and vaporizers shall be sized for total peak demand flow, including peak demand flow to the mixer and any other areas of utilization.
   b. Operating limits shall be established, at a minimum, for the oxygen and nitrogen source pressures, both high and low, and for the Medical Air oxygen concentration, both high and low, based upon USP specifications. A process upset may be defined as an excursion in the process windows established for oxygen and nitrogen source pressures and/or Medical Air oxygen concentration.
   A means to detect excursion from these process limits and power failure shall be provided.
   c. At least one dedicated valve or other control shall be installed in the proportioning system and/or the line(s) between the oxygen and/or nitrogen supply system(s) and proportioning system. The purpose of the dedicated control(s) is to prevent the cross contamination of the oxygen and nitrogen lines due to product backflow.
      i. Control(s) shall be separate from the valve(s) or other device(s) used to control oxygen flow and nitrogen flow in normal operation.
      ii. Control(s) shall not cycle in normal operation
      iii. If installed in the line(s) between the oxygen and/or nitrogen supply system(s) and proportioning system, upon activation of the control(s), an alarm shall be sent to the facility.
      iv. Control(s) may not exist exclusively via the use of check valves.
      d. In the event of a process upset, the dedicated control(s) shall either positively isolate the supply of oxygen and/or nitrogen from the mixer, or the dedicated control(s) shall reduce the mixer pressure to less than half of the minimum final line pressure values, each, for the oxygen and nitrogen lines. In the event of a process upset, the control(s) shall operate. Manual reset shall be required to restart the proportioning system.
   d. The minimum safe supply gas temperature and recommended alarm point shall be specified by the Proportioning System manufacturer. Such low temperature alarms shall be provided and connected to the facility master alarm panel.
   e. The Proportioning System shall be connected to the emergency electrical service.
requirements of the essential electrical system as described in Chapter 4 of NFPA 99. Electrical installation and wiring shall conform to the requirements of NFPA 70, National Electrical Code.

6) Dual final line regulators shall be installed within or downstream of the Proportioning System.

7) Dual line regulators are not required between the oxygen and nitrogen sources and the medical air mixer.

8) The Proportioning System shall be connected to at least one reserve supply, meeting the requirements of 5.1.3.4 (Central Supply Systems) and 5.1.3.5 (Level 1 Medical Air Supply Systems), with the exception to 5.1.3.5.11.2 that one compressor may be allowed to be utilized for the reserve system.

9) The Proportioning System shall be monitored for conditions that may affect air quality during use or in the event of failure, based on the type of Proportioning System design used in the system.

a. A local alarm complying with 5.1.9.5 (Local Alarms) shall be provided for the Proportioning System.

b. Where Proportioning System with one primary Proportioning System with a medical air reserve header per 5.1.3.4.9 (Headers) are used.

c. Where Proportioning System with one primary Proportioning System with a Proportioning System reserve are used.

d. Where Proportioning System with one primary Proportioning System with a medical air compressor per 5.1.3.5.3 (Medical Air Compressor Sources) are used.

e. When or at a predetermined set point before the reserve supply begins to supply the system, indicating reserve supply in use.

f. When or at a predetermined set point before the reserve supply contents fall to one day’s average supply, indicating reserve low

determine a stoppage of Medical Air production, malfunction of the equipment, or nonconforming oxygen concentration.

10) Alarms shall be present in accordance with 5.1.9 (Level 1 Warning Systems).

11) Where proportioning systems include or utilize receivers, the following apply:

a. Water-in-receiver alarms are not required for mixing systems. The receiver should be constructed of corrosion-resistant materials.

b. The pressure of the receiver and/or other device utilized to mix oxygen and nitrogen shall be limited by an ASME-coded relief valve to a value not greater than 80% of either the oxygen or nitrogen source pressure low limit, whichever is lower. The relief valve capacity shall be adequate considering all foreseeable failure scenarios.

12) Vent lines shall be properly sized, and materials for the vent line must comply with 5.1.10.1. The discharge of all proportioning system relief valves, process vents, and safety vents shall meet the following requirements:

a. The discharge of the valve shall be vented outside, in areas away from flammable materials and not where a passerby may be endangered by the discharge.

b. The discharge must be turned down and screened at the discharge end to prevent the entry of water or vermin.

5.1.3.4.3 Proportioning Systems local signal s and alarms shall include the following

1) A local indicator of the operating status of the Proportioning System, oxygen concentration of the Medical Air supplied, and any other critical operating or quality parameters, as determined by the manufacturer.

2) A Proportioning System proportioning alarm meeting the requirements of 5.1.9 (Level 1 Warning Systems)

3) At least one recorder of Proportioning System performance providing a means of recording Proportioning System performance and air quality for a period of time not less than 24 hours.

4) A mechanism for shutting off supply from the Proportioning System to the medical air piping system, and activating the reserve supply that employing sequential valves for redundancy.

5) At least two oxygen analyzers capable of independently monitoring oxygen concentration

6) A mechanism where each analyzer based upon non conforming oxygen concentration is capable directly or via other Proportioning System controls, of automatically shutting off the supply from the Proportioning System to the medical air piping system and activating the reserve supply.

7) A mechanism where each analyzer based upon non conforming oxygen concentration is capable directly or via other Proportioning System controls, of automatically shutting off the supply of oxygen and nitrogen to the Proportioning System and activating the reserve supply.

8) A provision for manual resetting of the Proportioning System after detection of non-conforming oxygen concentration and subsequent shutdown once conforming oxygen concentration is established, in order to reestablish flow to the medical air piping system.

9) A means of verifying the performance of the analyzers by reference to an air standard, with known traceable oxygen content.

5.1.3.4.4 Location

Proportioning Systems should include atmospheric monitoring for oxygen concentration in consideration of ventilation in the area and shall be located per 5.1.3.3 as follows:

1) In a dedicated area, adequately ventilated and with any required utilities (e.g., electricity, drains, lighting, etc.)
(2) In an area constructed per 5.1.3.3.2
(3) In an area ventilated per 5.1.3.3.2
(4) For air-cooled equipment, in an area designed to maintain the ambient temperature range as recommended by the manufacturer.

**Substantiation:** Section 3.3.106 Medical Air Definition and Section 5.1.3.5 Level 1 Medical Air Supply Systems refer to Medical Air USP reconstituted from oxygen USP and oil free, dry Nitrogen NF. Currently, NFPA 99 does not define a system that reconstitutes Medical Air USP form Oxygen USP and Nitrogen NF.

The New Section 5.1.3.5.4 Proportioning System for Medical Air USP will substantiate and define the type of system required to supply Medical Air USP supplied by reconstituted Oxygen USP and Nitrogen NF.

This is not original material; its reference/source is as follows:

References to International Standard ISO 7396-1 and Canadian Standards CSA – Z305.1

**Committee Meeting Action:** Accept in Principle

Add a new Medical Air Supply Section – 5.1.3.5.4 Proportioning Systems for Medical Air USP as follows:

(Renumber existing 5.1.3.5.3 – 5.1.3.15 to 5.1.3.5.3 –5.1.3.5.3.15 for Medical Air Compressor Requirements and specify these section for Medical Air Compressors)

5.1.3.5.4 Level 1 Medical Air Proportioning System

A.5.1.3.4 See Figure A.5.1.3.5.X.X

5.1.3.5.4.1 General

5.1.3.5.4.1.1 Medical Air reconstituted from Oxygen USP and Nitrogen NF, produced using Proportioning System(s) shall be required to meet the following:

(1) Quality of Medical Air per 5.1.3.5.1
(2) Capable of supplying this quality of medical air, per 5.1.3.5.1, over the entire range of flow
(3) Produce Oxygen content of 19.5-23.5%
(4) Cleared for marketing by the FDA or approved by the FDA

5.1.3.5.4.1.2 The Medical Air Proportioning System shall operate automatically.

5.1.3.5.4.1.3 The mixture shall be analyzed continuously and a recording capability shall be provided, e.g. via a data port.

5.1.3.5.4.1.4 This analyzing system shall be a dedicated and an independent analyzer used to control the Medical Air Proportioning System.

5.1.3.5.4.1.5 If the mixture goes out of specification, automatically an alarm shall be activated, and the primary Medical Air Proportioning System be disconnected and the reserve supply be activated.

5.1.3.5.4.1.6 The system shall be arranged such that manual intervention is necessary to correct the composition of the mixture before reconnecting the Medical Air Proportioning System to the healthcare facility pipeline system.

5.1.3.5.4.1.7 If dedicated sources of oxygen USP and nitrogen NF supply the Medical Air Proportioning System, reserve sources for the oxygen and nitrogen shall not be required.

5.1.3.5.4.1.8 If dedicated sources of oxygen USP and nitrogen NF supply the Medical Air Proportioning System, they cannot be used as the reserves for oxygen and nitrogen systems supplying the pipelines of the healthcare facility.

5.1.3.5.4.1.9∗ If the sources of oxygen USP and nitrogen NF that supply the Medical Air Proportioning System are the same sources that supply the healthcare facility, engineering controls shall be provided to prevent cross-contamination of oxygen and nitrogen supply lines, as provided in 5.1.3.4.7.

5.1.3.5.4.1.10 A risk analysis and approval from the AHJ shall be required.

(Annex) A.5.1.3.5.4.1.9∗ The engineering controls should include, as a minimum, the following:

1. Engineering controls should be in place when the sources of oxygen USP and / or nitrogen NF are the same sources as those supplying the oxygen USP and / or nitrogen NF pipelines for other uses within the healthcare facility.

   a. In cases where a new supply system is installed or in cases where the one or more bulk supplies are used to supply the mixer, bulk systems and vaporizers should be sized for total peak demand flow, including peak demand flow to the mixer and any other areas of utilization.

   b. Operating limits should be established, at a minimum, for the oxygen and nitrogen source pressures, both high and low, and for the Medical Air oxygen concentration, both high and low, based upon USP specifications. A process upset may be defined as an excursion in the process windows established for oxygen and nitrogen source pressures and/or Medical Air oxygen concentration.

   A means to detect excursion from these process limits and power failure should be provided.

   c. At least one dedicated valve or other control should be installed in the proportioning system and/or the line(s) between the oxygen and/or nitrogen supply system(s) and proportioning system. The purpose of the dedicated control(s) is to prevent the cross-contamination of the oxygen and nitrogen lines due to product backflow.

   i. Control(s) should be separate from the valve(s) or other device(s) used to control oxygen flow and nitrogen flow in normal operation.
ii. Control(s) should not cycle in normal operation
iii. If installed in the line(s) between the oxygen and/or nitrogen supply system(s) and proportioning system, upon activation of the control(s), an alarm should be sent to the facility.
iv. Control(s) may not exist exclusively via the use of check valves.
d. In the event of a process upset, the dedicated control(s) should either positively isolate the supply of oxygen and/or nitrogen from the mixer, or the dedicated control(s) should reduce the mixer pressure to less than half of the minimum final line pressure values, each, for the oxygen and nitrogen lines. In the event of a process upset, the control(s) should operate. Manual reset should be required to restart the proportioning system.

5.1.3.4.2 Location

5.1.3.4.2.1 Medical Air Proportioning System shall be located per 5.1.3.3 as follows:
(1) The Medical Air Proportioning System’s Supply of Oxygen USP and Nitrogen NF shall be located per 5.1.3.3 and NFPA 55, as applicable.
(2) The mixing device and controls, analyzers, and receivers, shall be located indoors within a room or area per 5.1.3.3.1
(3) The indoor location shall include atmospheric monitoring for oxygen concentration.
(4) The indoor location shall be constructed with all required utilities (e.g., electricity, drains, lighting, etc.) per NFPA 5000
(5) The indoor location shall be ventilated and heated per Chapter X Heating, Ventilation and Air Conditioning and manufacturer’s recommendations.

5.1.3.4.3 Required Components. Medical Air Proportioning System shall consist of the following:
(1) A supply of oxygen USP and supply of nitrogen NF
   a. The supply lines shall be filtered to remove particulate entering the proportioning system
   b. The minimum safe supply gas temperature and recommended local signal shall be specified by the Medical Air Proportioning System manufacturer.
(2) A mixing device with analyzers and engineering controls per manufacturers recommendations to include, as a minimum, the following:
   a. At least two oxygen analyzers capable of independently monitoring oxygen concentration
   b. A mechanism where each analyzer based upon non conforming oxygen concentration is capable directly or via other Medical Air Proportioning System controls, of automatically shutting off the supply from the Medical Air Proportioning System to the Medical Air Piped Distribution System and activating the reserve supply.
   c. A mechanism where each analyzer based upon non conforming oxygen concentration is capable directly or via other Proportioning System controls, of automatically shutting off the supply of oxygen and nitrogen to the Proportioning System and activating the reserve supply.
   d. A provision for manual resetting of the Proportioning System after detection of non-conforming oxygen concentration and subsequent shutdown once conforming oxygen concentration is established, in order to re-establish flow to the medical air piping system
   e. A means of verifying the performance of the analyzers by reference to an air standard, with known traceable oxygen content.
(3) A minimum of one recorder for recording the Medical Air Proportioning System performance and air quality for a period of time not less than 24 hours.
(4) The mixture shall be analyzed continuously and a recording capability shall be provided, e.g. via a data port.
(5) A mechanism for isolating the primary Medical Air Proportioning System from the reserve supply and the medical air piping distribution system, by employing sequential valves for redundancy.
(6) The reserve supply shall be capable of automatically activating if the primary supply is isolated.
(7) A reserve supply of Medical Air USP shall be sized, at minimum, for an averaged day’s supply and consisting of one of the following:
   a. An additional Medical Air Proportioning Unit with a dedicated Supply of Oxygen USP and Nitrogen NF.
   b. A Medical Air Compressor System per 5.1.3.5.3 with the exception that a simplex medical air compressor system shall be allowed.
   c. A Medical Air Cylinder Manifold per 5.1.3.4.10
(8) A receiver fitted with a pressure relief valve and pressure gauge
   a. The receiver should be constructed of corrosion-resistant materials.
   b. The receiver, relief valves and pressure gauges shall comply with ASME Boiler and Vessel Code and manufacturers recommendations.
(9) Warning Systems per 5.1.9 and include a local signal and master alarm that indicates nonconforming oxygen concentration per the manufacturers recommendations.
A.5.1.3.5.4.3(9) The Proportioning System should be monitored for conditions that may affect air quality during use or in
the event of failure, based on the type of Proportioning System design used in the system.

a. Where Proportioning Systems are configured with a Primary Proportioning System and a reserve medical air manifold per 5.1.3.4.10 are used,

b. Where Proportioning Systems are configured with a Primary Proportioning System and a reserve Proportioning System are used,

c. Where Proportioning Systems are configured with a primary Proportioning System and a reserve medical air compressor per 5.1.3.5.3 are used,

d. When or at a predetermined set point before the reserve supply begins to supply the system, indicating reserve supply in use

e. When or at a predetermined set point before the reserve supply contents fall to one day's average supply, indicating reserve low

f. Water-in-receiver alarms are not required for proportioning systems.

(10) Final line pressure regulators complying with 5.1.3.4.5
(11) Pressure Relief complying with 5.1.3.4.6
(12) Local Signals complying with 5.1.3.4.8.2

Committee Statement: The proposal changed to include the MOS format.

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99-196 Log #83 HEA-PIP Final Action: Accept in Principle
(5.1.3.5.1 and 5.1.3.6.1.1)

Submitter: Kyle Jossel, Medical Air Systems, Inc.
Recommendation: Revise text to read as follows:
5.1.3.6.1.1 (2) In a room constructed per 5.1.3.3.2
5.1.3.5.3.1 (2) In a room constructed per 5.1.3.3.2
These codes for construction of mechanical rooms need to contain different information, such as 8.1.3.4.13.1 where there is a broader construction definition for Bulk field locations.

Substantiation: The code currently refers to medical air compressor/vacuum pump (mechanical room) being constructed per 5.1.3.3.2, which seems to be intended more for manifold room purposes. Do mechanical rooms really need to be heated by indirect means, have outlets (electrical) 5 ft. above ground, etc.? There needs to be a summary for construction of a mechanical room.

Committee Meeting Action: Accept in Principle
Revise text to read as follows:
5.1.3.6.1.1 (2) In a room constructed per 5.1.3.3.2
5.1.3.5.3.1 (2) In a room constructed per 5.1.3.3.2
5.1.3.7.1.3(3) In a room constructed per 5.1.3.3.2
5.1.3.8.2.2 In a room constructed per 5.1.3.3.2

Committee Statement: For correlation this requirement also pertains to deleting other sections, which were added to the meeting action.

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99-197 Log #309 HEA-PIP Final Action: Accept
(5.1.3.5.1(5))

Submitter: Fritz Koppenberger, Environmental Testing Services Inc.
Recommendation: Revise text to read as follows:
Have equal to or less than (1) \(5 \text{ mg/m}^3\) of permanent particulates sized 1 micron or larger in the air at normal atmospheric pressure.

Substantiation: This is a substantial and unacceptable level of particulate matter. The allowable particulate matter in medical air should not exceed the 1 milligram that is allowed in all the other positive pressure gas systems.

Committee Meeting Action: Accept
Committee Statement: Note: This is now in section 5.1.3.6.1(5) of the preprint.

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Printed on 3/3/2010
Submitter: Craig B. Williams, Life Medical Networks
Recommendation: Delete the following text:

5.1.3.5.9 Medical Air Regulators. Medical air regulators shall meet the requirements:
(1) Be sized for 100 percent of the system peak calculated demand at design condition
(2) Be constructed of materials deemed suitable by the manufacturer
(3) Be equipped with a pressure indicator indicating delivery pressure.

Substantiation: Deletion of entire paragraph since it is already stated as requirements under 5.1.3.4.4, 5.1.3.4.5 and 5.1.3.4.9(5).

Committee Meeting Action: Accept

Submitter: Keith Ferrari, Praxair
Recommendation: Revise text to read as follows:

5.1.3.5.4.2 For liquid ring compressors
(a) Service water and seal water of a quality recommended by the compressor manufacturer shall be used.
(b) Reserve Medical Air standby headers shall be installed. The header shall comply with 5.1.3.4.9, except the number of attached cylinders shall be sufficient for one hour normal operation.

Substantiation: Under the current standard, if water builds up in the receiver an alarm sounds and the Medical Air Compressor System will completely shutdown. This is a patient safety issue. By incorporating reserve medical air header with cylinders, the health care facility will have time to inspect and hopefully correct the water problem prior to the system shutting down. At least this will allow the health care facility some time to react to any patients on the Medical Air System and place them on a backup system.

Committee Meeting Action: Accept in Principle

Revise text to read as follows:

5.1.3.5.4.2 Liquid ring compressors shall comply with the following:
(a) Service water and seal water of a quality recommended by the compressor manufacturer shall be used.
(b) Reserve Medical Air standby headers or a backup compressor shall be installed.
(c) When installed the header shall comply with 5.1.3.4.9.
(d) When installed the number of attached cylinders shall be sufficient for one hour normal operation.

Committee Statement: Text was revised to meet the Manual of Style.
99-200  Log #298  HEA-PIP

(5.1.3.5.4.2) Final Action: Accept in Principle

Submitter: Mark W. Allen, BeaconMedaes
Recommendation: Add new:
5.1.3.5.4.2 For liquid ring compressors, service water and seal water shall be purified to prevent waterborne pathogens and chlorine from hyperchlorination from entering the medical air.

Substantiation: The state of knowledge about waterborne pathogens and their control has made it clear that there are patient safety concerns which can result from ordinary unpurified water. The control of these pathogens commonly involves hyperchlorination, which is a standard procedure for many hospitals. The fact has been known since the 1960’s that undesirable elements in the seal water can transmit into the air, and there are documented cases of chlorine attack on plastics in outlets and ventilators. These compressors can and are still being used for medical air, and it is appropriate that the specification for seal water be changed to reflect the new understanding.

Committee Meeting Action: Accept in Principle
Add new:
5.1.3.5.4.2 For liquid ring compressors, service water and seal water shall be treated to control waterborne pathogens and chlorine from hyperchlorination from entering the medical air.
Renumber existing 5.1.3.5.4.2.
Committee Statement: You can not "prevent" but you can "control".

99-201  Log #282  HEA-PIP

(5.1.3.5.7) Final Action: Reject

Submitter: Keith Ferrari, Praxair, Mark Storey
Recommendation: Revise text to read as follows:
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 that is below the frost point [0°C (32°F)] or an Atmospheric Dew Point (ADP of -45°C (-49°F)) or a Pressure Dew Point (PDP) of -31°C (-23°F) at 101 psig (7 bar g) at any level of demand

Substantiation: We believe that the current dew point level (0°C/32°F) is inadequate for medical purposes as it is not low enough to prevent bacterial growth and inhibits the performance of downstream filtration. We also believe that people are still specifying refrigeration dryers into medical air applications, and that they are unaware they are unable to provide adequate moisture removal.

The European Pharmacopoeia, which specifies the requirements for medical air throughout Europe, states that water should not be present in concentrations greater than 60 ppm. This equates to an Atmospheric Dew Point (ADP) of -45°C (-49°F) or a Pressure Dew Point (PDP) of -31°C (-23°F) at 101 psig (7 bar g) which is below the point at which microorganisms can survive. i.e., -26°C (-15°F) PDP.

We believe to promote best practice and to ensure the integrity of our healthcare systems, that a similar approach to the specification laid out in Europe Pharmacopoeia be adopted in the next revision of NFPA 99.
Note: Supporting material is available for review at NFPA Headquarters.

This is not original material; its reference/source is as follows:
NFPA 99, 2005 handbook; NFPA 55; IMC; IBC; NFPA 5000
Committee Meeting Action: Reject
Committee Statement: A dew point that low is not considered necessary for medical air.
Medical Air Dryers shall meet the following requirements:

(1) Be designed to provide air at a maximum dew point that is below the frost point [0°C (32°F) at 345-380 (50-55 psi)] at any level of demand.

Current wording is confusing to many users since it does not specify the location within the medical air system's piping where the dew point reading is taken. Dew point falls when the pressure of compressed gas being measured also falls. NFPA 99 is also used and provides guidance to manufacturers of medical air systems and this revised text will provide them with the proper information they need to know when specifying dryers for their systems based on where the required dew point temperature is taken.

Recommendation: Revise text to read as follows:

Substantiation: Current wording is confusing to many users since it does not specify the location within the medical air system's piping where the dew point reading is taken. Dew point falls when the pressure of compressed gas being measured also falls. NFPA 99 is also used and provides guidance to manufacturers of medical air systems and this revised text will provide them with the proper information they need to know when specifying dryers for their systems based on where the required dew point temperature is taken.

Committee Meeting Action: Accept

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Compressors complying with 5.1.3.5.4.1 (2) and 5.1.5.3.4.1(3) shall be provided with the following:

(1) Coalescing filters with element change indicators
(2) Charcoal absorbers with colorimetric indicators.

This text is unnecessary since it stated in more detail under 5.1.3.5.14.4, which covers the requirements for medical air systems having compressors that comply with 5.1.3.5.4.1 (2) and 5.1.5.3.4.1(3).

Committee Meeting Action: Accept

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...minimum distance of 3.05 m (10 ft) 7.62 m (25 ft) from...


Committee Meeting Action: Accept in Principle

Delete existing 5.1.3.5.13.1 and 5.1.3.5.13.2 and replace with the following:

5.1.3.5.13.1 The medical air compressors shall draw their air from a source of clean air.
5.1.3.5.13.2 The medical air intake shall be located a minimum of 7.6 m (25 ft) from ventilating system exhausts, fuel storage vents, combustion vents, plumbing vents, vacuum and WAGD discharges, or areas that may collect vehicular exhausts or other noxious fumes.
5.1.3.5.13.3 The medical air intake shall be located a minimum of 3.0 m (10 ft) from any door, window or other opening in the building.
5.1.3.5.13.4 The medical air intake shall be located a minimum of 6 m (20 ft) above ground level.

(Remainder renumbered)

Committee Statement: The committee agrees with the submitter and wants to harmonize the requirements between AIA Guidelines and NFPA 99.
5.1.3.5.13.4 Compressor intake piping shall be permitted to be made of any material and using any jointing technique permitted under 5.1.10.1.

**Substantiation:** Any materials and methods suitable to the piping of the medical gas system should be permitted for compressor intakes.

**Committee Meeting Action:** Accept in Principle

Rereword to read:

5.1.3.5.13.4 Compressor intake piping shall be permitted to be made of materials and using a jointing technique as permitted under 5.1.10.2.

**Committee Statement:** The reference was corrected and the word "any" was deleted as it was too broad.

---

Add new text to read as follows:

5.1.3.5.13.7 Compressor air intake piping shall be brazed in accordance with 5.1.10.

There are currently no requirements for the joining of the Copper pipe mandated for use as Medical Air intake piping, which means that it can be joined any way the installer sees fit, including any of the methods that are specifically prohibited for other portions of the piping system. Adding this section corrects that oversight.

**Committee Meeting Action:** Accept in Principle

**Committee Statement:** See Committee Action on Proposal 99-205 (Log #297).

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Delete the requirement for the continuous liquid hydrocarbon monitor.

In the available forms, this device is not achieving the desired results, in fact, is virtually incapable of giving any warning at all, and is simply adding cost with no benefit in safety.

When originally promulgated, it was believed that a simple color change liquid hydrocarbon indicator was available, and although an indicator meeting the written description does in fact exist, the only practical way to implement the device also eliminates any use it has in providing an early warning of seal failure. There is no advantage in continuing to require it.

**Committee Meeting Action:** Accept

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Revise text to read as follows:

(1) Dew point shall be monitored and shall activate a local alarm and all master alarms when the dew point at system pressure exceeds +4 °C (39° F).

In the 2005 standard the dew point was changed and it was missed in this section.

**Committee Meeting Action:** Accept in Principle

**Committee Statement:** See Committee Action on Proposal 99-209 (Log #153).
## 99-209  Log #153  HEA-PIP

(5.1.3.5.15(1))

**Final Action:** Accept

**Submitter:** Craig B. Williams, Life Medical Networks

**Recommendation:** Revise text to read as follows:

Dew point shall be monitored and shall activate a local alarm and all master alarms when the dew point at system delivery pressure exceeds +4°C (+39°F) +2°C (+35°F).

**Substantiation:** This revised text is to provide the same dew point reading as stated under 5.1.9.2.4 (10) for the requirement of medical air dew point alarm at the master alarm panels and will allow for consistent dew point requirement throughout this standard.

**Committee Meeting Action:** Accept

## 99-210  Log #373  HEA-PIP

(5.1.3.5.15(1))

**Final Action:** Reject

**Submitter:** David D. Eastman, Metro Detroit Plumbing Industry Training Center

**Recommendation:** Revise text to read as follows:

5.1.3.5.15(1) Dewpoint shall be monitored and shall activate a local alarm and all master alarms when the dew point at system pressure exceeds +4°C/39°F.

**Substantiation:** All of the other requirements listed elsewhere for dew point alarm temperature refer to 39°F. Changing this section of the text will bring it into compliance with the other sections.

**This is not original material; its reference/source is as follows:**

5.1.3.5.15(1)

**Committee Meeting Action:** Reject

**Committee Statement:** The number listed is incorrect. See Proposal 99-209 (Log #153).

## 99-211  Log #154  HEA-PIP

(5.1.3.5.15(3))

**Final Action:** Accept

**Submitter:** Craig B. Williams, Life Medical Networks

**Recommendation:** Revise text to read as follows:

Dew point and carbon monoxide monitors shall activate the individual monitor’s signal at all master alarm panels if the monitor loses power, the alarm panels where their signals are required when their power is lost.

**Substantiation:** The current statement indicates that the master alarm panel will have to show an alarm condition for high carbon monoxide if its monitor loses power, which would require the carbon monoxide monitor to have its signal wired directly to both master alarm panels. The revised text will require the dew point alarm to alarm at the master and the carbon monoxide to alarm at the local alarm when their monitors loss power.

**Committee Meeting Action:** Accept
Piping between the vacuum pump(s), discharge(s), receiver(s) and the vacuum source shutoff valve shall be in accordance with 5.1.10.2, except stainless, galvanized, or black steel pipe shall be permitted to be used.

Revised text eliminates the exception of stainless steel since it is already allowed as material for vacuum systems under 5.1.10.2.

This is consistent with the Committee Action on 99-225 (Log #157).

---

Delete paragraph 6.

(6) Except as defined in 5.1.3.6.1.2(1) through 5.1.3.6.1.2(5), materials and devices used between the medical vacuum exhaust and the medical vacuum source shall be permitted to be of any design or construction appropriate for the service as determined by the manufacturer.

This paragraph implies that any material can be used for the exhaust piping to the outside of the building. That conflicts with 5.1.3.6.7.4.

The selection of material should be left to the manufacturer to determine the appropriate material.
5.1.3.6.2.1 Vacuum pumps shall be constructed of materials deemed suitable by the manufacturer.

(1) Medical vacuum pumps installed in Level 1 facilities shall be oxygen compatible, if used for combination WAGD and medical vacuum systems with a common vacuum producer pump. This does not apply if the individual piped systems and producers are installed, and provided the WAGD system producer is oxygen compatible.

Substantiation: This is intended to eliminate the possibility of an oxygen fire in the medical vacuum producer. The new anesthesia machines on the market today are not designed for use with oil containing medical vacuum producers used in this country. Most anesthesia machines are produced in Europe where dedicated piped systems are employed routinely. This is not the case in North America. An existing system which has operated satisfactorily and safely for years may be adversely affected by use with the new design anesthesia machines which allow large volumes of medical oxygen to enter the combination WAGD/medical vacuum systems. If, for example, the piping system does not provide enough dilution effect of the WAGD/vacuum content, the pure oxygen will wind up in the oil containing medical vacuum pump, leading to possible fire and explosion. Needless to say, system failure or worse.

This is not original material; its reference/source is as follows:

I am proposing this revision on behalf of the ASHE Medical Gas Workgroup chaired by Ed Tinsley
Committee Meeting Action: Reject
Committee Statement: See Committee Action on Proposal 99-226 (Log #185).

99-215 Log #376 HEA-PIP

(5.1.3.6.3(1))

Submitter: David D. Eastman, Metro Detroit Plumbing Industry Training Center

Recommendation: Revise text to read as follows:

5.1.3.6.3(1) Be made of ferrous and/or nonferrous materials: Be made of materials deemed suitable by the manufacturer.

Substantiation: Basically an editorial change that would bring the material requirements for vacuum receivers into exact compliance with the material requirements for other pieces of manufactured equipment.

This is not original material; its reference/source is as follows:

5.1.3.6.3(1)

Committee Meeting Action: Accept

99-216 Log #168 HEA-PIP

(5.1.3.6.3(3))

Submitter: Craig B. Williams, Life Medical Networks

Recommendation: Revise text to read as follows:

Be capable of withstanding a gauge pressure of 415 kPa (60 psi) and 760 mm (29.9–30 in.) gauge HgV.

Substantiation: Attempt to be realistic to vacuum gauges and vacuum pressures used in the United States.

Committee Meeting Action: Accept
<table>
<thead>
<tr>
<th>Log #</th>
<th>HEA-PIP</th>
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<tbody>
<tr>
<td>99-217</td>
<td>Log #155</td>
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<tr>
<td>99-218</td>
<td>Log #302</td>
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<td>99-219</td>
<td>Log #CP2</td>
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</tbody>
</table>

**99-217 Log #155 HEA-PIP**

(5.1.3.6.5.2)  

**Submitter:** Craig B. Williams, Life Medical Networks  
**Recommendation:** Revise text to read as follows:  
The medical-surgical vacuum receiver(s) shall be serviceable without shutting down the medical-surgical vacuum system by any of the following methods that will ensure continuation of service to the facility’s medical-surgical pipeline distribution system.  
(1) By providing an isolation valve where the receiver is tee’d into the main line  
(2) By piping the receiver at the end of a valved isolation line  
(3) By providing a three-valve bypass.  
**Substantiation:** Revised text is an attempt to eliminate extra unnecessary text.  
**Committee Meeting Action:** Accept in Principle  
**Revise text to read as follows:**  
The medical-surgical vacuum receiver(s) shall be serviceable without shutting down the medical-surgical vacuum system by any of the following methods that will ensure continuation of service to the facility’s medical-surgical pipeline distribution system.  
(1) By providing an isolation valve where the receiver is tee’d into the main line  
(2) By piping the receiver at the end of a valved isolation line  
(3) By providing a three-valve bypass.  
**Committee Statement:** Editorial.

| 99-218 Log #302 HEA-PIP  
(5.1.3.6.7.2(2)) |

**Submitter:** Keith Ferrari, Praxair  
**Recommendation:** Revise text to read as follows:  
5.1.3.6.7.2 (2) At least 3.05 m (10 ft) from any door, window, air intake, other openings in buildings or places of public assembly.  
**Substantiation:** Vacuum discharge exhaust is considered contaminated and thus is a patient/employee risk. The location the exhaust 10 feet away and including items 5.1.3.6.7.2(1 – 4) will allow the exhaust fumes to dissipate in the air before coming into contact with people.  
**Committee Meeting Action:** Accept in Principle  
**Revise text to read as follows:**  
5.1.3.6.7.2 (2) At least 3.05 m (10 ft) from any door, window, air intake, other openings in buildings or outdoor places of public assembly.  
**Committee Statement:** A slight change was made to indicate which type of places of public assembly was proposed.

| 99-219 Log #CP2 HEA-PIP  
(5.1.3.6.7.4) |

**Submitter:** Technical Committee on Piping Systems,  
**Recommendation:** Delete 5.1.3.6.7.4.  
**Substantiation:** This section was in conflict with section 5.1.3.6.1.2(6)  
**Committee Meeting Action:** Accept
99-220 Log #156 HEA-PIP
(5.1.3.6.7.5) Final Action: Accept in Principle

Submitter: Craig B. Williams, Life Medical Networks

Recommendation: Revise text to read as follows:
The exhaust shall be free of dips and loops that might trap condensate or oil or provided with a drip leg and valved drain at the bottom of a low point where the low point is unavoidable. Where such low points are unavoidable, a drip leg and valved drain shall be installed.

Substantiation: Revised text is an attempt clearly state to the user of preventing low points in the exhaust or providing a means to discharge liquids from the low point if the are unavoidable.

Committee Meeting Action: Accept in Principle

Revise text to read as follows:
The exhaust shall be free of dips and loops that might trap condensate or oil or provided with a drip leg and valved drain at the bottom of the low point.

Committee Statement: Editorial revision to make it read better.

99-221 Log #187 HEA-PIP
(5.1.3.7 (New)) Final Action: Reject

Submitter: Dale Woodin, ASHE-American Society for Healthcare Engineering of the American Hospital Association (AHA)

Recommendation: Add new text:
5.1.3.7.0 Anesthesia machines used in conjunction with WAGD systems shall meet the following requirements:
A) Be capable of ventilating/clearing the device with medical air in lieu of medical oxygen as a source gas. When medical oxygen is used for calibration of the anesthesia machine it shall ventilate the medical oxygen into the room space and not into the WAGD removal system.

Substantiation: From a practical standpoint, it would be simpler to require a handful of manufacturers in the medical equipment industry to modify the life support equipment used within the patient anesthesia application than mandate special WAGD system design capable of oxygen compatibility. Existing system, while safe to operate with present anesthesia machines, might not be capable of safe operation with the newer anesthesia machines using larger quantities of medical oxygen for ventilation and calibration of the device. Often, hospital equipment is purchased with new state of the art design to replace aging high use equipment. In some cases, the hospital engineering staff may not have knowledge of this new equipment or its intended operation which may have adverse affects on present support equipment such as medical vacuum producers containing oil as operational lubricant. Normal anesthesia drive gas quantities generally are safe to operate in existing systems and equipment provided the normal dilution occurs. The newer machines have been showing up that have higher rates of oxygen for clearing and calibration methods. These machines are okay for use in Europe with dedicated WAGD piped systems and producers, not so in North America. This is not original material; its reference/source is as follows:
I am proposing this revision on behalf of the ASHE Medical Gas Workgroup chaired by Ed Tinsley

Committee Meeting Action: Reject

Committee Statement: The recommendation is impractical and it's not the document's responsibility to tell the manufacturers how to operate their ventilators.
Submitter: Craig B. Williams, Life Medical Networks
Recommendation: Revise text to read as follows:
- **Flammable anesthetics or other flammable vapors**: Oxygen concentration shall be diluted below 23.5 percent the lower flammable limit prior to disposal into the medical-surgical vacuum system or the vacuum pump shall comply with 5.1.3.7.2.1(2).

Substantiation: Flammable anesthetics are no longer used and flammable vapors are limited in WAGD applications.
The real problem exist of high level of oxygen from the anesthesia machine during operation of the anesthesia machine, particularly at the end of a procedure when the patient's respiratory system is being flushed out with 100 percent oxygen. This high concentration of oxygen being introduced into a oil, lubricated vacuum pump operating at high temperatures is the real fire hazard.

Committee Meeting Action: Accept in Principle
Revise 5.1.3.7.1.2(2) to read as follows:
"The total concentration of oxidizers (oxygen and nitrous oxide) shall be maintained below 23.6 percent or the vacuum pump shall comply with 5.1.3.7.2.1(2)."

Committee Statement: Nitrous oxide is also an oxidizer and you can not dilute one oxidizer with another oxidizer.

---

Submitter: Bill Marlowe, Praxair
Recommendation: Revise text to read as follows:
**If WAGD... with a total power greater than or equal to 1 horsepower in total...**.

Substantiation: 5.1.3.7.1.3 currently lists requirements for WAGD greater than 1 HP, and 5.1.3.7.1.4 lists requirements for WAGD less than 1 HP, but there are no requirements for 1 HP for WAGD.

Committee Meeting Action: Accept in Principle
Revise text to read as follows:
If WAGD is produced by a dedicated WAGD producer with a total power equal to or greater than 1 horsepower in total (both producers), the following shall apply...

Committee Statement: Editorial.

---

Submitter: Craig B. Williams, Life Medical Networks
Recommendation: Revise text to read as follows:
A shutoff valve to isolate each WAGD producer from the centrally piped system and other WAGD producers for maintenance or repair without the loss of medical-surgical vacuum in the system.

Substantiation: Revised text eliminates incorrect reference to medical-surgical vacuum.
Committee Meeting Action: Accept
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<td>225</td>
<td>Log #157</td>
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<td>(5.1.3.7.1.6(4))</td>
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<td><strong>Submitter:</strong> Craig B. Williams, Life Medical Networks</td>
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<td><strong>Recommendation:</strong> Revise text to read as follows:</td>
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<td>Piping between the WAGD producers and the source shutoff valve compliant with 5.1.10.2, except stainless, galvanized, or black steel pipe shall be permitted to be used.</td>
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<td><strong>Substantiation:</strong> Revised text eliminates the exception of stainless steel since it is already allowed as material for vacuum systems under 5.1.10.2. Galvanized and black steel is allowed within as pipe material within a medical-surgical system and should also be allowed as pipe material within a WAGD system.</td>
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<td><strong>Committee Meeting Action:</strong> Accept in Principle</td>
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<td>Revise text to read as follows:</td>
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<td>Piping between the WAGD producers and the source shutoff valve compliant with 5.1.10.2, as recommended by the manufacturer.</td>
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<td><strong>Committee Statement:</strong> The material should be specified by the manufacturer.</td>
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<tr>
<td>226</td>
<td>Log #185</td>
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<td><strong>Submitter:</strong> Dale Woodin, ASHE-American Society for Healthcare Engineering of the American Hospital Association (AHA)</td>
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<td><strong>Recommendation:</strong> Revise text to read as follows:</td>
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<td>5.1.3.7.2 Dedicated WAGD Producers.</td>
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<td><strong>Substantiation:</strong> The purpose for this change is to highlight that the section headed by this title pertain to dedicated WAGD producers. Without this clarification, there has been some confusion that all WAGD producers need to meet these requirements, even where WAGD is produced through the medical-surgical vacuum source. This clarification is consistent with paragraph 5.1.3.7.1.2 which refers to 5.1.3.7.2 if flammable vapors can not be sufficiently diluted.</td>
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<td>This is not original material; its reference/source is as follows:</td>
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<td>I am proposing this revision on behalf of the ASHE Medical Gas Workgroup chaired by Ed Tinsley</td>
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<td><strong>Committee Meeting Action:</strong> Accept in Principle</td>
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<td>In section 5.1.3.7.2.1 replace the word &quot;used&quot; with &quot;dedicated&quot;.</td>
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<td><strong>Committee Statement:</strong> This does not apply to the entire section. The committee believes the intent applies to 5.1.3.7.2.1 rather than the entire section.</td>
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<td>227</td>
<td>Log #182</td>
<td>Reject</td>
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<td>(5.1.3.8)</td>
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<td><strong>Submitter:</strong> Dale Woodin, ASHE-American Society for Healthcare Engineering of the American Hospital Association (AHA)</td>
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<td><strong>Recommendation:</strong> 5.1.3.8* Instrument Air Supply Systems: (delete entire section)</td>
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<td><strong>Substantiation:</strong> With the air changes required for an OR and delivery rooms, and the change in this code to allow Nitrogen as a support gas, why install such an expensive system when Nitrogen is already present.</td>
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<td><strong>Committee Meeting Action:</strong> Reject</td>
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<td><strong>Committee Statement:</strong> Instrument air is a valid alternative and is optional.</td>
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</table>
99-228 Log #CP246 HEA-PIP Final Action: Accept
(5.1.3.8.2)

Submitter: Technical Committee on Piping Systems,
Recommendation: Revise text to read as follows:

5.1.3.8.2. Instrument air shall be permitted to be used for any medical support purpose (e.g., to remove excess moisture from instruments before further processing, or to operate medical-surgical tools, air-driven booms, pendants, or similar applications) and, if appropriate to the procedures, to be used in laboratories.

Substantiation: To clarify misperception throughout the industry that Support Gas is required to power booms, pendants and similar devices and make clear that any type air that can accomplish this equipment's needs is acceptable. Also to clarify that support gas is permitted to be used to blow dry medical instruments in Central Service and Surgical Instrument Processing departments.
Committee Meeting Action: Accept

99-229 Log #CP211 HEA-PIP Final Action: Reject
(5.1.3.8.5.1(2))

Submitter: Technical Committee on Piping Systems,
Recommendation: Revise 5.1.3.8.5.1(2) as follows:
(2) Use connections as for medial air or nitrogen NF in CGA V-1, Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections (ANSI B57.1)

Substantiation: Added Nitrogen NF because this is a medical gas used for patient support and not for patient respiratory application. Nitrogen NF would be easier for remote hospitals to purchase from local suppliers than medical air and less costly. Also, Nitrogen NF is another medical gas used for patient support. Nitrogen NF is also used as a supplemental supply for Level 3 gas-powered supply system which has a similar application.
Committee Meeting Action: Reject
Committee Statement: There is a safety risk associated with having nitrogen or medical air distributed from an instrument air outlet.

99-230 Log #126 HEA-PIP Final Action: Accept
(5.1.3.8.6)

Submitter: David B. Mohile, Medical Engineering Services, Inc.
Recommendation: Change wording as follows:

Intake air for instruments air compressors shall be permitted to be drawn from the outside, ducted air, or from the equipment location.

Substantiation: Current wording confuses some installers and engineers and appears to state that the intake air can only come from the machine room.
Committee Meeting Action: Accept
5.1.4.2 Accessibility of Valves.

5.1.4.2.1 Zone valves shall be placed in valve box(es) with frangible or removable windows. The box(es) shall be large enough to permit manual operation of the valves. The zone valves in their box(es) shall be located at a height above the floor which can be comfortably viewed and the valves conveniently accessed by a standing person 1.5 m (5 foot) tall.

5.1.4.2.2 Zone valves shall never be locked open except that zone valves for areas which require extraordinary security (such as pediatric or psychiatric) and with the approval of the authority having jurisdiction shall be permitted to be secured to prevent inappropriate access. Windows for zone valves shall be permitted to be alarmed to notify staff that the valve has been tampered with. Zone valves shall be permitted to be locked closed for lockout/tagout purposes during construction or maintenance.

5.1.4.2.2 All valves other than zone valves shall be located in secure areas such as locked pipe chases, or be locked or latched in their operating position. It shall be permitted to remove the actuating handles from such valves.

5.1.4.2.3 Valves other than zone valves shall be permitted to be in boxes similar to zone valves and located as desired by the facility provided they are locked in the operating position and clearly labelled substantially as follows:

CAUTION
Medical (Gas) / (Vacuum) Valve
To be Operated by Authorized Personnel Only

It shall be permitted to remove actuating handles from such valves.

Substantiation: Zone valves in boxes are often located in areas where security is at odds with the fire safety function of the zone valve, facilities have essentially disabled their zone valves by locking them in such cases from fear of inappropriate actuation. This proposal attempts to clarify the requirement, reassert the fire safety function of the zone valve and to explicitly permit alarming the valve for security.

Prohibiting locking zone valves opens the question of Lockout/tagout requirements and this proposal permits this. The mounting height of zone valves is a frequently asked question. This proposal attempts to offer guidance without being excessively limiting.

Many facilities prefer to remove valve handles from secure valves, which practice should be permitted.

Some facilities prefer or are forced by legacy conditions to deal with valves (e.g. riser, mainline, service valves) which are in boxes like a zone valve. While this is undesirable, it can be dealt with in a safe manner without ripping out the valve with all the disruption implied thereby. The proposal attempts to offer a solution.

Committee Meeting Action: Reject
Committee Statement: The proposed requirements are currently allowed in the standard. The proposed change does not add anything new.

5.1.4.3 should be amended to include:

(6) Have either one gauge port on the downstream side of the valve or have two gauge/purge ports one on either side of the valve.

Substantiation: Currently gauge and/or purge ports are not identified as a requirement.

Committee Meeting Action: Reject
Committee Statement: It is not necessary to mandate ports on every valve.
### 99-233 Log #92 HEA-PIP

| 5.1.4.3.1 | Final Action: Reject |

**Submitter:** J. Richard Wagner, Poole & Kent Corporation  
**Recommendation:** Revise text to read as follows:

- Valves for positive pressure gases shall be cleaned for oxygen service by the manufacturer. **These valves shall not be lubricated or otherwise contaminated after being cleaned for oxygen service.**
- Substantiation: Lubricants in ball valves, even if not affected by oxygen service, will contaminate the interior of the piping and foul station outlets, particularly after the valve connections are brazed.

**Committee Meeting Action:** Reject  
**Committee Statement:** Removal of the lubricant will not allow the valve to function properly.

### 99-234 Log #188 HEA-PIP

| 5.1.4.5 | Final Action: Reject |

**Submitter:** Dale Woodin, ASHE-American Society for Healthcare Engineering of the American Hospital Association (AHA)  
**Recommendation:** Revise text to read as follows:

- **Main line valve.** A shut off valve shall be provided in the main supply line inside of the building, except where one or more of the following conditions exist.
  1) The source and source valve are located inside the buildings served.
  2) The source system is physically mounted to the wall of the buildings served and the pipeline enters the building in the immediate vicinity of the source valve.
- Substantiation: Manifold systems, other than medical air should have main line valves installed outside of the manifold room in case of an emergency, staff would not have to enter this area until the mechanical ventilation has cleared the room.

This is not original material; its reference/source is as follows:

I am proposing this revision on behalf of the ASHE Medical Gas Workgroup chaired by Ed Tinsley  
**Committee Meeting Action:** Reject  
**Committee Statement:** This proposal would require more valves than are necessary in most situations.
5.1.4.7 Service Valves

Branch Valves shall be installed to allow servicing or modification of lateral branch piping from a main or riser without shutting down the entire main, riser, or facility.

5.1.4.7.1 Only one service valve branch valve shall be required for each branch off of a riser regardless of how many zone valve boxes are installed on that lateral.

5.1.4.7.2 Service valves Branch valves shall be placed in the branch piping prior to any zone valve box assembly on that branch.

5.1.4.7.3 Service valves Branch valves shall be located according to any one of the following:

1) Behind a locked access door
2) Locked open above ceiling
3) Locked open in a secure area

5.1.4.7.4 Service valves Branch valves shall be labeled in accordance with 5.1.11.2

5.1.4.7.5 Sensors for area alarm panels as required in 5.1.9.3.4 shall be permitted to be placed in any relationship to service valves branch valves (if installed).

Substantiation: Branch is the common nomenclature used by the pipe trades who would be installing these lines. This would make it easier for the installer to understand where these valves should be placed and why.

This is not original material; its reference/source is as follows:
I am proposing this revision on behalf of the ASHE Medical Gas Workgroup chaired by Ed Tinsley

Committee Meeting Action: Reject
Committee Statement: Using the term branch would require valves for every branch.
5.1.4.8. Zone Valve. The piping system shall be divided into control zones using zone valves. Control zones shall be provided to ensure the final piping system meets the following requirements:

(1) Every outlet or inlet, including those in manufactured assemblies, shall be controlled by a zone valve located on the same floor and in accord with 5.1.4.8.1.

(2) A zone valve on one floor may not control supply to outlets on another floor.

(3) Each gas and vacuum service piped into an occupancy shall have its own zone valve, and all zone valves for the gases and vacuum services within the same occupancy shall be located together, except as permitted under (5) below.

(4) All outlets/inlets of the same gas or vacuum service in a single occupancy may be controlled by one zone valve, but it shall be permitted to subdivide a single occupancy into multiple zones.

(5) A separate control zone shall be provided for each critical car and anesthetizing occupancy.

(6) Zone valves shall never be connected in series (e.g. no zone valve shall be permitted to shut off another zone valve) with the exception that two zone valves shall be permitted to be placed in series when a single occupancy is provided with two equally likely egress paths, and the facility requires as part of their disaster plan to ensure that whichever path is used, a valve is accessible.

(7) It shall be permitted to divide the systems into as many control zones as are appropriate for maintenance or to facilitate the facility's disaster plan provided (1) to (6) above are observed.

5.1.4.8.1 Zone valves shall be physically located as follows:

(1) The zone valve shall be located outside any space(s) contiguous with the outlet/inlets themselves. For this purpose, a space is contiguous if smoke could propagate from the outlet/inlet location into that space without encountering a solid physical barrier (e.g. a drop ceiling, floor to ceiling wall, automatic door, etc.) Partial or intermittent barriers (e.g. curtains, partial walls, doors without automatic closers, etc.) shall not be considered as separations.

(2) The zone valve shall be located on a corridor wall along the egress path which would most likely be used by a staff member evacuating a patient.

(3) The zone valve shall be located where they are visible and accessible at all times, and not hidden behind normally open doors, carts or other items.

(4) The zone valves shall not be located in closed or locked rooms (e.g. closets, offices, etc.)

5.1.4.8.2 Zone valves shall be readily operable by a standing person 1.5m (5 foot) tall.

5.1.4.8.3 Zone valves shall be labeled in accordance with 5.1.11.2.

5.1.4.8.4 Each zone valve shall be provided with a pressure/vacuum indicator on the patient side of the valve.

Substantiation: Designers seek guidance on where zone valves are required and where to locate the zone valves. The revised wording is intended to make the existing rules more clear and complete.

New 5.1.4.8.1 sets out a new test for determining what constitutes an acceptable location for the valve relative to the area controlled.

5.1.4.8(6) permits a rare valving arrangement with two zone valves in series.

Committee Meeting Action: Reject

Committee Statement: The new term "control zone" is not defined and is confusing.

Also see Committee Action on Proposal 99-239 (Log #48), Proposal 99242- (Log #61), Proposal 99-240 (Log #62), Proposal 99-244 (Log #162), Proposal 99-245 (Log #163), Proposal 99-246 (Log #164) and Proposal 99-241 (Log #258).
99-239  Log #48  HEA-PIP
(5.1.4.8 Exception (New )

Final Action: Reject

Submitter: Wayne Baer, Wyoming Valley Health Care System

Recommendation: Add an Exception to read:

Exception: An intervening wall shall not be required when zone valves are positioned near the exit from any area that treats multiple non-ambulatory patients. i.e., 1. Nurseries 2. O.R. Holding Rooms 3. O.R. Recovery Rooms 4. Short Stay Holding Rooms 5. Emergency Suites.

Substantiation: In any situation when the closure of the zone valve(s) is deemed an appropriate action, an intervening wall poses an additional safety risk to patients who are in need of constant care or supervision. It would be counterproductive to abandon those patients to go outside of the critical patient care area to shut down a gas valve. In some cases (Nurseries, E.D.’s) a door would lock behind the nurse causing even further delay in returning to patient(s) who could not care for themselves. Also an intervening wall to a critical patient area might put the zone valves in a public area thus bringing another element of concern for the patient’s safety.

Committee Meeting Action: Reject
Committee Statement: First responders should be able to access the zone valve for the oxidizing gas without entering the fire area.

99-240  Log #62  HEA-PIP
(5.1.4.8(1))

Final Action: Reject

Submitter: G. Drew Phillips, Prayair Healthcare Services

Recommendation: Revise text to read as follows:

The zone valve shall be placed such that a wall or door (intervenes) isolates (between) the valve and outlets/inlets that it controls.

Substantiation: If an area is consumed by flames an intervening wall may not insure a safe shut off of the zone valve. If the zone valve is isolated (outside the area that it serves) the chance of mortality will decrease.

Committee Meeting Action: Reject

99-241  Log #258  HEA-PIP
(5.1.4.8(1) (Zone Valve))

Final Action: Reject

Submitter: Bill Marlowe, Praxair

Recommendation: Revise text to read as follows:

The zone valve shall be placed such that a wall intervenues between the valve and outlets/inlets that it controls. The intervening wall shall have a minimum fire rating of ½ hour that interrupts the line of sight between the outlet/inlet and the zone valve. The intervening wall shall allow someone to shut off the flow of gas to a fire site without being directly exposed to the fire and any products of combustion.

Substantiation: The intervening wall is not defined. As the standard reads, any cardboard wall, or half wall, or other ridiculous structure can be placed between the outlet and valve and literally comply with the standard. Although a 2 hr fire wall has been removed in the standard from earlier editions, there should be a min rated wall to allow some protection during a fire site. ½ hr rating would allow a ½ think drywall to be installed.

Committee Meeting Action: Reject
Committee Statement: A fire rating is not a necessary criteria for location of zone valves.
<table>
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<td>99-242</td>
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<td>Reject</td>
<td>(5.1.4.8(3) (New))</td>
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<tr>
<td>Submitter:</td>
<td>Roger D. Williams, PIC Medical Gas Testing, Inc.</td>
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<td>Recommendation:</td>
<td>Add text to read as follows:</td>
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<tr>
<td>Substantiation:</td>
<td>(3) The zone valve shall not be located in a room with station outlets/inlets.</td>
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<td>Committee Meeting Action:</td>
<td>Reject</td>
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<tr>
<td>Committee Statement:</td>
<td>In an emergency, if there is a valve in the same room as the effected outlets/inlets, responsible personnel are likely to close this valve even though it does not control these outlets/inlets. This would exclude a common situation in health care facilities that is necessary for operation for the facility.</td>
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| 99-243     | CP207   | Accept        | (5.1.4.8.3 (New)) |
| Submitter: | Technical Committee on Piping Systems, |
| Recommendation: | Add text to read as follows: |
| Substantiation: | (3) The zone valve shall not be located in a room with station outlets/inlets that it controls. |
| Committee Meeting Action: | Accept |
| Committee Statement: | This would eliminate common questions about separation of station outlets and inlets from zone valves and provides more clarification of the committee's intent. |

| 99-244     | Log #162 | Reject | (5.1.4.8.5) |
| Submitter: | Craig B. Williams, Life Medical Networks |
| Recommendation: | Delete the following text: 5.1.4.8.5 Zone valve boxes shall not be installed behind normally open or normally closed doors, or otherwise hidden from plain view. |
| Substantiation: | Unnecessary statement since it is already covered under 5.1.4.8.4. |
| Committee Meeting Action: | Reject |
| Committee Statement: | This requirement needs to remain to explain that it is not desirable to have open or closed doors which may obscure the panel. |

| 99-245     | Log #163 | Reject | (5.1.4.8.6) |
| Submitter: | Craig B. Williams, Life Medical Networks |
| Recommendation: | Delete the following text: 5.1.4.8.6 Zone valve boxes shall not be installed in closed or locked rooms, areas, or closets. |
| Substantiation: | Unnecessary statement since it is already covered under 5.1.4.8.4. |
| Committee Meeting Action: | Reject |
| Committee Statement: | This requirement needs to remain to explain that it is not desirable to have open or locked doors which may obscure the panel. |
99-246     Log #164  HEA-PIP
(5.1.4.8.7.2)

Submitter: Craig B. Williams, Life Medical Networks
Recommendation: Delete the following text:
5.1.4.8.7.2 Zone valves shall be so arranged that shutting off the supply of gas to an one operating room or
anesthetizing location will not affect the others.
Substantiation: Unnecessary statement since it is already covered under 5.1.4.8.2.
Committee Meeting Action: Accept

99-247     Log #193  HEA-PIP
(5.1.4.9)

Submitter: Dale Woodin, ASHE-American Society for Healthcare Engineering of the American Hospital Association
(AHA)
Recommendation: Revise text to read as follows:
5.1.4.9 **In-line valves.** Optional in-line valves shall be permitted to be installed to isolate or shut off
piping for servicing of individual rooms or areas.
5.1.4.9.1 **In-line shutoff valves** Service valves intended for use to isolate piping for maintenance or modification shall
meet the following requirements.
1) Be located in a restricted area
2) Be locked or latched open
3) Be identified in accordance with 5.1.11.2
5.1.4.9.2 Sensors for area alarm panels as required in 5.1.9.3.4 shall be permitted to be placed in any relationship to
**in-line valves** service valves (if installed).
Substantiation: The reason given by NFPA for installing these valves is for service. This change would make it easier
for the installer to understand where to place these valves.
This is not original material; its reference/source is as follows:
I am proposing this revision on behalf of the ASHE Medical Gas Workgroup chaired by Ed Tinsley
Committee Meeting Action: Reject
Committee Statement: Previously the committee did not accept the change from service valve to branch valve,
therefore we can not change the name of the in-line valve to service valve.

99-248     Log #165  HEA-PIP
(5.1.4.9.2)

Submitter: Craig B. Williams, Life Medical Networks
Recommendation: Delete the following text:
5.1.4.9.2 Sensors for area alarm panels as required in 5.1.9.3.4 shall be permitted to be placed in any relationship
to **in-line valves** (if installed).
Substantiation: Statement is covered under warning systems section that covers the requirements for location of area
alarm sensors under 5.1.9.3.4 and should not be in the section that covers the requirement of valves.
Committee Meeting Action: Accept
Committee Statement: This is being deleted because of duplication in section 5.1.9.3.4(3).
### 99-249 Log #190 HEA-PIP

**(5.1.4.10(4))**  
**Final Action:** Reject

**Submitter:** Dale Woodin, ASHE-American Society for Healthcare Engineering of the American Hospital Association (AHA)  
**Recommendation:** Revise text to read as follows:  
5.1.4.10(4) **Valves for future connections.** Shut off valves provided for the connection of future piping shall meet the following requirements.  
1) Be located in a restricted area.  
2) Be locked or latched closed.  
3) Be identified in accordance with 5.1.11.2.  
4) Be installed on source side of zone valve box if installed in a critical care, life support or anesthetizing area.  
**Substantiation:**  
1) To prevent the extension of the piping system from a critical care area to non critical area of the facility.  
2) To prevent future installers from tying a zone valve downstream of another ZVB.  
This is not original material; its reference/source is as follows:  
I am proposing this revision on behalf of the ASHE Medical Gas Workgroup chaired by Ed Tinsley  
**Committee Meeting Action:** Reject  
**Committee Statement:** Future valves are never mandatory and it would be inappropriate to limit their application.

### 99-250 Log #167 HEA-PIP

**(5.1.5.15(3))**  
**Final Action:** Reject

**Submitter:** Craig B. Williams, Life Medical Networks  
**Recommendation:** Revise text to read as follows:  
If operated at a gauge pressure in excess of 550 kPa (80 psi), be either D.I.S.S. connectors or comply with 5.1.5.15(4).  
**Substantiation:** Eliminate the reference to outlets that operate at pressures between 200 psi and 300 psi under section 5.1.5.15 (4) since no medical gas pipeline currently operates at pressures above 200 psi and there are no medical gas outlets or other components currently manufactured that are rated to operate above 200 psi making this statement unnecessary. Another proposal is provided to eliminate 5.1.5.15 (4).  
**Committee Meeting Action:** Reject  
**Committee Statement:** There are systems that still need the ability to use the higher pressure of 200 psi.

### 99-251 Log #166 HEA-PIP

**(5.1.5.15(4))**  
**Final Action:** Reject

**Submitter:** Craig B. Williams, Life Medical Networks  
**Recommendation:** Delete the following text:  
If operating at a gauge pressure between 1380 kPa (200 psi) and 2070 kPa (300 psi), the station outlet shall be so designed as to prevent the removal; to prevent the adapter injuring the user or others when removed from the outlet.  
**Substantiation:** No medical gases are currently operated at pressures above 200 psi and there are no medical gas outlets or other medical pipeline components that are rated for pressures above 200 psi. Since currently manufactured medical pipeline products are rated to operate at pressures less than 200 psi this statement is unnecessary.  
**Committee Meeting Action:** Reject  
**Committee Statement:** There are systems that still need the ability to use the higher pressure of 200 psi.
99-252 Log #407 HEA-PIP

(5.1.6.5) Final Action: Accept

Submitter: Marcelo M. Hirschler, GBH International

Recommendation: Revise text to read as follows:

5.1.6.5 Manufactured assemblies shall have a flame spread index rating of not greater than 200 when tested in accordance with NFPA 255, Standard Method of Test of Surface Burning Characteristics of Building Materials, ASTM E 84, Standard Test Method for Surface Burning Characteristics of Building Materials, or shall comply with the requirements for heat release in accordance with NFPA 286, Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth as described in Section 10.2 of NFPA 101.

Also, delete NFPA 255 from Chapter 2 and replace it by ASTM E 84. Also add NFPA 286 to Chapter 2.

Substantiation: This proposal is purely editorial. Flame spread rating is a terminology that does not exist any more. Moreover, NFPA 255 is slated for withdrawal by the NFPA Fire tests committee, and it will be replaced by ASTM E 84. Finally, while ASTM E 84 (or NFPA 255) assesses flame spread, NFPA 286 (the room-corner test in Section 10.2 of NFPA 101) assesses heat release and materials passing it are considered suitable alternates to materials complying with the Steiner tunnel test, ASTM E 84 (or NFPA 255).

Committee Meeting Action: Accept

99-253 Log #132 HEA-PIP

(5.1.6.6) Final Action: Accept in Principle

Submitter: Taylor Culpepper, Modular Services Co. / Rep. Dir. R&D

Recommendation: Revise text to read as follows:

Manufactured assemblies employing flexible hose or tubing shall be attached to the pipelines using station outlets/inlets, or other semipermanent connection complying with 3.3.166.

Substantiation: The only station inlet/outlet available with removable check valves are D.I.S.S. series connectors. Thus only D.I.S.S. station inlets will be able to meet flow requirements of 5.1.12.3.10.3, hence limiting the range of usable connectors to D.I.S.S. inlets alone. D.I.S.S. connections are available only for ½ in. (pressure) and 5/16 in. (vacuum) I.D. hoses which results in requiring a separate hose assembly for each inlet/outlet. Many ceiling service “boom” systems now employ twelve or more medical gas inlets/outlets which then require twelve hose assemblies to supply them. This situation requires twelve sets of D.I.S.S. fittings and twelve bulkhead assemblies (pipe to D.I.S.S.) respectively. Twelve hoses typically consume more than 60 percent of the available throat area within the boom system, limiting space for electrical, communication and control wiring and respective conduit(s). Additionally, twelve hose assemblies present the opportunity for four times as many leaks and/or loose fittings (as opposed to a larger diameter hose assembly providing single point oxygen, medical air and vacuum services). A larger diameter, noninterchangeable series of fittings provides larger supply volumes and larger flow rates. Previous revisions to this section omitting primary and/or secondary check valves have been required to allow hose assemblies meet flow requirements for even one inlet/outlet.

Committee Meeting Action: Accept in Principle

Committee Statement: See Committee Action on Proposal 99-254 (Log #293).
99-254     Log #293  HEA-PIP
(5.1.6.7 (New))

Submitter: Mark W. Allen, BeaconMedaes
Recommendation: Replace (1) with:
(1) Be gas specific connections with positive locking mechanisms that ensure the connector is firmly seated and cannot detach without intentional actuation of the release. (e.g. D.I.S.S connectors).
Substantiation: The requirement here is for a connector which, once correctly connected, will not detach inadvertently inside or behind the manufactured assembly. While DISS is one method that can work, it is not the only such method, and the inherent dimensional limitations of the DISS system make this connector a flow restrictor in some applications.
Committee Meeting Action: Accept

99-255     Log #133  HEA-PIP
(5.1.6.7(1))

Submitter: Taylor Culpepper, Modular Services Co. / Rep. Dir. R&D
Recommendation: Revise text to read as follows:
Be D.I.S.S. connectors or other semipermanent connection complying with 3.3.166.
Substantiation: D.I.S.S. connections are available only for ¼ in. (pressure) and 5/16 in. (vacuum) I.D. hoses which results in requiring a separate hose assembly for each inlet/outlet. Many ceiling service “boom” systems now employ twelve or more medical gas inlets/outlets which then require twelve hose assemblies to supply them. This situation requires twelve sets of D.I.S.S. fittings and twelve bulkhead assemblies (pipe to D.I.S.S.) respectively. Twelve hoses typically consume more than 60 percent of the available throat area within the boom system, limiting space for electrical, communication and control wiring and respective conduit(s). Additionally, twelve hose assemblies present the opportunity for four times as many leaks and/or loose fittings (as opposed to a larger diameter hose assembly providing single point oxygen, medical air and vacuum services). A larger diameter, noninterchangeable series of fittings provides larger supply volumes and larger flow rates. Previous revisions to this section omitting primary and/or secondary check valves have been required to allow hose assemblies meet flow requirements for even one inlet/outlet.
Committee Meeting Action: Accept in Principle
Committee Statement: See Committee Action on Proposal 99-254 (Log #293).

99-256     Log #387  HEA-PIP
(5.1.6.9)

Submitter: Jan Ehrenwerth, Yale University School of Medicine
Recommendation: Add new text to read as follows:
The installation of manufactured assemblies shall be tested in accordance with 5.1.12. The multi service electrical and gas surgical booms installed in operating rooms must be inspected for leaks and electrical safety at the end of installation and then at a minimum of every six months.
Substantiation: ECRI is aware of three fires in these surgical booms due to gas leaks in the presence of exposed electrical connections. There is currently no standard for the periodic inspection of these booms. Also since they are frequently moved, the gas and electrical systems enclosed in the boom are subject to excessive wear and loosening of the connections.
Committee Meeting Action: Accept in Principle
Accept in Principle.
Committee Statement: See Committee Action on Committee Proposal 99-341(CP# 251).
99-257 Log #CP208 HEA-PIP
(5.1.7.10) Final Action: Accept

Submitter: Technical Committee on Piping Systems,
Recommendation: Revise as follows:
The installation of the MGR shall be tested in accordance with 5.1.12.
Substantiation: The last reference was incorrect as the material was deleted last cycle.
Committee Meeting Action: Accept

99-258 Log #292 HEA-PIP
(5.1.8.1) Final Action: Accept in Principle

Submitter: Mark W. Allen, BeaconMedaes
Recommendation: Reword to read:
5.1.8.1.3 The scale range of positive pressure analog indicators shall be such that the normal operating pressure is within the middle third of the total range (e.g. an indicator of 0-2,070 kPa (0-300 psi) would have a lower third of 0-690 kPa) 0-100 psi, a middle third of 690-1,380 kPa (100-200 psi) and a top third of 1,380-2,070 kPa (200-300 psi). This gauge would therefore be suitable for any operating pressure between 690-1,380 kPa (100-200 psi).
5.1.8.1.4 The accuracy of digital indicators shall be +/-5% of the operating pressure on which they are used.
Substantiation: The wording of 5.1.8.1.3 has been the subject of some very creative interpretation which determined that the traditional 0-300 psi gauge could no longer be used for nitrogen systems. I do not believe that was ever the intent of the committee. This is a rewrite intending to make the intent more apparent.
5.1.8.1.4 The actual scale of an indicator is of no consequence, and can only be justified based on an intent to make the indicator as accurate as a traditional gauge. Simply stipulating the desired accuracy is a better approach.
Committee Meeting Action: Accept in Principle
Change all the "psi" to "psig".
Committee Statement: Editorial.

99-259 Log #169 HEA-PIP
(5.1.8.1.5) Final Action: Accept

Submitter: Craig B. Williams, Life Medical Networks
Recommendation: Revise text to read as follows:
5.1.8.1.5 The scale range of vacuum indicators shall be 0 mm to 760 mm (0 in. to 29.9 in.) gauge HgV, except that indicators with normal range display shall indicate normal only above 300 mm (12 in.) HgV.
Substantiation: Attempt to be realistic to vacuum gauges that are available and used in the United States and help to clarify the requirement for indicators, which show normal vacuum pressures.
Committee Meeting Action: Accept
Add new exception as follows:

Exception:
A building's supervised fire alarm system "remote annunciator" may be used as the second master alarm location without using separate individual wiring to a separate alarm panel as long as all of the following conditions are met:
1. Applicable only to existing facilities where the medical gas alarms are currently monitored by the building's supervised fire alarm system.
2. Applicable only where new source equipment is being provided and/or involves upgrades to the existing source equipment as part of a building expansion, addition and/or renovation to the existing facility.
3. The fire alarm system shall report a trouble signal upon loss of communication with either a sensor or the remote annunciator panel.

Substantiation: BVH believes that by allowing the exception for the continued use of the building's supervised fire alarm system, which is fairly extensive and has been very reliable to date, that this is as good if not a better installation as the required separate wiring in that the fire alarm system continuously monitors the continuity of the wiring from the sensor to the alarm panel with an end-of-line resistor.

By limiting this exception to the conditions stated above we believe that this will enable existing facilities which currently use a building's supervised fire alarm system to monitor their source equipment, to be able to expand the system without having to bear the cost and disruption of a total system replacement. Additionally we believe that the level of redundancy/reliability built into an addressable fire alarm system also meets the intent of the code for redundancy for medical gas master alarm panels.

Committee Meeting Action: Accept in Principle
Revise 5.1.9.2.3 as follows:
The two master alarm panels required in 5.1.9.2.1 shall communicate to the alarm initiating devices that they monitor in accordance with 5.1.9.2.3.1 through 5.1.9.2.3.7.
Revise 5.1.9.4.1(5) as follows:
Computer systems shall be permitted to communicate directly to the sensors/switches in 5.1.9.2.3 in the same manner as an alarm panel if operation of another alarm panel(s) is not impaired.

Committee Statement: The goal is to provide continuous surveillance that is supervised or protected. Current verbage restricts new technologies such as optical data transfer (i.e., fiber optics or laser) and electromagnetic (i.e., wireless).
### 99-262 Log #84 HEA-PIP

**Final Action:** Reject

**(5.1.9.2)**

**Submitter:** Carl Nicosia, Airgas Inc.

**Recommendation:** Revise text to read as follows:

5.1.9.2 Master Alarms. A master alarm system shall be provided to monitor the operation and condition of the source of supply, the reserve system (if any), and the pressure in the main lines of each medical gas and vacuum piping system. A master alarm system shall also be required to monitor the purity of the source of supply in the main lines of each medical gas.

**Substantiation:** The problem that would be resolved by this recommendation would be that if ever medical gas purity levels fall below a preset point an audio and visual alarm will be activated and the healthcare facilities staff alerted to a potentially life threatening situation.

**Committee Meeting Action:** Reject

**Committee Statement:** This is not practical and there is no data presented to resolve the outcome.

### 99-263 Log #70 HEA-PIP

**Final Action:** Reject

**(5.1.9.2.1(1))**

**Submitter:** Jason D. Sweatt, Wm. G. Frank Medical Gas Services, LLC

**Recommendation:** Revise text to read as follows:

One master alarm panel shall be located in the office or workspace of the on-site individual responsible for the maintenance of the medical gas and vacuum piping systems.

**Substantiation:** One master alarm panel shall be located in the office or workspace, defined as area (not foyer in an enclosed area) of the individual responsible for maintenance of the medical gas and vacuum piping systems.

**Committee Meeting Action:** Reject

**Committee Statement:** The proposal does not say anything different from the current requirement of the standard.

### 99-264 Log #291 HEA-PIP

**Final Action:** Accept

**(5.1.9.2)**

**Submitter:** Mark W. Allen, BeaconMedaes

**Recommendation:** Change the reference in this paragraph from "5.1.9.5" to "5.1.9.4"

**Substantiation:** I believe this is a numbering error left over from the 2005 revision, but it clearly is incorrect.

**Committee Meeting Action:** Accept

### 99-265 Log #137 HEA-PIP

**Final Action:** Accept in Principle

**(5.1.9.2.3.1)**

**Submitter:** Jack Stein, Medical Gas Specialists, Inc.

**Recommendation:** Add new text as follows:

Master alarm switches/sensors shall be installed so as to be accessible for testing.

**Substantiation:** Field experience has shown many switches have been installed with no regard for future testing, adjusting, or replacing these devices. One sentence would address the problem.

**Committee Meeting Action:** Accept in Principle

Add new text to 5.1.9.1 (14) as follows:

Alarm switches/sensors shall be installed so as to be removable.

**Committee Statement:** This requirement pertains to all alarm sensors, not just master alarm.
Add a new line to section 5.1.9.2.4 Master Alarms.

(13) An alarm indication if the primary or reserve production stops on a Proportioning System.

Substantiation: Section 3.3.106 Medical Air Definition and Section 5.1.3.5 Level 1 Medical Air Supply Systems refer to Medical Air USP reconstituted from oxygen USP and oil free, dry Nitrogen NF. Currently, NFPA 99 does not define a system that reconstitutes Medical Air USP form Oxygen USP and Nitrogen NF.

If the new Section 5.1.3.5.4 Proportioning System for Medical Air USP is accepted, the section above will need to add to this line.

This is not original material; its reference/source is as follows:
References to International Standard ISO 7396-1 and Canadian Standards CSA – Z305.1

Committee Meeting Action: Accept

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1. Delete “vital life support.”
2. Change “critical areas” to “critical care areas.”

Substantiation: 1. Term is not defined. Critical care areas, by its definition, would include vital life support areas.
2. The term “critical care area” is used throughout NFPA 99.

Committee Meeting Action: Accept

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Area alarm panels for medical gas systems shall provide visual and audible indication in the event a cross connection occurs between transducer(s) and gas circuit board(s).

Substantiation: When servicing medical gas alarm panels, facilities personnel sometimes disconnect and reconnect wires. This may result in a cross connection (i.e., an oxy transducer being connected to a N2O gas circuit board). Making this a requirement in NFPA 99C will ensure that all manufacturers comply and assure the safety of the patients.

Committee Meeting Action: Accept in Principle

Add new text as follows:

Area alarm panels for medical gas systems shall provide visual and audible indication in the event a mismatch occurs between transducer(s) and its associated circuit board(s).

Committee Statement: The revised wording clarified that a cross connection was a wiring problem.
99-269     Log #111  HEA-PIP  
(5.1.9.3)  
Final Action: Reject  

Submitter: Jim Lucas, Tri-Tech Medical Inc.  
Recommendation: Add new text as follows:  
Transducers for medical gas area alarm panels shall not be installed above the ceiling.  
Substantiation: In addition to making the transducers difficult to locate, there are also the ICRA requirement in many facilities to erect tents, NFPA 99C’s required periodic testing and JAHCO’s recommended annual testing requirements that necessitate the transducers be located in an easily locatable and accessible place. Not allowing transducers to be installed above the ceiling would improve safety conditions for testing personnel and make it easier for facilities to comply with the NFPA 99C and JAHCO requirements and avoid ICRA situations.  
Committee Meeting Action: Reject  
Committee Statement: This requirement would exceed the minimum requirement in this standard.

99-270     Log #140  HEA-PIP  
(5.1.9.3)  
Final Action: Accept in Principle  

Submitter: Jim Lucas, Tri-Tech Medical Inc.  
Recommendation: I don’t know whether this belongs under 5.1.3.4.14.2 or its own new paragraph check valves. New or replacement check valves shall be as follows:  
(1) Brass or bronze construction  
(2) Have brazed extensions  
(3) Consist of three pieces permitting inline serviceability  
(4) Shall not have threaded connections.  
Substantiation: Check valve construction is currently undefined.  
Committee Meeting Action: Accept in Principle  
Add a new 5.1.4.11 as follows:  
5.1.4.11 In-Line Check Valves. New or replacement check valves shall be as follows:  
(1) Brass or bronze construction  
(2) Have brazed extensions  
(3) In-line serviceability  
(4) Not have threaded connections  
(5) Threaded purge points of \( \frac{1}{8} \) in. NPT  
Committee Statement: This pertains to in-line valves and should not be limited to three piece valves. Check valve was changed for correlation purposes.

99-271     Log #60  HEA-PIP  
(5.1.9.3.1)  
Final Action: Reject  

Submitter: Roger D. Williams, PIC Medical Gas Testing, Inc.  
Recommendation:  
The alarm panel shall be labeled indicating the location of the zone valve that it monitors.  
The requirement of . . . . . shall not apply if the zone valve is next to the alarm panel.  
Substantiation: In an emergency the alarm will draw attention which needs to be directed to the zone valve if it is not immediately obvious.  
Committee Meeting Action: Reject  
Committee Statement: The standard presently requires the panels to be labeled for area of surveillance.
5.1.9.3.1 Area alarm panels shall be placed in a location which will most closely fulfill the following criteria (recognizing that no location may exist able to fulfill all):

1. Near or within the location where the staff will most often be present (e.g. a staff base, a nurses station, etc.)
2. Where the audible alert will best carry throughout the unit being surveilled.
3. Where the panel is visible from the largest number of rooms, beds or stations within the zone.
4. Where visualization of the panel will not be blocked. (e.g. by cabinet doors, carts, room doors, curtains, supplies, etc.)
5. At a height above the floor which can be comfortably viewed and the mute button conveniently accessed by a standing person 1.5m (5 foot) tall.

**Substantiation:** Designers seek guidance on where to locate the physical panels within the units. Although it is not possible to state categorically where to locate a panel, the revised wording offers a designer a more comprehensive set of criteria on which to evaluate a given location.

**Committee Meeting Action:** Accept in Principle

Add this material as A.5.1.9.3.1:

A. 5.1.9.3.1 Area alarm panels should be placed in a location that will most closely fulfill the following criteria (recognizing that no location may exist able to fulfill all):

1. Near or within the location where the staff will most often be present (e.g. a staff base, a nurses station, etc.)
2. Where the audible alert will best carry throughout the unit being surveilled.
3. Where the panel is visible from the largest number of rooms, beds or stations within the zone.
4. Where visualization of the panel will not be blocked. (e.g. by cabinet doors, carts, room doors, curtains, supplies, etc.)
5. At a height above the floor that can be comfortably viewed and the mute button be conveniently accessed.

**Committee Statement:** The 5 ft level for panel location will not be feasible in all cases. This is better suited as annex material.
99-273 Log #346 HEA-PIP  
(5.1.9.3.4)  

Final Action: Accept in Principle

Submitter: J. Richard Wagner, Poole & Kent Corporation  

Recommendation: Revise text to read as follows:

5.1.9.3.4 Pressure Sensors sensors for area alarms shall be located as follows:

(1)* Vital life support and critical care areas shall have the alarm sensors installed on the patient or use side of any of the individual zone valve box assemblies.

EXCEPTION: The alarm sensors for operating rooms shall be permitted to be installed on the source side of the zone valve box assemblies.

(2)* Areas for anesthetizing gas delivery shall have the sensors installed on the source side of any of the individual room zone valve box assemblies or on the patient or use side of each of the individual zone valve box assemblies.

(3) The placement of the pressure sensors shall not be affected by service valves (see 5.1.4.7) or in-line valves (see 5.1.4.9) that are located in areas accessible only to authorized personnel.

Substantiation: To clarify the requirements of 5.1.9.3.4.

The term "vital life support area" is not defined.

Committee Meeting Action: Accept in Principle

Revise text to read as follows:

5.1.9.3.4 Alarm Sensors sensors for area alarms shall be located as follows:

(1)* Vital life support and critical care areas shall have the alarm sensors installed on the patient or use side of any of the individual zone valve box assemblies.

(2)* Areas for anesthetizing gas delivery shall have the alarm sensors installed on the source side of any of the individual room zone valve box assemblies or on the patient or use side of each of the individual zone valve box assemblies.

(3) Area alarm sensors shall be permitted to be located in any relationship to the service or in-line valves (see 5.1.4.7) or in-line valves (see 5.1.4.9).

Committee Statement: The wording was changed to "alarm" for consistency. The exception was deleted because it was redundant.

99-274 Log #313 HEA-PIP  
(5.1.9.3.4(2))  

Final Action: Reject

Submitter: John M. Skinner, Medical Equipment Technology, Inc.

Recommendation: Revise text to read as follows:

(2) *Areas for anesthetizing gas delivery shall have the sensors installed either on the source side of any of the individual room zone valve box assemblies, or on the patient or use side of each of the individual zone valve box assemblies.

Substantiation: Wording for the 2005 NFPA Standard should return to the 2002 wording. The 2005 leads to confusion on how many alarm panels are actually needed.

Committee Meeting Action: Reject

Committee Statement: This proposal takes away a viable option. In some cases, a sensor is desired to be on the patient side.
99-275  Log #272  HEA-PIP
(5.1.9.5.1 Local Alarms)

Submitter: Keith Ferrari, Praxair, Tamara Brown
Recommendation: Add text to section 5.1.9.5 Local Alarms.

Substantiation: Section 3.3.106 Medical Air Definition and Section 5.1.3.5 Level 1 Medical Air Supply Systems refer to Medical Air USP reconstituted from oxygen USP and oil free, dry Nitrogen NF. Currently, NFPA 99 does not define a system that reconstitutes Medical Air USP form Oxygen USP and Nitrogen NF.

If the new Section 5.1.3.5.4 Proportioning System for Medical Air USP is accepted, the section above will need to add to this line.

This is not original material; its reference/source is as follows:
References to International Standard ISO 7396-1 and Canadian Standards CSA – Z305.1
Committee Meeting Action: Accept

99-276  Log #274  HEA-PIP
(5.1.9.5.3 Local Alarms)

Submitter: Keith Ferrari, Praxair, Tamara Brown
Recommendation: Add text to section 5.1.9.5.3 Local Alarms.

Substantiation: Section 3.3.106 Medical Air Definition and Section 5.1.3.5 Level 1 Medical Air Supply Systems refer to Medical Air USP reconstituted from oxygen USP and oil free, dry Nitrogen NF. Currently, NFPA 99 does not define a system that reconstitutes Medical Air USP form Oxygen USP and Nitrogen NF.

If the new Section 5.1.3.5.4 Proportioning System for Medical Air USP is accepted, the section above will need to add to this line.

This is not original material; its reference/source is as follows:
References to International Standard ISO 7396-1 and Canadian Standards CSA – Z305.1
Committee Meeting Action: Accept

99-277  Log #222  HEA-PIP
(5.1.9.5.4)

Submitter: Thomas J. Mraulak, Metropolitan Detroit Plumbing Industry
Recommendation: Revise text to read as follows:

(3) Medical air dew point high to indicate when the line pressure dew point is greater than +4 °C (39° 35°F).

Substantiation: In the 2005 standard the dew point was changed and it was missed in this section.

Committee Meeting Action: Accept in Principle
Committee Statement: The change corrected an error.
99-278 Log #273 HEA-PIP
(5.1.9.5.4 Local Alarms)

Final Action: Accept

Submitter: Keith Ferrari, Praxair, Tamara Brown

Recommendation: Add text to section 5.1.9.5.4 Local Alarms.

The following...site:

(10) Proportioning Systems high/low indicator when the oxygen concentration is outside 19.5 – 23.5% oxygen.

(11) Proportion Systems reserve system is in operation.

Substantiation: Section 3.3.106 Medical Air Definition and Section 5.1.3.5 Level 1 Medical Air Supply Systems refer to Medical Air USP reconstituted from oxygen USP and oil free, dry Nitrogen NF. Currently, NFPA 99 does not define a system that reconstitutes Medical Air USP form Oxygen USP and Nitrogen NF.

If the new Section 5.1.3.5.4 Proportioning System for Medical Air USP is accepted, the section above will need to add to this line.

This is not original material; its reference/source is as follows:

References to International Standard ISO 7396-1 and Canadian Standards CSA – Z305.1

Committee Meeting Action: Accept

99-279 Log #170 HEA-PIP
(5.1.9.5.4(3))

Final Action: Accept

Submitter: Craig B. Williams, Life Medical Networks

Recommendation: Revise text to read as follows:

Medical air dew point high to indicate when the line pressure dew point is greater than 4°C (+39°F) ±2°C (+3°F).

Substantiation: Provides uniform consistency of the requirement stated in this standard for the dew point alarm limit used for medical air.

Committee Meeting Action: Accept

99-280     Log #CP243  HEA-PIP
(5.1.10)

Final Action: Accept
Submitter: Technical Committee on Piping Systems,
Recommendation:

***INCLUDE 99_LCP243_R. HERE***

Substantiation: This committee proposal takes all of the public and committee proposals related to Section 5.1.10 and combines them into one proposal for housekeeping purposes. A separate substantiation for each of the proposed changes by the committee is provided below.

5.1.10.4.5.10 and 5.1.10.4.5.11: These changes clarify the requirements for final connections.
5.1.10.6.1 and 5.1.10.6.2: These changes add specific installation requirements for memory metal fittings.
5.1.10.7.1 and 5.1.10.7.2: These changes add specific installation requirements for axially swaged fittings.
5.1.10.9: Memory metal fittings are now covered in 5.1.10.6. Reference to "listed and approved metallic gas tube fittings" is no longer necessary because specific fittings are now listed. Elastic strain preload fittings are now covered in 5.1.10.7. Dielectric fittings need requirements listed.
5.1.10.11.5.5: When reducing ground cover from 36" to 18", preventing physical damage implies that something needs to be done to justify the reduction. Potential damage would be from surface loads or possible digging, such as under driveways or planters for shrubbery.
5.1.10.11.5.7: Dirt is "dirty". The concern in backfill is rocks and other solids.
5.1.10.11.10: If both ends are sealed and the outside seal leaked, the indoor seal could hold water in contact with the pipe. Possible prolonged contact between copper tube and ground water is the reason for deleting the requirement for protective conduits for underground piping.
5.1.10.11.10.2 and 5.1.10.11.10.3: Provides clarification for Category 1 System installer qualifications.

Committee Meeting Action: Accept

99-281     Log #171  HEA-PIP
(5.1.10.1.4)

Final Action: Accept in Principle
Submitter: Craig B. Williams, Life Medical Networks
Recommendation: Revise text to read as follows:
5.1.10.1.4 Tubes shall be hard-drawn seamless copper ASTM B 819, *Standard Specification for Seamless Copper Tube for Medical Gas Systems*, medical gas tube, Type L, except Type K shall be used that where operating pressures are above a gauge pressure of 1275 kPa (185) and the pipe sizes are larger than DN80 (NPS 3 (3 1/8 in. O.D.) Type K shall be used for sizes larger than DN80 (NPS 3 (3 1/8 in. O.D.).
Substantiation: Current wording is confusing. This is an attempt to clarify the intent of the requirement.
Committee Meeting Action: Accept in Principle
Committee Statement: See Committee Action on Proposal 99-280 (Log #CP243).
5.1.10 Category 1 Distribution.

5.1.10.1 Piping Materials for Field-Installed Positive Pressure Medical Gas Systems.

5.1.10.1.1 Tubes, valves, fittings, station outlets, and other piping components in medical gas systems shall have been cleaned for oxygen service by the manufacturer prior to installation in accordance with CGA G-4.1, Cleaning Equipment for Oxygen Service, except that fittings shall be permitted to be cleaned by a supplier or agency other than the manufacturer.

5.1.10.1.2 Each length of tube shall be delivered plugged or capped by the manufacturer and kept sealed until prepared for installation.

5.1.10.1.3 Fittings, valves, and other components shall be delivered sealed, labeled, and kept sealed until prepared for installation.

5.1.10.1.4* Tubes shall be hard-drawn seamless copper ASTM B 819, Standard Specification for Seamless Copper Tube for Medical Gas Systems, medical gas tube, Type L, except Type K shall be used where operating pressures are above a gauge pressure of 1275 kPa (185 psi) and the pipe sizes are larger than DN80 [NPS 3 (3 1/8 in. O.D.)].

5.1.10.1.5 ASTM B 819, Standard Specification for Seamless Copper Tube for Medical Gas Systems, medical gas tube shall be identified by the manufacturer's markings “OXY,” “MED,” “OXY/MED,” “OXY/ACR,” or “ACR/MED” in blue (Type L) or green (Type K).

5.1.10.1.6 The installer shall furnish documentation certifying that all installed piping materials comply with the requirements of 5.1.10.1.1.

5.1.10.2 Piping Materials for Field-Installed Medical–Surgical Vacuum and WAGD Systems.

5.1.10.2.1 Tubes for Vacuum. Piping for vacuum systems shall be constructed of any of the following:

(a) ASTM B 88, Standard Specification for Seamless Copper Water Tube, copper tube (Types K, L, M)

(b) ASTM B 280, Standard Specification for Seamless Copper Tubing for Air Conditioning and Refrigeration Field Service, copper ACR tube

(c) ASTM B 819, Standard Specification for Seamless Copper Tube for Medical Gas Systems, copper medical gas tubing (Type K or L)

(2) Stainless steel tube

5.1.10.2.2 Vacuum Tube Marking Where Required.

5.1.10.2.2.1 If copper vacuum tubing is installed along with any medical gas tubing, the vacuum tubing shall, prior to installation, be prominently labeled or otherwise identified to preclude using materials or installation procedures in the medical gas system that are not suitable for oxygen service.

5.1.10.2.2.2 If medical gas tube (ASTM B 819, Standard Specification for Seamless Copper Tube for Medical Gas Systems) is used for vacuum piping, such special marking shall not be required, provided that the vacuum piping installation meets all other requirements for medical gas piping, including the prohibition of flux on copper-to-copper joints and the use of a nitrogen purge while brazing.

5.1.10.2.3 WAGD System Piping. WAGD systems shall be piped as follows:

(1) Using materials compliant with 5.1.10.2.1 or 5.1.10.2.2

(2) In systems operated under 130 mm (5 in.) HgV maximum vacuum only, using any noncorroding tube or ductwork

5.1.10.3 Joints.
5.1.10.3.1* Positive-pressure patient gas systems, medical support gas systems, vacuum systems, and WAGD systems shall have all turns, offsets, and other changes in direction made using fittings or techniques appropriate to any of the following acceptable joining methods:

1. Brazing, as described in 5.1.10.4
2. Welding, as described in 5.1.10.5
3. Memory metal fittings, as described in 5.1.10.6
4. Axially swaged, elastic preload fittings, as described in 5.1.10.7
5. Threaded, as described under 5.1.10.8

5.1.10.3.2 Vacuum systems and WAGD systems shall be permitted to have branch connections made using mechanically formed, drilled and extruded tee-branch connections that are formed in accordance with the tool manufacturer's instructions. Such branch connections shall be joined by brazing, as described in 5.1.10.4.

5.1.10.3.3 WAGD systems designed for operation below 130 mm (5 in.) HgV shall be permitted to be joined using any method that will result in a leak-free network when tested per 5.1.12.3.2.

5.1.10.4 Brazed Joints.

5.1.10.4.1 General Requirements.

5.1.10.4.1.1 Fittings shall be wrought copper capillary fittings complying with ASME B16.22, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings, or brazed fittings complying with ASME B16.50, Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings.

5.1.10.4.1.2 Cast copper alloy fittings shall not be permitted.

5.1.10.4.1.3 Brazed joints shall be made using a brazing alloy that exhibits a melting temperature in excess of 538°C (1000°F) to retain the integrity of the piping system in the event of fire exposure.

5.1.10.4.1.4 Brazed tube joints shall be the socket type.

5.1.10.4.1.5 Filler metals shall bond with and be metallurgically compatible with the base metals being joined.

5.1.10.4.1.6 Filler metals shall comply with ANSI/AWS A5.8, Specification for Filler Metals for Brazing and Braze Welding.

5.1.10.4.1.7 Copper-to-copper joints shall be brazed using a copper–phosphorus or copper–phosphorus–silver brazing filler metal (BCuP series) without flux.

5.1.10.4.1.8 Brazing performed between bulk cryogenic liquid vessels and their vaporizers (i.e., subject to cryogenic exposure) shall be permitted to be brazed using BAg brazing alloy with flux by a brazer qualified to CGA M-1, Guide for Medical Gas Installations at Consumer Sites.

5.1.10.4.1.9 Joints to be brazed in place shall be accessible for necessary preparation, assembly, heating, filler application, cooling, cleaning, and inspection.

5.1.10.4.1.10 Brazed joints shall be continuously purged with nitrogen NF.

5.1.10.4.2 Cutting Tube Ends.

5.1.10.4.2.1 Tube ends shall be cut square using a sharp tubing cutter to avoid deforming the tube.

5.1.10.4.2.2 The cutting wheels on tubing cutters shall be free from grease, oil, or other lubricant not suitable for oxygen service.

5.1.10.4.2.3 The cut ends of the tube shall be permitted to be rolled smooth or deburred with a sharp, clean deburring tool, taking care to prevent chips from entering the tube.

5.1.10.4.3 Cleaning Joints for Brazing.
5.1.10.4.3.1 The interior surfaces of tubes, fittings, and other components that are cleaned for oxygen service shall be stored and handled to avoid contamination prior to assembly and brazing.

5.1.10.4.3.2 The exterior surfaces of tube ends shall be cleaned prior to brazing to remove any surface oxides.

5.1.10.4.3.3 When cleaning the exterior surfaces of tube ends, no matter shall be permitted to enter the tube.

5.1.10.4.3.4 If the interior surfaces of fitting sockets become contaminated prior to brazing, they shall be recleaned for oxygen in accordance with 5.1.10.4.3.10 and be cleaned for brazing with a clean, oil-free wire brush.

5.1.10.4.3.5 Clean, nonshedding, abrasive pads shall be used to clean the exterior surfaces of the tube ends.

5.1.10.4.3.6 The use of steel wool or sand cloth shall be prohibited.

5.1.10.4.3.7 The cleaning process shall not result in grooving of the surfaces to be joined.

5.1.10.4.3.8 After being abraded, the surfaces shall be wiped using a clean, lint-free white cloth.

5.1.10.4.3.9 Tubes, fittings, valves, and other components shall be visually examined internally before being joined to verify that they have not become contaminated for oxygen service and that they are free of obstructions or debris.

5.1.10.4.3.10 The interior surfaces of tube ends, fittings, and other components that were cleaned for oxygen service by the manufacturer, but became contaminated prior to being installed, shall be permitted to be recleaned on-site by the installer by thoroughly scrubbing the interior surfaces with a clean, hot water–alkaline solution, such as sodium carbonate or trisodium phosphate, 450 g to 11 L (1 lb to 3 gal) of potable water and thoroughly rinsing them with clean, hot, potable water.

5.1.10.4.3.11 Other aqueous cleaning solutions shall be permitted to be used for on-site recleaning permitted in 5.1.10.4.3.10 provided that they are as recommended in CGA G-4.1, Cleaning Equipment for Oxygen Service, and are listed in CGA O2-DIR, Directory of Cleaning Agents for Oxygen Service.

5.1.10.4.3.12 Material that has become contaminated internally and is not clean for oxygen service shall not be installed.

5.1.10.4.4 Brazing Dissimilar Metals.

5.1.10.4.4.1 Flux shall only be used when brazing dissimilar metals such as copper and bronze, or brass, using a silver (BAg series) brazing filler metal.

5.1.10.4.4.2 Surfaces shall be cleaned for brazing in accordance with 5.1.10.4.3.

5.1.10.4.4.3 Flux shall be applied sparingly to minimize contamination of the inside of the tube with flux.

5.1.10.4.4.4 The flux shall be applied and worked over the cleaned surfaces to be brazed using a stiff bristle brush to ensure complete coverage and wetting of the surfaces with flux.

5.1.10.4.4.5 Where possible, short sections of copper tube shall be brazed onto the noncopper component and the interior of the subassembly shall be cleaned of flux prior to installation in the piping system.

5.1.10.4.4.6 On joints DN20 (NPS ¾) (7/8 in. O.D.) size and smaller, flux-coated brazing rods shall be permitted to be used in lieu of applying flux to the surfaces being joined.

5.1.10.4.5* Nitrogen Purge.
5.1.10.4.5.1 When brazing, joints shall be continuously purged with oil-free, dry nitrogen NF to prevent the formation of copper oxide on the inside surfaces of the joint.

5.1.10.4.5.2 The source of the purge gas shall be monitored and the installer shall be audibly alerted when the source content is low.

5.1.10.4.5.3 The purge gas flow rate shall be controlled by the use of a pressure regulator and flowmeter or combination thereof.

5.1.10.4.5.4 Pressure regulators alone shall not be used to control purge gas flow rates.

5.1.10.4.5.5 In order to assure that all ambient air has been removed from the pipeline prior to brazing, an oxygen analyzer shall be used to verify the effectiveness of the purge. The oxygen analyzer shall read below 1 percent oxygen concentration before brazing is to begin.

5.1.10.4.5.6 During and after installation, openings in the piping system shall be kept sealed to maintain a nitrogen atmosphere within the piping to prevent debris or other contaminants from entering the system.

5.1.10.4.5.7 While a joint is being brazed, a discharge opening shall be provided on the opposite side of the joint from where the purge gas is being introduced.

5.1.10.4.5.8 The flow of purge gas shall be maintained until the joint is cool to the touch.

5.1.10.4.5.9 After the joint has cooled, the purge discharge opening shall be sealed to prevent contamination of the inside of the tube and maintain the nitrogen atmosphere within the piping system.

5.1.10.4.5.10 The final brazed connection of new piping to an existing, pipeline containing the system gas shall be permitted to be made without the use of a nitrogen purge.

5.1.10.4.5.11 After a final brazed connection in a positive pressure medical gas pipeline is made without a nitrogen purge, an outlet in the immediate downstream zone of the affected portion(s) of both the new and existing piping shall be tested in accordance with the Final Tie-In Test in 5.1.12.3.9.

5.1.10.4.5.12* When using the autogenous orbital welding process, joints shall be continuously purged inside and outside with inert gas(es) in accordance with the qualified welding procedure.

5.1.10.4.6 Assembling and Heating Brazed Joints.

5.1.10.4.6.1 Tube ends shall be inserted into the socket either fully or to a mechanically limited depth that is not less than the minimum cup depth (overlap) specified by ASME B16.50, Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings.

5.1.10.4.6.2 Where flux is permitted, the joint shall be heated slowly until the flux has liquefied.

5.1.10.4.6.3 After flux is liquefied, or where flux is not permitted to be used, the joint shall be heated quickly to the brazing temperature, taking care not to overheat the joint.

5.1.10.4.6.4 Techniques for heating the joint, applying the brazing filler metal, and making horizontal, vertical, and large-diameter joints shall be as stated in sections on “Applying Heat and Brazing” and “Horizontal and Vertical Joints” in Chapter VII, “Brazed Joints,” in the CDA Copper Tube Handbook.

5.1.10.4.7 Inspection of Brazed Joints.

5.1.10.4.7.1 After brazing, the outside of all joints shall be cleaned by washing with water and a wire brush to remove any residue and permit clear visual inspection of the joint.

5.1.10.4.7.2 Where flux has been used, the wash water shall be hot.

5.1.10.4.7.3 Each brazed joint shall be visually inspected after cleaning the outside surfaces.

5.1.10.4.7.4 Joints exhibiting the following conditions shall not be permitted:
(1) Flux or flux residue (when flux or flux-coated BAg series rods are used with dissimilar metals)
(2) Base metal melting or erosion
(3) Unmelted filler metal
(4) Failure of the filler metal to be clearly visible all the way around the joint at the interface between the socket and the tube
(5) Cracks in the tube or component
(6) Cracks in the braze filler metal
(7) Failure of the joint to hold the test pressure under the installer-performed initial pressure test (5.1.12.2.3) and standing pressure test (5.1.12.2.6 or 5.1.12.2.7)

5.1.10.4.7.5 Brazed joints that are identified as defective under conditions 5.1.10.4.7.4(2) or 5.1.10.4.7.4(5) shall be replaced.
5.1.10.4.7.6 Brazed joints that are identified as defective under conditions 5.1.10.4.7.4(1), 5.1.10.4.7.4(3), 5.1.10.4.7.4(4), 5.1.10.4.7.4(6), or 5.1.10.4.7.4(7) shall be permitted to be repaired, except that no joint shall be reheated more than once before being replaced.

5.1.10.5 Welded Joints.
5.1.10.5.1 Gas Tungsten Arc Welding (GTAW) for Copper and Stainless Tube.
5.1.10.5.1.1 Welded joints for medical gas and medical–surgical vacuum systems shall be permitted to be made using a GTAW autogenous orbital procedure.
5.1.10.5.1.2 The GTAW autogenous orbital procedure and the welder qualification procedure shall be qualified in accordance with Section IX, “Welding and Brazing Qualifications,” of the ASME Boiler and Pressure Vessel Code.
5.1.10.5.1.3 Welder qualification procedures shall include a “bend test” and a “tensile test” per Section IX, “Welding and Brazing Qualifications,” of the ASME Boiler and Pressure Vessel Code on each tube size diameter.
5.1.10.5.1.4 Each welder shall qualify to a welding procedure specification (WPS) for each tube diameter.
5.1.10.5.1.5* GTAW autogenous orbital welded joints shall be purged during welding with a commercially available mixture (±5 percent) of 75 percent helium and 25 percent argon.
5.1.10.5.1.6 The shield gas shall be as required in 5.1.10.5.1.5.
5.1.10.5.1.7 Test coupons shall be welded and inspected, as a minimum, at start of work and every 4 hours thereafter, or when the machine is idle for more than 30 minutes, and at the end of the work period.
5.1.10.5.1.8 Test coupons shall be inspected on the I.D. and O.D. by a qualified quality control inspector.
5.1.10.5.1.9 Test coupons shall also be welded at change of operator, weld head, welding power supply, or gas source.
5.1.10.5.1.10 All production welds shall be visually inspected on the O.D. by the operator and any obvious weld failures shall be cut out and re-welded.
5.1.10.5.2 Welding for Stainless Tube.
5.1.10.5.2.1 Stainless tube shall be welded using metal inert gas (MIG) welding, tungsten inert gas (TIG) welding, or other welding techniques suited to joining stainless.
5.1.10.5.2.2 Welders shall be qualified to Section IX, “Welding and Brazing Qualifications,” of the ASME Boiler and Pressure Vessel Code.
5.1.10.6 Memory Metal Fittings.
5.1.10.6.1 Memory metal fittings having a temperature rating not less than 538°C (1000°F) and a pressure rating not less than 2070 kPa (300 psi) shall be permitted to be used to join copper or stainless steel tube.

5.1.10.6.2 Memory metal fittings shall be installed by qualified technicians in accordance with the manufacturer's instructions.

5.1.10.7 Axially Swaged Fittings.

5.1.10.7.1 Axially swaged, elastic strain preload fittings providing metal to metal seals, having a temperature rating not less than 538°C (1000°F) and a pressure rating not less than 2070 kPa (300 psi), and when complete are permanent and nonseparable shall be permitted to be used to join copper or stainless steel tube.

5.1.10.7.2 Axially swaged elastic strain preload fittings shall be installed by qualified technicians in accordance with the manufacturer's instructions.

5.1.10.8 Threaded Fittings. Threaded fittings shall meet the following criteria:

(1) Be limited to connections for pressure and vacuum indicators, alarm devices, check valves, and source equipment on the source side of the source valve

(2) Be tapered pipe threads complying with ASME B1.20.1, Pipe Threads, General Purpose, Inch

(3) Be made up with polytetrafluoroethylene (such as Teflon™) tape or other thread sealant recommended for oxygen service, with sealant applied to the male threads only and care taken to ensure sealant does not enter the pipe

5.1.10.9 Special Fittings.

5.1.10.9.1 Listed or approved metallic gas tube fittings that, when made up provide a permanent joint having the mechanical, thermal, and sealing integrity of a brazed joint shall be permitted to be used.

5.1.10.9.2 Dielectric Fittings. Dielectric fittings that comply with the following shall be permitted only where required by the manufacturer of special medical equipment to electrically isolate the equipment from the system distribution piping:

(1) Is brass or copper construction with an appropriate dielectric.

(2) Is permitted to be a union.

(3) Is clean for oxygen where used for medical gases and medical support gases.

5.1.10.10 Prohibited Joints. The following joints shall be prohibited throughout medical gas and vacuum distribution pipeline systems:

(1) Flared and compression-type connections, including connections to station outlets and inlets, alarm devices, and other components

(2) Other straight-threaded connections, including unions

(3) The use of pipe-crimping tools to permanently stop the flow of medical gas and vacuum piping

(4) Removable and non-removable push-fit fittings that employ a quick assembly push fit connector.

5.1.10.11 Installation of Piping and Equipment.

5.1.10.11.1 Pipe Sizing.

5.1.10.11.1.1 Piping systems shall be designed and sized to deliver the required flow rates at the utilization pressures.

5.1.10.11.1.2 Mains and branches in medical gas piping systems shall be not less than DN15 (NPS ½) (5/8 in. O.D.) size.
5.1.10.11.1.3 Mains and branches in medical-surgical vacuum systems shall be not less than DN20 (NPS ¾) (7/8 in. O.D.) size.
5.1.10.11.1.4 Drops to individual station outlets and inlets shall be not less than DN15 (NPS ½) (5/8 in. O.D.) size.
5.1.10.11.1.5 Runouts to alarm panels and connecting tubing for gauges and alarm devices shall be permitted to be DN8 (NPS ¼) (3/8 in. O.D.) size.
5.1.10.11.2 Protection of Piping. Piping shall be protected against freezing, corrosion, and physical damage.
5.1.10.11.2.1 Piping exposed in corridors and other areas where subject to physical damage from the movement of carts, stretchers, portable equipment, or vehicles shall be protected.
5.1.10.11.2.2 Piping underground within buildings or embedded in concrete floors or walls shall be installed in a continuous conduit.
5.1.10.11.3 Location of Piping.
5.1.10.11.3.1 Piping risers shall be permitted to be installed in pipe shafts if protected from physical damage, effects of excessive heat, corrosion, or contact with oil.
5.1.10.11.3.2 Piping shall not be installed in kitchens, elevator shafts, elevator machine rooms, areas with open flames, electrical service equipment over 600 volts, and areas prohibited under NFPA 70, National Electrical Code, except for the following locations:
(1) Room locations for medical air compressor supply systems and medical-surgical vacuum pump supply systems
(2) Room locations for secondary distribution circuit panels and breakers having a maximum voltage rating of 600 volts
5.1.10.11.3.3 Medical gas piping shall be permitted to be installed in the same service trench or tunnel with fuel gas lines, fuel oil lines, electrical lines, steam lines, and similar utilities provided that the space is ventilated (naturally or mechanically) and the ambient temperature around the medical gas piping is limited to 54°C (130°F) maximum.
5.1.10.11.3.4 Medical gas piping shall not be located where subject to contact with oil, including a possible flooding area in the case of a major oil leak.
5.1.10.11.4 Pipe Support.
5.1.10.11.4.1 Piping shall be supported from the building structure in accordance with MSS SP-69, Pipe Hangers and Supports — Selection and Application.
5.1.10.11.4.2 Hangers and supports shall comply with MSS SP-58, Pipe Hangers and Supports — Materials, Design, and Manufacture.
5.1.10.11.4.3 Hangers that support copper tube shall be sized for copper tube.
5.1.10.11.4.4 In potentially damp locations, copper tube hangers or supports that are in contact with the tube shall be plastic-coated or otherwise be electrically insulated from the tube by a material that will not absorb moisture.
5.1.10.11.4.5 Maximum support spacing shall be in accordance with Table 5.1.10.11.4.5.

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Hanger Spacing:mm</th>
<th>Hanger Spacing:ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>DN8 (NPS ¼) (3/8 in. O.D.)</td>
<td>1520</td>
<td>5</td>
</tr>
<tr>
<td>DN10 (NPS 3/8) (½ in. O.D.)</td>
<td>1830</td>
<td>6</td>
</tr>
<tr>
<td>DN15 (NPS ½) (5/8 in. O.D)</td>
<td>1830</td>
<td>6</td>
</tr>
<tr>
<td>DN20 (NPS ¾) (7/8 in. O.D.)</td>
<td>2130</td>
<td>7</td>
</tr>
</tbody>
</table>
DN25 (NPS 1) (11/8 in. O.D.)  
2440  
8
DN40 (NPS 1½) (15/8 in. O.D.) and larger  
3050  
10
Vertical risers, all sizes  
4570  
15

5.1.10.11.4.6 Where required, medical gas and vacuum piping shall be seismically restrained against earthquakes in accordance with the applicable building code.

5.1.10.11.5 Underground Piping Outside of Buildings.

5.1.10.11.5.1 Buried piping outside of buildings shall be installed below the local level of frost penetration.

5.1.10.11.5.2 The installation procedure for underground piping shall protect the piping from physical damage while being backfilled.

5.1.10.11.5.3 If underground piping is protected by a conduit, cover, or other enclosure, the following requirements shall be met:

(1) Access shall be provided at the joints for visual inspection and leak testing.

(2) The conduit, cover, or enclosure shall be self-draining and not retain groundwater in prolonged contact with the pipe.

5.1.10.11.5.4 Buried piping that will be subject to surface loads shall be buried at a depth that will protect the piping or its enclosure from excessive stresses.

5.1.10.11.5.5 The minimum backfilled cover above the top of the pipe or its enclosure for buried piping outside of buildings shall be 900 mm (36 in.), except that the minimum cover shall be permitted to be reduced to 450 mm (18 in.) if there is no potential for damage from surface loads or surface conditions.

5.1.10.11.5.6 Trenches shall be excavated so that the pipe or its enclosure has firm, substantially continuous bearing on the bottom of the trench.

5.1.10.11.5.7 Backfill shall be clean, free from material that can damage the pipe and compacted.

5.1.10.11.5.8 A continuous tape or marker placed immediately above the pipe or its enclosure shall clearly identify the pipeline by specific name.

5.1.10.11.5.9 A continuous warning means shall also be provided above the pipeline at approximately one-half the depth of bury.

5.1.10.11.5.10 Where underground piping is installed through a wall sleeve, the outdoor end of the sleeve shall be sealed to prevent the entrance of groundwater into the building.

5.1.10.11.6 Hose and Flexible Connectors.

5.1.10.11.6.1 Hose and flexible connectors, both metallic and nonmetallic, shall be no longer than necessary and shall not penetrate or be concealed in walls, floors, ceilings, or partitions.

5.1.10.11.6.2 Flexible connectors, metallic or nonmetallic, shall have a minimum burst pressure, with a gauge pressure of 6895 kPa (1000 psi).

5.1.10.11.6.3 Metallic flexible joints shall be permitted in the pipeline where required for expansion joints, seismic protection, thermal expansion, or vibration control and shall have the following characteristics:

(1) All wetted surfaces made of bronze, copper, or stainless steel

(2) Cleaned at the factory for oxygen service and received on the job site with certification of cleanliness
(3) Suitable for service at 2070 kPa (300 psig gauge) or above and able to withstand temperatures of 538°C (1000°F)
(4) Provided with brazing extensions to allow brazing into the pipeline per 5.1.10.5
(5) Supported with pipe hangers and supports as required for their additional weight

5.1.10.11.7 Prohibited System Interconnections.
5.1.10.11.7.1 Two or more medical gas or vacuum piping systems shall not be interconnected for installation, testing, or any other reason.
5.1.10.11.7.2 Leak testing shall be accomplished by separately charging and testing each individual piping system.

5.1.10.11.8 Manufacturer’s Instructions.
5.1.10.11.8.1 The installation of individual components shall be made in accordance with the instructions of the manufacturer.
5.1.10.11.8.2 Such instructions shall include directions and information deemed by the manufacturer to be adequate for attaining proper operation, testing, and maintenance of the medical gas and vacuum systems.
5.1.10.11.8.3 Copies of manufacturer’s instructions shall be left with the system owner.

5.1.10.11.9 Changes in System Use.
5.1.10.11.9.1 Where a positive pressure medical gas piping distribution system originally used or constructed for the use at one pressure and for one gas is converted for operation at another pressure or for another gas, all provisions of 5.1.10 shall apply as if the system were new.
5.1.10.11.9.2 A vacuum system shall not be permitted to be converted for use as a gas system.

5.1.10.11.10 Qualification of Installers.
5.1.10.11.10.1 The installation of medical gas and vacuum systems shall be made by qualified, competent technicians who are experienced in making such installations, including all personnel who actually install the piping system.
5.1.10.11.10.2 Installers of medical gas and vacuum systems shall be certified in accordance with ASSE 6010, Professional Qualification Standard for Medical Gas Systems Installers.
5.1.10.11.10.3 Installers of medical gas and vacuum systems shall not use their certification to oversee installation by non-certified personnel.
5.1.10.11.10.4 Brazing shall be performed by individuals who are qualified in accordance with the provisions of 5.1.10.11.
5.1.10.11.10.5 Prior to any installation work, the installer of medical gas and vacuum piping shall provide and maintain documentation on the job site for the qualification of brazing procedures and individual brazers that is required under 5.1.10.11.
5.1.10.11.10.6 Health care organization personnel shall be permitted to install piping systems if all of the requirements of 5.1.10.11.10 are met during the installation.

5.1.10.11.11 Qualification of Brazing Procedures and Brazing.
5.1.10.11.11.1 Brazing procedures and brazer performance for the installation of medical gas and vacuum piping shall be qualified in accordance with either Section IX, “Welding and Brazing Qualifications,” of the ASME Boiler and Pressure Vessel Code, or AWS B2.2, Standard for Brazing Procedure and Performance Qualification, both as modified by 5.1.10.11.11.2 through 5.1.10.11.11.5.
5.1.10.11.11.2 Brazers shall be qualified by visual examination of the test coupon followed by sectioning.
5.1.10.11.11.3 The brazing procedure specification shall address cleaning, joint clearance, overlap, internal purge gas, purge gas flow rate, and filler metal.
5.1.10.11.11.4 The brazing procedure qualification record and the record of brazer performance qualification shall document filler metal used, cleaning, joint clearance, overlap, internal purge gas and flow rate during brazing of coupon, and the absence of internal oxidation in the completed coupon.

5.1.10.11.11.5 Brazing procedures qualified by a technically competent group or agency shall be permitted under the following conditions:

1. The brazing procedure specification and the procedure qualification record meets the requirements of this code.

2. The employer obtains a copy of both the brazing procedure specification and the supporting qualification records from the group or agency and signs and dates these records, thereby accepting responsibility for the qualifications that were performed by the group or agency.

3. The employer qualifies at least one brazer following each brazing procedure specification used.

5.1.10.11.11.6 An employer shall be permitted to accept brazer qualification records of a previous employer under the following conditions:

1. The brazer has been qualified following the same or an equivalent procedure that the new employer uses.

2. The new employer obtains a copy of the record of brazer performance qualification tests from the previous employer and signs and dates these records, thereby accepting responsibility for the qualifications performed by the previous employer.

5.1.10.11.11.7 Performance qualifications of brazers shall remain in effect indefinitely unless the brazer does not braze with the qualified procedure for a period exceeding 6 months, or there is a specific reason to question the ability of the brazer.

5.1.10.11.12 Breaching or Penetrating Medical Gas Piping.

5.1.10.11.12.1 Positive pressure patient medical gas piping and medical support gas piping shall not be breached or penetrated by any means or process that will result in residual copper particles or other debris remaining in the piping or affect the oxygen-clean interior of the piping.

5.1.10.11.12.2 The process shall ensure that any debris created by the process remains contained within the work area.
5.1.10.3 Jointing.
5.1.10.3.1 Positive pressure patient gas systems, medical support gas systems, vacuum systems and WAGD systems shall have all turns, offsets, and other changes in direction made using fittings or techniques appropriate to any of the acceptable jointing methods:
(1) Brazing, as described in 5.1.10.4.
(2) Welding as described in 5.1.10.5.
(3) Memory metal fittings, as described in 5.1.10.6.
(4) Axially swaged, elastic preload fittings, as described in 5.1.10.7.
(5) Threaded, as described under 5.1.10.9.
5.1.10.3.2 Vacuum systems and WAGD systems shall be permitted to have branch connections made using mechanically formed, drilled and extruded tee-branch connections that are formed in accordance with the tool manufacturer's instructions. Such branch connections shall be joined by brazing, as described in 5.1.10.4.
5.1.10.3.3 WAGD systems designed for operation below 130 mm (5 in.) HgV shall be permitted to be joined using any method that will result in a leak free network when tested per 5.1.12.3.2.
5.1.10.4 Brazed Joints.
5.1.10.4.1 General Requirements.
5.1.10.4.1.1 Fittings shall be wrought copper capillary fittings complying with...(remainder of current 5.1.10.3.1).
5.1.10.4.1.2 Cast copper alloy fittings shall not be permitted.
5.1.10.4.1.3 Insert 5.1.10.5.1.1 to 5.1.10.5.7.6 unchanged and renumber, such that:
Current 5.1.10.5.2 becomes 5.1.10.4.2.
Current 5.1.10.5.3 becomes 5.1.10.4.3.
Current 5.1.10.5.4 becomes 5.1.10.4.4.
Current 5.1.10.5.5 becomes 5.1.10.4.5.
Current 5.1.10.5.6 becomes 5.1.10.4.6.
Current 5.1.10.5.7 becomes 5.1.10.4.7.
5.1.10.5 Welded Joints.
5.1.10.5.1 GTAW Welding for copper and stainless tube.
Insert and renumber current 5.1.10.6.1 to 5.1.10.6.10 as 5.1.10.5.1.1 to 5.1.10.5.1.10.
5.1.10.5.2 Welding for Stainless tube.
5.1.10.5.2.1 Stainless tube shall be welded using MIG welding, TIG welding or other welding techniques suited to joining stainless.
5.1.10.5.2.2 Welders shall be qualified to ASME XXXX.
5.1.10.6 Memory Metal Fittings.
5.1.10.6.1 Memory metal fittings having a temperature rating not less than 538°C (1,000°F) and a pressure rating not less than 2,070 kPa (300 psi) may be used to join copper or stainless.
5.1.10.7 Axially Swaged Fittings.
5.1.10.7.1 Axially swaged, elastic strain preload fittings providing metal to metal seals, having a temperature rating not less than 538°C (1,000°F) and a pressure rating not less than 2,070 kPa (300 psi), and when complete are permanent and nonseparable may be used to join copper or stainless.
5.1.10.8 Threaded Fittings.
5.1.10.8.1 Threaded fittings shall:
(1) be limited to connections for pressure and vacuum indicators, alarm devices, check valves and source equipment on the source side of the source valve.
(2) be tapered pipe threads complying with ASME B1.20.1, Pipe Threads, General Purpose, Inch.
(3) be made up with polytetrafluoroethylene (such as Teflon™) tape or other thread sealant recommended for oxygen service, with sealant applied to the male threads only and care taken to ensure sealant does not enter the pipe.
(4) when joining stainless tubing only, be made up using standard stainless steel threaded fittings to ANSI 16.3 and suitable for 150 psi service.
Substantiation: This proposal seeks to clarify and eliminate a problem in the standard and in the field. The current standard ostensibly permits the use of stainless tubing for vacuum service but gives no clear guidance as to the jointing
techniques appropriate to it. At present, the cost of stainless makes its use very attractive, and users require more complete guidance to use it safely. The proposal reorganizes the section and thereby attempts to clarify the methods acceptable to both copper and stainless.

The section on welding stainless is new, based on accepted welding techniques for this material now widely used in laboratories, foot and pharma plants, etc.

The section on memory metal and on axially swaged fittings clarifies the previous wording by defining the temperature and pressure ratings.

Threaded fittings has a section added to permit joining of stainless tubing using standard threaded fittings.

**Committee Meeting Action:** Accept in Principle

**Committee Statement:** See Committee Action on Proposal 99-280 (Log #CP243).

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99-283 Log #63 HEA-PIP (5.1.10.5.2.3)  
Final Action: Accept in Principle

**Submitter:** Joseph Kerze, Gilbert, AZ

**Recommendation:** Revise text to read as follows:

5.1.10.5.2.3 The cut ends of the tube shall be deburred with a sharp, clean deburring tool, taking care to prevent chips from entering the tube (or rolled smooth with a chipless reamer.)

****Insert Artwork Here****

Chipless Reamer

**Substantiation:** Problem: (1) All references to deburring in the current and past codes states or implies that the burr has to be cut out by removing material therefore forbidding new technologies or innovation in dealing with the problem of deburring copper pipe that does not remove material.

Problem: (2) Governing plumbing authorities not familiar with newer technologies for preparing the end of copper pipe for assembly may reject (and have rejected) the use of a tool that does not cut or remove the burr (traditional and stated process) [NFPA 99.5.1.10.5.2.3] and UPC 2006 IS 3-2003 2.3.4 but re-forms or smoothes the burr to the full inside diameter of the pipe without removing material.

Problem: (3) When a burr is removed from a copper pipe by cutting it with a blade type deburring tool, sharp chips and debris (down to the microscopic level) are created. The chips may become lodged in valves or other devises causing problems or if ingested or inhaled by the end user a health hazard may occur. A chipless reamer reforms the burr without removing material therefore debris is not produced in the process. This may be useful in addressing UPC 1317.2 and NFPA 99 5.1.10.5.3.12 (field contamination of pipe).

Problem: (4) When reaming installed hard drawn in the vertical position with a blade deburring tool most of the chips and debris cut from the pipe falls down the tubing containing the system. A chipless reamer does not produce debris in the process of meeting the installation standard of [NFPA 99.5.1.10.5.2.3].

**Committee Meeting Action:** Accept in Principle

**Committee Statement:** See Committee Action on Proposal 99-280 (Log #CP243).
1/2" to 2" copper pipe

Copper Pipe

Rollers roll the burr out...no cutting!

Chipless Reamer

NFPA 99 Log 63 Artwork
Deburring is the process of removing any burrs that were created while cutting copper tubing. This deburring increases the inner diameter of the tubing back to its original diameter. While deburring is a standard practice in the installation of plumbing systems due to the relative viscosity of water, it is not necessary when dealing with low pressure gas such as oxygen and nitrogen. In addition, the deburring process adds small chips and burrs of copper to the line. These are especially problematic when dealing with tie ins to existing vertical pipelines. There is no way to prevent these burrs from dropping into the pipeline. There is no proof that deburring assists in the flow of low pressure gas.

By not removing the burr you may create an obstruction in the pipeline.

Revise 5.1.10.5.6.1 to read:

Tube ends shall be inserted into the socket either fully or to a mechanically limited depth that is not less than the minimum cup depth (overlap) specified by the Brazing Procedure Specification (BPS). Trimming of fittings to a cup depth that is not less than the minimum overlap specified by the BPS is also permitted provided the clearance between the tube and the fitting (joint clearance) is maintained within the limits of the BPS.

As discussed in more detail in the submitted article, the copper tube brazing industry has known since the early 1960s that an overlap of twice the thickness of the thinner member (2t) will result in a brazed joint that is stronger than the tube itself. The use of shallow cups is accepted by NFPA 99 by the recognition of MSS SP-73 in Annex A, yet the industry continues to use pipe fittings with deep cups made to ASME B16.22. The reasons for this are many, including cost, availability, liability and apparently lack of awareness that only a little overlap is needed when copper is brazed.

Extensive testing by CDA and ARI and industry experience show that deep socket fittings make it difficult for brazers to make quality brazed joints, particularly with larger tube sizes. In addition, CDA and ARI research has shown that the deeper the socket is, the sooner a joint that is subject to vibration will fail due to typically poor joint quality that occurs with deeper socket joints. Additional articles showing the negative relationship between excessive overlap length and joint quality are available at www.brazingdimpler.com.

To make higher quality brazed joints by taking advantage of shallower socket cups, the installing contractor can do several things:

(1) Purchase brazed joint fittings manufactured in accordance with MSS SP-73. These are difficult to obtain and cost significantly more (6 to 8 times) than B16.22 fittings.
(2) Trim the fittings mechanically and reclean them. This prohibitively expensive, and there is always risk of changing the roundness and inside diameter of the fitting, making the fitting even more difficult to braze properly.
(3) One can mechanically deform the fitting using a tool such as the Brazing Dimpler. This patented tool forms a small dimple on the outside of the fitting which protrudes sufficiently into the inside surface of the fitting to provide a positive mechanical stop for the tube a short distance from the end of the fitting. The fitting is adequately supported during dimpling so that there is no other deformation which might affect braze joint quality. The distance from the end of the fitting to the dimple is sufficient that there will be at least 2t overlap available for all sizes and tube types up to 6 inch.

Accordingly, the writer requests the following revision to NFPA 99 which will improve the quality of brazed joints, make them last longer, make them easier to make, reduce installed cost and maintain joint strength greater than that of the tube itself.

Committee Meeting Action: Accept in Principle
Committee Statement: See Committee Action on Proposal 99-280 (Log #CP243).
<table>
<thead>
<tr>
<th>Log #</th>
<th>Submitter</th>
<th>Recommendation</th>
<th>Substantiation</th>
<th>Committee Meeting Action</th>
<th>Committee Statement</th>
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<tbody>
<tr>
<td>99-286</td>
<td>Craig B. Williams, Life Medical Networks</td>
<td>Delete the following text: Axially swaged, elastic strain preload fittings providing metal to metal seal having pressure and temperature rating not less than that of a brazed joint and when complete are permanent and nonseparable</td>
<td>Unnecessary text since this type of fitting would be allowed under 5.1.10.7(2).</td>
<td>Reject</td>
<td>The fitting specified in part (4) is needed to clarify the standard.</td>
</tr>
<tr>
<td>99-287</td>
<td>Burton R. Klein, Burton Klein Associates</td>
<td>Make item (2) in the list the last item of list.</td>
<td>Editorial. More logical order of prohibited joints.</td>
<td>Reject</td>
<td>Item 2 is related to item 1.</td>
</tr>
<tr>
<td>99-289</td>
<td>J. Richard Wagner, Poole &amp; Kent Corporation</td>
<td>Revise text to read as follows: Hangers and supports for copper tube shall have a copper finish and be sized for copper tube.</td>
<td>The copper finish on hangers and supports for copper tube is not for corrosion protection. It simply indicates that the device is sized for copper tube. This change is supported by Formal Interpretation FI No. 99.05.1.</td>
<td>Accept in Principle</td>
<td>See Committee Action on Proposal 99-280 (Log #CP243).</td>
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<td>Log #</td>
<td>HEA-PIP</td>
<td>Final Action: Accept in Principle</td>
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<td>(5.10.10.4.4)</td>
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<tr>
<td><strong>Recommendation:</strong></td>
<td>Revise text to read as follows:</td>
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<td>In potentially damp locations, copper tube hangers and supports that are in contact with the tubes shall be plastic-coated or otherwise be electrically insulated from the tube by a material that will not absorb moisture.</td>
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<td><strong>Substantiation:</strong></td>
<td>Insulating materials such as felt should not be used in damp locations.</td>
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<td>Log #78</td>
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<td>(5.10.10.6)</td>
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<td><strong>Submitter:</strong></td>
<td>Burton R. Klein, Burton Klein Associates</td>
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<td><strong>Recommendation:</strong></td>
<td>Delete 5.10.10.6 Branch takeoffs.</td>
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<td><strong>Substantiation:</strong></td>
<td>Paragraph 5.10.3.1 requires turns, offsets and any changes in directions to be accomplished with fittings. No restrictions as to angles (horizontally or vertically) are stipulated. Gases in tubing is under either positive or negative pressure, and its flow is not affected by the route tubing takes in reaching outlets or inlets.</td>
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<td><strong>Committee Statement:</strong></td>
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<td>99-292</td>
<td>Log #122</td>
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<td><strong>Submitter:</strong></td>
<td>David B. Mohile, Medical Engineering Services, Inc.</td>
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<tr>
<td><strong>Recommendation:</strong></td>
<td>Delete paragraph.</td>
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<td><strong>Substantiation:</strong></td>
<td>There is no practical reason to mandate that branch takeoffs be done at a minimum of 45 degrees from the horizontal. The original proposal for this change indicated that this would assist in the prevention of particulate matter from migrating in the pipeline. While this may be necessary in water and other plumbing lines, it is not necessary in medical gas lines. Medical gas lines are inherently clean of particulate matter down to 98 percent efficiency at 1 micron or cleaner. Oxygen and other manufactured gases are even cleaner. This is an unnecessary cost to the project since it requires more fittings and tubing and additional installation of brazed joints. Additionally there frequently is not space available to go up before you run horizontally. Additionally, strict interpretation of this paragraph would appear to require this 45 degree runoff each time the contractor runs off the horizontal. How many times do we need to &quot;trap&quot; particulate matter?</td>
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<td><strong>Committee Statement:</strong></td>
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</table>
Craig B. Williams, Life Medical Networks Inc.

Delete the following text:

Runouts from horizontal piping shall be taken off above the centerline of the main or branch pipe and rise vertically or at an angle of not more than 45 degrees from the vertical. This requirement has caused more problems than it is trying to prevent. Installers are required to perform a blow out of the new pipeline networks and also conduct a visual particulate test by purging out each outlet and inlet with a high-intermittent flow. The verifier is then required to conduct another visual particulate test at each outlet and then a weighted particulate test at the furthermost outlet of 25% of the zones for new medical gas pipelines. Are there particulates hiding and waiting to come out later and travel through the pipeline system? Why are we requiring branch takeoffs for vacuum systems?

Committee Meeting Action: Accept in Principle
Committee Statement: See Committee Action on Proposal 99-280 (Log #CP243).

Mark W. Allen, BeaconMedaes

Add new text as follows:

5.1.10.10.7.3 Metallic flexible joints may be placed in the pipeline where required for expansion joints, seismic protection, thermal expansion or vibration control. Such flexible joints shall have the following characteristics:
(1) have all wetted surfaces made of bronze, copper or stainless steel.
(2) be cleaned at the factory for oxygen service and received on the job site with certification of cleanliness.
(3) be suitable for service at 2,070 kPa (300 psig) or above and able to withstand temperatures of 538°C(1000°F).
(4) be provided with brazing extensions to allow brazing into the pipeline per 5.1.10.5.
(5) be supported with pipe hangers and supports as required for their additional weight.

Substantiation: There are a number of reasons that flexible sections may be required in a pipeline, seismic being the best known. As written, 5.1.10.7 prohibits such joints. The rewrite permits them and defines how they are to be made and installed.

Committee Meeting Action: Accept in Principle
Committee Statement: See Committee Action on Proposal 99-280 (Log #CP243).

Dale Woodin, ASHE-American Society for Healthcare Engineering of the American Hospital Association (AHA)

Revise text to read as follows:

5.1.10.10.11.1 The installation of medical gas and vacuum systems shall be made by qualified, competent technicians who are experienced in making such installations. This includes all personnel who actually installing the piping system. The certified installer shall not use their certification to oversee other non-qualified personnel installing medical gas systems.

Substantiation: It is not uncommon for some contractors to only have one qualified technician on the job overseeing a group non-qualified installers.

This is not original material; its reference/source is as follows:
I am proposing this revision on behalf of the ASHE Medical Gas Workgroup chaired by Ed Tinsley

Committee Meeting Action: Accept in Principle
Committee Statement: See Committee Action on Proposal 99-280 (Log #CP243).
99-296  Log #87  HEA-PIP
(5.1.10.12.2)  Final Action: Reject

Submitter: John F. Youhouse, Youhouse Plumbing
Recommendation:  Add: By a third party competent group or agency and not the brazers employer. This requirement is for the initial braze qualification only.
Substantiation:  Employers should not evaluate the brazing performance for initial qualification. This is a loop hole allowing employers to evaluate the coupons of their own employees. This process should be performed by a third party.
Committee Meeting Action: Reject
Committee Statement:  This requirement is currently in ASSE 6010 which is referenced in NFPA 99.

99-297  Log #88  HEA-PIP
(5.1.10.12.5)  Final Action: Reject

Submitter: John F. Youhouse, Youhouse Plumbing
Recommendation:  Add text to read as follows:
Brazing procedures qualified by a third party technically competent.
Delete bowleg (3) in its entirety.
Substantiation:  An employer can consider itself a "competent group" and qualify its own workers. This can lead to shortcuts in qualification of brazers without proper sectioning and examination of test coupons.
Committee Meeting Action: Reject
Committee Statement:  This requirement is currently in ASSE 6010 which is referenced in NFPA 99.

99-298  Log #95  HEA-PIP
(5.1.10.13)  Final Action: Accept in Principle

Submitter: J. Richard Wagner, Poole & Kent Corporation
Recommendation:  Add text to read as follows:
Breaching or Penetrating Medical Gas Piping.
Positive-pressure patient medical gas piping and medical support gas piping shall not be breached or penetrated by any means or process that may introduce copper particles or other contaminants into the piping or affect the oxygen-clean interior of the piping.
Substantiation:  Drills, saws and other abrasive devices should not be used to cut into positive pressure medical gas piping, whether in-use or not.
Committee Meeting Action: Accept in Principle
Committee Statement:  See Committee Action on Proposal 99-280 (Log #CP243).
Edward J. Lyczko, The Cleveland Clinic

A.5.1.11 Standard Operating Pressure of Nitrous Oxide. It is recommended that the facility's normal operating pressure of Nitrous Oxide be initially set and continually maintained at least five (5) psig below the normal operating pressures of the Oxygen and Medical Air.

During the initial installation, renovation, or operations of these piping systems that are typically simultaneously blended and used for components of general anesthesia, in the event of any type of accidental and undiscovered cross connection (either internally or externally of the piping) of non-lethal Oxygen or Medical Air piping with potentially lethal N2O piping, the higher pressure Oxygen or Medical Air will always flow back into the lower pressure Nitrous Oxide pipeline. This will absolutely prevent, throughout these pipelines operational life, life-threatening injury to patients who may breathe lethal doses of higher pressure Nitrous Oxide accidentally delivered from their lower pressure labeled and indexed Oxygen or Medical Air station outlets.

Substantiation: During the life of these systems, the potential for the cross connection of these three gases always exists.

This could occur during normal operations where anesthesia and, particularly, heart-lung machines are continually connected and reconnected between surgical cases. The indexing system can easily be breached by unknowledgeable technicians. If the N2O is of higher pressure than the O2 and Medical Air, the patient could possibly breathe 100% N2O from his/her lower pressure labeled and indexed O2 or Medical Air station outlets. This would cause immediate suffocation causing either permanent brain damage or death.

Also, because of the multitude of renovation construction projects requiring planned multiple medical gas shutdowns, it would be very easy for unknowledgeable construction trades personnel to perform these shutdowns incorrectly and cross the pipelines when connecting new branches. If the verifier does not discover this mistake, it moves to the anesthesiologist to discover. Even though each anesthesia machine has an O2 analyzer as a last resort, this is still not a 100% safeguard - especially in the case of Medical Air that has no analyzer.

Keeping the pressure of the N2O at least 5 psi below that of the O2 and Medical Air is a very simple "error management" solution that would remove these "Human" and "Mechanical" interventional elements and completely take this potentially deadly scenario out of play.

Note: Supporting material is available for review at NFPA headquarters.

Committee Meeting Action: Accept in Principle

Revise 5.1.11 as follows:

5.1.11* Labeling and Identification. See Table 5.1.11 and annex.

Add new text as follows:

A.5.1.11 Standard Operating Pressure of Nitrous Oxide. It is recommended that the facility's normal operating pressure of Nitrous Oxide be initially set and continually maintained at least five (5) psig below the normal operating pressures of the Oxygen and Medical Air.

Piping systems which are connected though blending devices are in effect cross-connected through the device. In the rare event of a failure of the safeties inside the equipment, the possibility exists of having the gases flow across the device. When the device is an anesthesia machine, and one of the gases is nitrous oxide, a pressure in the nitrous oxide pipeline greater than the pressure in the medical air or oxygen system opens the possibility of nitrous oxide flowing into the other pipelines. A patient could then receive a lethal quantity of nitrous oxide from a labeled and indexed medical air or oxygen outlet. Adjusting the pressure as recommended can reduce the likelihood of the causative equipment failure and also reduce the severity of the problem in the event it did occur.

Committee Statement: Information was added to prevent backfeeding of nitrous oxide into the oxygen or medical air system during equipment failure.

99-300  Log #79  HEA-PIP
(5.111.1.4 and A.5.1.11.1.4 (New))

Subvertiser: Burton R. Klein, Burton Klein Associates

Recommendation: Add new 5.1.11.1.4 to read as follows:
5.111.1.4 Labeling shall be visible from a standing position.
Add new Annex A.5.1.11.4 to read as follows:
A.5.1.11.4 Piping above six ft from floor should be labeled on the bottom side of tubing. Piping below three ft from
floor should be labeled on the top side of the tubing.
Substnuation: To make identification of content within piping by user or inspector possible without having to use a
ladder or to lie on the floor.
Committee Meeting Action: Reject
Committee Statement: Ductwork and piping may obstruct the labeling and this may not be practical.

99-301  Log #36  HEA-PIP
(5.1.12.1.3, 5.1.12.1.4, 5.1.12.1.5, and 5.1.12.1.12)

Submitter: Burton R. Klein, Burton Klein Associates

Recommendation: Move these sections to new 5.1.13.3: "Repair, renovation of existing systems" and renumber
5.12.1.3 as new 5.1.13.3.1.
Renumber 5.1.12.1.4 as new 5.1.13.3.2.
Renumber 5.1.12.1.5 as new 5.1.13.3.3, and renumber 5.12.1.12 as new 5.1.13.3.4.
Substnuation: This material is applicable to existing systems, and thus should be located in "existing system" section.
Conform to NFPA 99 style of placing new requirements in new sections, and existing requirements in maintenance or
operation sections.
Committee Meeting Action: Reject
Committee Statement: The current location is more appropriate than under operations and management.

99-302  Log #14  HEA-PIP
(5.1.12.1.12.1)

Submitter: Daniel N. Miller, Medical Gas Technology Inc.
Recommendation: Where no piping is changed, functional testing shall be performed as follows by an ANSI/ASSE
Standard 6040, Professional Qualification Standard for Medical Gas System Maintenance Personnel.
Substnuation: Prevent unqualified people from doing the work. Safety! Provide a minimum performance criteria for
doing medical gas maintenance work.
Committee Meeting Action: Accept in Principle
Committee Statement: See Committee Action on Proposal 99-341(Log #CP251).
<table>
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<td>99-303</td>
<td>Log #15 HEA-PIP</td>
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<td><strong>Submitter:</strong> Curtis Mezzic, National ITC Corporation</td>
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<td><strong>Recommendation:</strong> Where no piping is changed, functional testing shall be performed as follows by an ANSI/ASSE Standard 6040, Professional Qualification Standard for Medical Gas System Maintenance Personnel.</td>
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<td><strong>Substantiation:</strong> Prevent unqualified people from doing the work. Safety! Provide a minimum performance criteria for doing medical gas maintenance work.</td>
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<td><strong>Committee Statement:</strong> See Committee Action on Proposal 99-341(Log #CP251).</td>
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<td><strong>Submitter:</strong> Larry Savastano, EMSE Corporation</td>
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<td>Log #18 HEA-PIP</td>
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<td><strong>Submitter:</strong> Gerald Lagura, Holden Hospital Supply</td>
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<td><strong>Recommendation:</strong> Where no piping is changed, functional testing shall be performed as follows by an ANSI/ASSE Standard 6040, Professional Qualification Standard for Medical Gas System Maintenance Personnel.</td>
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<td><strong>Submitter:</strong> Edwin Chun, Holden Hospital Supply Inc.</td>
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<td><strong>Recommendation:</strong> Where no piping is changed, functional testing shall be performed as follows by an ANSI/ASSE Standard 6040, Professional Qualification Standard for Medical Gas System Maintenance Personnel.</td>
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**Submitter:** Anthony Lowe, Allied Air Compressor, Inc.

**Recommendation:** Where no piping is changed, functional testing shall be performed as follows by an ANSI/ASSE Standard 6040, Professional Qualification Standard for Medical Gas System Maintenance Personnel.

**Substantiation:** Prevent unqualified people from doing the work. Safety! Provide a minimum performance criteria for doing medical gas maintenance work.

**Committee Meeting Action:** Accept in Principle

**Committee Statement:** See Committee Action on Proposal 99-341(Log #CP251).

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**Submitter:** Russell Chun, Holden Hospital Supply

**Recommendation:** Where no piping is changed, functional testing shall be performed as follows by an ANSI/ASSE Standard 6040, Professional Qualification Standard for Medical Gas System Maintenance Personnel.

**Substantiation:** Prevent unqualified people from doing the work. Safety! Provide a minimum performance criteria for doing medical gas maintenance work.

**Committee Meeting Action:** Accept in Principle

**Committee Statement:** See Committee Action on Proposal 99-341(Log #CP251).

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<td>Log #25 HEA-PIP</td>
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**Submitter:** Don Holden, Holden Hospital Supply

**Recommendation:** Where no piping is changed, functional testing shall be performed as follows by an ANSI/ASSE Standard 6040, Professional Qualification Standard for Medical Gas System Maintenance Personnel.

**Substantiation:** Prevent unqualified people from doing the work. Safety! Provide a minimum performance criteria for doing medical gas maintenance work.

**Committee Meeting Action:** Accept in Principle

**Committee Statement:** See Committee Action on Proposal 99-341(Log #CP251).
Submitter: Technical Committee on Piping Systems,

Recommendation: Revise Section 5.1.12.2.2 and consolidate list into one requirement as follows:

5.1.12.2.2 Initial Blow Down. Piping in medical gas and vacuum distribution systems shall be blown clear by means of oil-free, dry nitrogen NF as follows:

1) After installation of the distribution piping
2) Before installation of station outlets/inlets and other system components (e.g., pressure/vacuum alarm devices, pressure/vacuum indicators, pressure relief valves, manifolds, source equipment)

5.1.12.2.2 Initial Piping Blow Down. Piping in medical gas and vacuum distribution systems shall be blown clear by means of oil-free, dry nitrogen NF after installation of the distribution piping, but before installation of station outlets/inlet rough-in assemblies and other system components (e.g., pressure/vacuum alarm devices, pressure/vacuum indicators, pressure relief valves, manifolds, source equipment).

Substantiation: 1. This is initial blow down by the installer.
2. Rough-in assemblies have a brazed tube connection.
3. Consolidating list is editorial and clarifies requirement.
Committee Meeting Action: Accept

Submitter: Technical Committee on Piping Systems,

Recommendation: Revise text as follows:

5.1.12.2.3.2 Initial pressure tests shall be conducted as follows:

1) After blow down of the distribution piping.
2) After installation of station outlets/inlets rough-in assemblies. Test caps shall be permitted to be used.
3) Prior to the installation of components of the distribution piping system that would be damaged by the test pressure (e.g., pressure/vacuum alarm devices, pressure/vacuum indicators, line pressure relief valves, manufactured assemblies with flexible hose, hose, etc.).

Substantiation: This is the initial pressure test by the installer. Manufactured assemblies are to be factory tested per 5.1.6.1. Hoses are to be rated for 1000 psi per 5.1.6.4.
Committee Meeting Action: Accept

Submitter: David B. Mohile, Medical Engineering Services, Inc.

Recommendation: Delete this section. Also, change 5.1.12.2.3.4 to read:

The test pressure for pressure gases and vacuum systems shall be..."

Substantiation: Since vacuum systems are now brazed and since copper tubing is used for vacuum systems, there is no reason for the test pressure for vacuum to be lower than the pressure used for positive pressure systems. This can lead to unnecessary confusion on the job site and may accidentally allow a positive pressure system to be tested at 60 psig.
Committee Meeting Action: Accept
5.1.12.3.9.2 Each joint in the final connection between the new work and the existing system shall be leak-tested with the gas of system designation at the normal operating pressure by means of an electronic leak detector or a leak detectant that is safe for use with oxygen and does not contain ammonia.

5.1.12.3.9.3 Vacuum joints shall be tested using an ultrasonic leak detector or other means that will permit detection of leaks in an active vacuum system.

Committee Statement: Ultrasonic leak detectors are a valid detection method.

99-314 Log #118 HEA-PIP

(5.1.12.2.6)  Final Action: Accept

Submitter: David B. Mohile, Medical Engineering Services, Inc.
Recommendation: Add new paragraph 5.1.12.2.6.7 as follows:

This 24-hour standing pressure test of the positive pressure system shall be witnessed by the AHJ or his designee. A form indicating that this test has been performed and witnessed shall be provided to the Verifier at the start of the tests called for in 5.1.12.3.

Renumber the rest of the paragraphs to accommodate this change.

Substantiation: In order to assure that the tests called for in this paragraph are performed it is important that an outside person witness them. It would also be adequate if the tests are witnessed by the general contractor on the job site. It is not necessary for the Verifier to make a separate trip to witness this.

This will also provide documentation that the medical gas pipeline work has been successfully completed and witnessed, and if a leak later develops it can usually be traced to other trades on the job site.

Committee Meeting Action: Accept
99-315 Log #120 HEA-PIP  
(5.1.12.2.6.5)  
Final Action: Accept in Principle  

Submitter: David B. Mohile, Medical Engineering Services, Inc.
Recommendation: Change wording to read:
At the conclusion of the tests, there shall be no change in the test pressure.
Delete the rest of the sentence.
Substantiation: We state under paragraph 5.1.12.2.6.6, "Leaks, if any shall be located, repaired (if permitted) or replaced (if required), and retested".
As a practical test for the mechanical contractor the reference to the test protocol under 5.1.12.2.7.6 cannot be completed in the field with instruments that are generally available to the contractor. It is sufficient to say that no leaks are acceptable which we do say in 5.1.12.2.6.6. There should be no tolerance for leaks.
Committee Meeting Action: Accept in Principle
Committee Statement: This information is valuable for the installer and does correct for a real circumstance in the field.

99-316 Log #223 HEA-PIP  
(5.1.12.2.6.5)  
Final Action: Accept in Principle  

Submitter: Thomas J. Mraulak, Metropolitan Detroit Plumbing Industry
Recommendation: Revise text to read as follows:
At the conclusions of the tests, there shall be no change in the test pressure other than that attributed to changes of ambient temperature, as permitted under 5.1.12.2.7.6 by means of the following pressure-temperature relationship:
1. The calculated final absolute pressure equals the initial absolute pressure times the final absolute temperature, divided by the initial absolute temperature.
2. Absolute pressure is the gauge pressure reading plus 101.4 kPa (14.7 psi).
3. Absolute temperature is the temperature reading plus 238°C (460°F).
4. The final allowable gauge pressure reading equals the final allowable absolute pressure minus a gauge pressure of 101.4 kPa (14.7 psi).
Substantiation: This formula is in 5.1.12.2.7.6 under vacuum. I don't know of nor can find any way to convert inches or mercury to absolute, so I can see if this works well for pressure gases but not vacuum.
Committee Meeting Action: Accept in Principle
Committee Statement: See Committee Action on Proposal 99-315 (Log #120).

99-317 Log #377 HEA-PIP  
(5.1.12.2.6.5)  
Final Action: Accept in Principle  

Submitter: David D. Eastman, Metro Detroit Plumbing Industry Training Center
Recommendation: Revise text to read as follows:
5.1.12.2.6.5 At the conclusion of these tests, there shall be no change in the test pressure other than that attributed to changes of ambient temperature, as permitted under 5.1.12.2.7.6 5.1.12.2.6.7.
Substantiation: I propose moving the information about determining whether or not test pressure changes are a result of changes in ambient temperature to a new section to be included in 5.1.12.2.6, and eliminating Section 5.1.12.2.7.6 altogether as being confusing and inaccurately applied.
This is not original material; its reference/source is as follows:
5.1.12.2.6.5
Committee Meeting Action: Accept in Principle
Committee Statement: See Committee Action on Proposal 99-315 (Log #120).
Technical Committee on Piping Systems,

**Recommendation:** Revise Section 5.1.12.2.6.5 and add A.5.1.12.2.6.5 and Table A.5.1.12.2.6.5 as follows:

5.1.12.2.6.5* At the conclusion of the tests, there shall be no change in the test pressure except that attributed to specific changes in ambient temperature.

A.5.1.12.2.6.5 The effect of temperature changes on the pressure of a confined gas is based on the Ideal Gas Law. The final absolute pressure (P2a) equals the initial absolute pressure (P1a) times the final absolute temperature (T2a) divided by the initial absolute temperature (T1a). The relationship is the same for nitrogen, nitrous oxide, oxygen, and compressed air.

Absolute pressure is the gauge pressure reading plus the absolute atmospheric pressure. See Table A.5.1.12.2.6.5 for the absolute atmospheric pressures for elevations at and above sea level.

Absolute temperature °K (°R) is the temperature gauge reading °C (°F) plus the absolute zero temperature 273°C (460°F).

Examples of pressure test data at sea level in SI and IP units are below:

The initial test pressure is 415 kPa or 60 psig at 27°C (80°F). A temperature decrease to 18°C (65°F) will cause the test pressure to drop to 400 kPa or 57.9 psig.

\[
\begin{align*}
P1g &= 415 \text{ kPa}, \quad T1g = 27^\circ C, \quad T2g = 18^\circ C \\
P1a &= 415 + 101 = 516 \text{ kPa} \\
T1a &= 27 + 273 = 300^\circ K \\
T2a &= 18 + 273 = 291^\circ K \\
P2a &= 516 \times 291/300 = 501 \text{ kPa} \\
P2g &= 501 – 101 = 400 \text{ kPa} \\
\end{align*}
\]

\[
\begin{align*}
P1g &= 60 \text{ psig}, \quad T1g = 80^\circ F, \quad T2g = 65^\circ F \\
P1a &= 60 + 14.7 = 74.7 \text{ psia} \\
T1a &= 80 + 460 = 540^\circ R \\
T2a &= 65 + 460 = 525^\circ R \\
P2a &= 74.7 \times 525/540 = 72.6 \text{ psia} \\
P2g &= 72.6 – 14.7 = 57.9 \text{ psig} \\
\end{align*}
\]

***Insert Table A.5.1.12.2.6.5. here***

**Substantiation:**
1. To clarify that a specific change in ambient temperature must be noted.
2. To provide an example of test pressure changes due to temperature change. The example shows that moderate temperature changes do not cause significant changes in pressure.

**Committee Meeting Action:** Accept
<table>
<thead>
<tr>
<th>Elevation (feet)</th>
<th>Absolute Atmospheric Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>kPa</td>
</tr>
<tr>
<td>0</td>
<td>101.33</td>
</tr>
<tr>
<td>500</td>
<td>99.49</td>
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<tr>
<td>1000</td>
<td>97.63</td>
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<td>95.91</td>
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<td>2000</td>
<td>94.19</td>
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<td>85.91</td>
</tr>
<tr>
<td>5000</td>
<td>84.33</td>
</tr>
</tbody>
</table>
Add new paragraph 5.1.12.2.7.7 as follows:

This 24-hour standing pressure test of the vacuum system shall be witnessed by the AHJ or his designee. A form indicating that this test has been performed and witnessed shall be provided to the Verifier at the start of the tests called for in 5.1.12.3.

Renumber the rest of the paragraphs to accommodate this change.

In order to assure that the tests called for in this paragraph are performed it is important that an outside person witness them. It would also be adequate if the tests are witnessed by the general contractor on the job site. It is not necessary for the Verifier to make a separate trip to witness this.

This will also provide documentation that the medical gas pipeline work has been successfully completed and witnessed, and if a leak later develops it can usually be traced to other trades on the job site.

Committee Meeting Action: Accept

Revise text to read as follows:

5.1.12.2.7.1, 5.1.12.2.7.2, 5.1.12.2.7.3, 5.1.12.2.7.4, 5.1.12.2.7.5, 5.1.12.2.7.6, 5.1.12.2.7.7. New 5.1.12.2.7.1 After the vacuum inlets are connected to the vacuum network piping, but before the vacuum source, alarm switches, and gauges are connected, the vacuum network piping shall be subjected to a test pressure of not less than 413 kPa gauge (60 psig) by means of oil-free, dry nitrogen. After allowance for temperature variation, the pressure at the end of 24 hours shall be within 345 kPa (5 psig) of the initial pressure. Corrective action shall be taken if this performance is not verified.

After completion of the test, corrections, and reverification if necessary, the system shall be connected to the vacuum pumps, receiver, alarm actuators (vacuum switches), and gauges.

Substantiation: The formula in 5.1.12.2.7.6 does not work for vacuum. I don’t know of or can find any way to convert inches of mercury to absolute, so as I see it this works well for pressure gases but not vacuum. This new statement is the same statement that was in NFPA 99, 1999 edition.

This is not original material; its reference/source is as follows:

4.3.4.2.2(4) NFPA 99, 1999 edition

Committee Meeting Action: Reject

Committee Statement: See Committee Action on Proposal 99-315 (Log #120).

At the conclusion of the tests, there shall be no change in the test pressure.

Delete the rest of the sentence.

Then, delete 5.1.12.2.7.6. Renumber 5.1.12.2.7.7 as necessary.

Substantiation: We state under paragraph 5.1.12.2.7.7, "Leaks, if any shall be located, repaired (if permitted) or replaced (if required), and retested".

As a practical test for the mechanical contractor the reference to the test protocol under 5.1.12.2.7.6 cannot be completed in the field with instruments that are generally available to the contractor. It is sufficient to say that no leaks are acceptable which we do say in 5.1.12.2.7.7. There should be no tolerance for leaks.

Committee Meeting Action: Accept in Principle

Committee Statement: See Committee Action on Proposal 99-315 (Log #120).
99-322     Log #CP244 HEA-PIP
(5.1.12.2.7.5, 5.1.12.2.7.6, a.5.1.12.2.7.5)
Final Action: Accept

Submitter: Technical Committee on Piping Systems,
Recommendation:   Revise 5.1.12.2.7.5, add A.5.1.12.2.7.5 and remove 5.1.12.2.7.6 as follows:

5.1.12.2.7.5*  At the conclusion of the test, there shall be no change in the vacuum other than that attributed to changes of ambient temperature, as permitted under 5.1.12.2.7.6.

A.5.1.12.2.7.5  The effect of temperature changes on the vacuum of a confined gas is based on the Ideal Gas Law. The final absolute vacuum (V2a) equals the initial absolute vacuum (V1a) times the final absolute temperature (T2a) divided by the initial absolute temperature (T1a).

Absolute vacuum is the absolute zero pressure 101 kPa (30 inHG) less the vacuum reading below atmospheric. See Table A.5.1.12.2.6.5 for the absolute atmospheric pressures for elevations at and above sea level.

Absolute temperature ºK (ºR) is the temperature gauge reading ºC (ºF) plus the absolute zero temperature 273ºC (460ºF).

Examples of vacuum test data at sea level in SI and IP units are below:

The initial test vacuum is 54 kPa or 16 inHg at 18ºC (65ºF). A temperature increase to 27ºC (80ºF) will cause the test vacuum to decrease to 52.5 kPa or 15.6 inHg.

\[
\begin{align*}
V1g = 54 \text{ kPa}, & \quad T1g = 18^\circ \text{C}, \quad T2g = 27^\circ \text{C} \\
V1a &= 101 - 54 = +47 \text{ kPa}  \\
T1a &= 18 + 273 = 291^\circ \text{K}  \\
T2a &= 27 + 273 = 300^\circ \text{K}  \\
V2a &= 47 \times 300/291 = +48.5 \text{ kPa}  \\
V2g &= 101 - 48.5 = 52.5 \text{ kPa}
\end{align*}
\]

5.1.12.2.7.6  Test vacuum changes due to expansion or contraction shall be permitted to be determined by means of the following pressure–temperature relationship:

(1)  The calculated final absolute pressure equals the initial absolute pressure times the final absolute temperature, divided by the initial absolute temperature:

(2)  Absolute pressure is the gauge pressure reading plus 101.4 kPa (14.7 psi):

(3)  Absolute temperature is the temperature reading plus 238°C (460°F):

(4)  The final allowable gauge pressure reading equals the final allowable absolute pressure minus a gauge pressure of 101.4 kPa (14.7 psi):

Substantiation:  1. "Attributed to" sounds like "blamed on" with no specific data, such as temperatures. 5.1.12.2.7.6 is a word description of the pressure/temperature calculation. An example in Appendix A is proposed below.

2. To provide an example of test vacuum changes due to temperature change. The example shows that moderate temperature changes do not cause significant changes in vacuum.

Committee Meeting Action: Accept
99-323 Log #378 HEA-PIP
(5.1.12.2.7.6) Final Action: Accept in Principle

Submitter: David D. Eastman, Metro Detroit Plumbing Industry Training Center
Recommendation: Delete text as follows:
5.1.12.2.7.6 Test vacuum changes due to expansion or contraction shall be permitted to be determined by means of the following pressure temperature relationship:

(1) The calculated final Absolute pressure equals the initial absolute pressure times the final absolute temperature, divided by the initial absolute temperature.
(2) Absolute pressure is the gauge pressure reading plus 101.4 kPa (14.7 psi)
(3) Absolute temperature is the temperature reading plus 238°C (460°F).
(4) The final allowable gauge pressure reading equals the final allowable absolute pressure minus a gauge pressure of 101.4 kPa (14.7 psi).

Substantiation: These calculations require the tester to convert the vacuum readings from inches HgV to either psi or kilobars, with the inherent accuracies of conversion. Adding this inaccuracy to the inaccuracies involved in reading small changes in relatively low pressures, and to the small amounts of temperature change necessary to change the vacuum readings makes this calculation almost meaningless.

This is not original material; its reference/source is as follows:
5.1.12.2.7.6

Committee Meeting Action: Accept in Principle
Committee Statement: See Committee Action on Proposal 99-315 (Log #120).

99-324 Log #17 HEA-PIP
(5.1.12.3.1.4) Final Action: Reject

Submitter: Peter Esherick, Patient Instrumentation Corp.
Recommendation: Add to the sentence: Testing shall be performed by a party other than the installing contractor, the equipment manufacturer or any of its distributors; i.e. sellers or its authorized agents.
Substantiation: The problem is: conflict of interest. This addition will eliminate the supplier of the equipment or its authorized agents testing material manufactured or supplied by them.

Remember-The manufacturer or supplier of fire doors may not test and certify the fire doors. It must be done by an independent testing agency.

Committee Meeting Action: Reject
Committee Statement: A person certified to ASSE 6030 is considered adequate to do the work.

99-325 Log #56 HEA-PIP
(Table 5.1.12.3.1.4) Final Action: Reject

Submitter: John Conway, Oxygen Generating Systems Int’l
Recommendation: Add new text:

Gas concentrations indicating the required concentrations of the medical gases for the system verification requiring greater than 90 percent purity on the oxygen.

Substantiation: See supporting material.

Note: Supporting material is available for review at NFPA Headquarters.

Committee Meeting Action: Reject
Committee Statement: When verifying the oxygen system, 90% concentration opens up many questions as to the unknown 10%. This could indicate there was a cross connection if the concentration levels are at that level.
Technical Committee on Piping Systems,

Revise 5.1.12.3.7 and add Annex material as follows:

5.3.12.3.7 Verifier Piping Purity Test. For each Level 3 medical gas (i.e., oxygen and nitrous oxide) system, the purity of the piping system shall be verified as follows:

(1) These tests shall be performed with oil-free, dry Nitrogen NF or the system gas.

(2) The tests shall be for total hydrocarbons (as methane) and halogenated hydrocarbons, and compared with the source gas.

(3) This test shall be performed at the outlet most remote from the source.

(4) The difference between the two tests shall in no case exceed the following:
   - Total hydrocarbons, 1 ppm
   - Halogenated hydrocarbons, 2 ppm

(5) A test shall be conducted at the outlet most remote from the source and the moisture concentration shall not exceed 500 ppm or an equivalent pressure dew point of -12°C (10°F) at 345 kPa (50 psig).

5.1.12.3.7* Verifier Piping Purity Test. For each medical gas system the purity of the piping system shall be verified in accordance with 5.1.12.3.8

5.1.12.3.7.1 These tests shall be performed with oil-free, dry nitrogen NF or the system gas.

5.1.12.3.7.2 The outlet most remote from the source shall be tested for total non-methane hydrocarbons and compared to the source gas.

5.1.12.3.7.3 If the system gas is used as the source gas, it shall be tested at the source equipment.

5.1.12.3.7.4 The difference between the two tests shall in no case exceed 5 ppm of total non-methane hydrocarbons.

5.1.12.3.7.5 The difference between the two tests shall in no case exceed 5 ppm halogenated hydrocarbons.

5.1.12.3.7.6 The moisture concentration of the outlet test shall not exceed 500 ppm or an equivalent pressure dew point of -12°C (10°F) at a gauge pressure of 345 kPa (50 psi).

A.5.1.12.3.7 The detector used for total hydrocarbons is calibrated with a gas that has a known quantity of methane. When a sample is run with this calibrated detector, the result will be total hydrocarbons as methane. Since methane is the one hydrocarbon that does not interact with the body and is present in all air and most oxygen, the actual amount of methane in the sample is subtracted from the total hydrocarbon result to give total non-methane hydrocarbons.

Substantiation: 5.1.12.3.8 was rewritten to provide more clear criteria for the verifier piping purity test of Category 1 systems.
Reword to read:

5.1.12.3.7.1 The outlet shall be opened to full flow using a standard adapter threaded on a diameter 0.47 mm filter holder with an inlet and outlet .6 mm diameter (0.25 in. diameter) or greater and otherwise completely open to flow. The filter holder shall be charged with a clean, white, preweighed 1 um borosilicate glass fibre filter supported by a perforated stainless steel plate.

The outlet shall flow for 30 seconds from connection to detachment. When detached, the filter shall be visually examined for visible particulates or damage. If particles are visible or the filter is damaged, the system must be further purged and retested. If undamaged, the filter shall be reweighed on a balance capable of resolving 0.001 gram. The filter shall accrue no detectable weight.

Delete 5.1.12.3.7.3.

Substantiation: This redefinition of the requirement is based on the actual result the standard seeks to achieve - no debris in the line - rather than the scientifically amusing but meaningless "0.001 g at 0.45 um" of the previous requirement.

The filter media is changed to be a simple filter with a larger porosity. The test is changed to simply be whatever the full flow of the outlet is, with the intent that full flow will move debris as much as could ever be moved. The first examination is for simple physical damage, as particles hitting the filter at these velocities will physically damage it, whereas a clean gas stream will not damage the media. Naturally, at the same time, the presence of visible particulates should of course mean a failure as well. An undamaged, visually clean filter can then be weighed, and so long as there is no gain in weight, the system can be accounted as clean.

While the test may lack scientific elegance, it is very appropriate to the actual conditions we seek to test and the site conditions under which the test is performed, and should be entirely valid in ensuring the systems are as clean or more clean than the present test.

Committee Meeting Action: Reject

Committee Statement: The current 0.45 um-micron type filter is commercially available and has been used for many years for CGA Grade D and E breathing air testing and is similar to the requirement in NFPA 1989 Standard on Breathing Air Quality for Fire and Emergency Services Respiratory Protection, 2008 Edition. It would be good field practice to visually inspect filters for particles or damage before proceeding since such test materials will result in a failed test, but it isn't necessary to tell the tester since they should be competent to know that. The full flow of the test outlets are required to deliver at least 100 SLPM. Sampling the air flow at full flow for 30 seconds only allows for 50 SL to pass through the filter. This is one-twentieth the volume currently required. In many cases the pipe volume of gas would be much more than 50 SL. The volume of gas tested should be at least as much as the volume of gas in the test piping system or matter at the beginning of the line would never have a chance to reach the test filter. The proposed change in amount of matter allowed from 1 mg to 10 mg is ten times more. The purpose of the enter section is to verify that the installation and purging operations were done properly. Any failures in the test are a means of identifying faulty systems. Our laboratory analysis of over 500 field medical system test samples shows that 3.6 percent have more than 1 mg of matter and failed the current requirement.

This means material was still in the pipe. Our laboratory results of this sample set further show that approximately one in one thousand samples had greater than 10 mg of matter even though this sample set was done at a minimum air volume of 1000 liters, ten times more than that in the proposal. If the specification is changed per the proposal the testing may never find system problems that generate matter.
Submitter: David B. Mohile, Medical Engineering Services, Inc.

Recommendation: Change the paragraph to read:

The filter shall accrue no more than 0.01g (10 mg) of matter from any outlet tested.

Substantiation: The measurement of 0.001g is difficult to do without very sophisticated instruments which are almost impossible to use in the field. This means that a facility would have to wait for the results of off site lab testing before they were able to open up for patient usage. With the almost universal usage of adequate nitrogen purging and ASTM B819 tubing the particulate problem is almost gone away. The installer has two blow down tests and the verifier has an additional test. These three tests remove particulate matter.

Committee Meeting Action: Accept in Principle

Revise as follows:

5.1.12.3.7.3 The filter shall accrue no more than 0.001 g (1 mg) of matter from any outlet tested.

Committee Statement: Many tests are conducted on new medical gas systems prior to patient use to assure patient safety is maintained. These tests are conducted first by the installers themselves as defined in NFPA 99, then by credentialed verifiers as defined in NFPA 99. The credentialed verifiers must meet all of the ASSE 6030 requirements and assure that at a minimum all tests are conducted in accordance with NFPA 99 as well.

The verifier conducts many tests including but not limited to: Piping purity tests, which include particulate testing, total hydrocarbon testing and halogenated hydrocarbon testing.

The current (NFPA 99, 2005 Edition) particulate test includes running one cubic meter at 100 lpm of the test or medical gas through a 0.45 micron filter. The particulate matter must be quantified and not exceed 1 milligram in total weight.

The submitters ROP includes increasing the allowable particulate matter to 10 milligrams.

The reasoning is as follows: since the current particulate level is difficult to do without sophisticated equipment, which is almost impossible to use in the field, the facility would have to wait for the results of a lab before they were able to put patients on the system. Since the use of nitrogen is almost universal, and the use of clean for oxygen piping is common, the particulate problem has almost gone away. The installer has two blow down test’s as well as the verifier purge test. These tests intend to remove particulate matter.

Author counterpoint: As a credentialed verifier who has tested thousands of systems, I have identified much of the following: copper tubing that is used for water lines and waste lines accidentally installed on medical gas systems, installers who were not credentialed and did not know to use nitrogen to eliminate oxides during high heat brazing, installers who forgot to remove the rubber/plastic caps and melted them during the installation, poor workmanship resulting in copper filings, improperly/not cleaned fittings, improperly cleaned tubing, etc.

The equipment required is not sophisticated. It is a balance (scale) that needs to be calibrated periodically per manufacturer. It is transportable and can be set up in minutes on a level surface. Balances are available from many sources and are not very expensive.

Reasons to keep the 1 mg weight standard:

1. The intent of the Purity testing requires that a Verifier perform a series of inspection tests to assure that proper installation procedures, materials and the medical gas equipment installed meet or exceed a minimum purity standard. Increasing the weight standard from 1 milligram to 10 milligrams diminishes the quality of this standard by 1000%. (As recent as NFPA 99, 1999 edition the standard was 0.1 mg). Although purging of the pipeline was included in the
NFPA 99 since 1987 (and also in prior NFPA editions 565 and 56F), the weight standard was introduced in 1993. Prior to the weight description being added to the standard, medical gas lines contamination was more common then not. This visual standard literally cleaned up the medical gas lines.

2. We are taking a quantifying test (scale measurement/lab analysis) and changing it to a subjective test (eg. If you do not see particulate, it passes).

3. NFPA 99 does not define the type of particulates, only the weight limit. Particulates can be Pneumoconioses, Pulmonary Irritant, or Toxic Inhalants. Although testing for every type of particulate may not be the solution, increasing the weight allowable limit opens the door for additional contaminants to enter the medical gas pipelines.

4. Effects of particulates in compressed gases can be classified into two categories:
   A. Those that have no harmful effects on the lungs, but pass from the lungs directly into the bloodstream either impairing the oxygen carrying capacity of the red blood cells or affecting other parts of the body possible causing delirious effects and
   B. Those that cause disease of the lungs tissue or damage the lungs to impair its function.

5. All medical gases are prescription drugs regulated by FDA and, accordingly, must be manufactured and distributed in compliance with applicable laws and regulations, including existing FDA Current Good Manufacturing Practice (CGMP) regulations. In stating this, it is true by association that the pipeline network distributing the medical gases shall meet the min. purity levels defined by the USP. Not correcting the cause of any medical gas system contamination can place the hospital in violation of state and local building and health codes and Food and Drug Administration (FDA) drug regulations, as well as create a health and fire risk.

6. Although filters can effectively trap dirt (e.g., oxide particles from improper brazing of the pipeline) until it can be blown from the system at a convenient time, in many cases, contamination will only get worse. For example, water found in medical compressed air is caused by failure of the production system and can allow bacteria and molds to colonize the pipeline; the longer repairs are delayed, the dirtier the system will become—and the more expensive the cleanup will be.

7. Breathing gas quality is especially critical when using breathing gases in healthcare. This is because, as pressure increases, so do the partial pressure exposures to contaminants in the breathing gas.

99-329  Log #73  HEA-PIP
(5.1.12.3.8) Final Action: Accept

Submitter: Jason D. Sweatt, Wm. G. Frank Medical Gas Services, LLC
Recommendation: Paragraph 5.1.12.3.8.1 thru 5.1.12.3.8.4.(2).
Substantiation: Delete entire section of the paragraphs listed above.
Committee Meeting Action: Accept

Printed on 3/3/2010
99-330 Log #124 HEA-PIP
(5.1.12.3.8.4) Final Action: Accept

Submitter: David B. Mohile, Medical Engineering Services, Inc.
Recommendation: Delete this paragraph.
Substantiation: Since the current levels are almost impossible to measure in the field, and since the gaseous contaminant problem has all but disappeared with the universal use of ASTM B819 tubing, these tests should no longer be necessary on a mandatory basis. Analytical laboratories are hard pressure to do this testing due to the low levels of detection mandated, and even the most sophisticated laboratories are reporting almost no problems noted.
Committee Meeting Action: Accept

99-331 Log #316 HEA-PIP
(5.1.12.3.8.4) Final Action: Accept

Submitter: John M. Skinner, Medical Equipment Technology, Inc.
Recommendation: Delete the following text:
5.1.12.3.8.4 The difference between the two tests shall in no case exceed the following:
(1) Total hydrocarbons (excluding methane), 5 ppm
(2) Halogenated hydrocarbons, 5 ppm
Substantiation: Instrumentation and Laboratory testing for this requirement is very unreliable. Pipe cleaning methods have changed by manufacturers.
Committee Meeting Action: Accept

99-332 Log #107 HEA-PIP
(5.1.12.3.8.4 and 5.1.12.3.12.3) Final Action: Reject

Submitter: Mike Clotfelter, BC Group International Inc.
Recommendation: I recommend that the board consider changing the requirements for hydrocarbon analysis to a specification that can actually be met with commercially available test equipment that is affordable to purchase, repair and calibrate. I'm not sure if the hydrocarbon limits can be increased so that more instrument options are available to measure these contaminants in the field. Perhaps one option is to use the detector tubes for measuring Oil Mist. Sensidyne offers a Compressed Breathing Air Analysis Test Kit that includes a detector tube for Oil Mist that has a range of 0.3-5 mg/M3. I'm assuming that these tubes are adequate for testing compressed breathing air for fire departments, scuba divers, etc., but I'm not sure if they would meet the requirements for medical air. I am aware that these tubes can have an accuracy tolerance of ~25 percent, but I also understand that the Thermo-Environment Sapphire has an accuracy tolerance of 15-25 percent.
Substantiation: I work for the leading provider of analytical instruments for the medical gas verifier industry and with the current hydrocarbon testing requirements, it's almost impossible to find an affordable instrument that's adequate to make these measurements for hydrocarbons in the field, primarily due to the very low required minimum detection limits. The Thermo-Environmental Sapphire is the only portable instrument that I'm aware of that is adequate to make these measurements, but it marginally meets the requirements and this instrument is big and bulky and it is expensive to purchase and expensive to maintain and to calibrate. Another option is to take grab samples and to send them to an analytical lab for analysis, but this option does not provide instant test results, which customers often require. I'm aware that a great percentage of verifiers either do not test for hydrocarbons at all, due to the lack of available instruments to make these measurements or if they do attempt to make these measurements, they're using instruments that do not provide the adequate minimum detection limits and accuracy and are not routinely calibrated.
I don't have the answer to this problem, but I felt that it was important to bring it up as an issue, since the current standard says one thing and many of the verifiers seem to be either ignoring it or not testing for Hydrocarbons with adequate test equipment. Please contact me if you have any questions or if I can be of assistance.
Committee Meeting Action: Reject
Committee Statement: The submitter did not provide any recommendation.
Technical Committee on Piping Systems,
Revise text as follows:

5.1.12.3.9.3 For pressure gases, immediately after the final brazed connection is made and leak-tested, the specific altered zone and components in the immediate zone or area an outlet in the new piping and an outlet in the existing piping that are immediately downstream from the point or area of intrusion shall be purged in accordance with the applicable requirements of 5.1.12.3.6.

Substantiation: These changes clarify the requirements for final connections.
Committee Meeting Action: Accept
Committee Statement: See Sections 5.1.10.4.5.10, 5.1.10.4.5.11, and 5.1.12.3.9.3 of draft.

Medical-surgical vacuum inlets shall draw 85 NL/min (3 SCFM) without reducing the vacuum pressure below 300 mm (12 in.) gage HgV at any adjacent station inlet.

Checking an adjacent outlet assumes that the adjacent outlet is correctly functioning, or assumes that the outlet is close enough to affect the test result. Vacuum outlets should be tested at the outlet for flow and pressure, the same way positive pressure outlets are tested. Testing the vacuum line pressure drop at the inlet is a very valid and repeatable test, and is much more reliable and consistent than attempting to check the next closest inlet, which might be in the next room or down the hall.

Medical Air (compressed) 20.9% oxygen
Medical Air (synthetic) 19.5% - 23.5%

Atmospheric air is 20.946% oxygen, +/- 0.002% (reference CRC Manual of Chemistry and Physics). This percentage has not changed in recorded history. The designation 19.5% to 23.5% refers to blended or synthetic air only. CGA G-7.1, Commodity Specification for Air, is almost universally misinterpreted because no one reads the fine print, which states that medical air shall be "atm/19.5-23.5", and there is a footnote, (#5) in the CGA G-71 specification, which states: "#5 - The term 'atm' (atmospheric) denotes the oxygen content normally present in atmospheric air; the numerical values denote the oxygen limits for synthesized air."

If compressed medical air is below 20.9% oxygen, there is a contamination problem with it, or there is still nitrogen in the system that needs to be purged. If the line percentage is above 20.9% oxygen, there is also a problem that must be addressed, because there is cross contamination from an oxygen source. Only synthetic air from a cylinder can be in the 19.5% to 23.5% oxygen range. This is a necessary technical change that will correctly synchronize NFPA with one of its reference documents, and provide the verifier with knowledge that will aid in diagnosing problems within the medical air system.

Committee Meeting Action: Reject
Committee Statement: The range in the table correlates with USP which is the requirement of this standard, section 5.1.3.5.1(2).
99-336   Log #225  HEA-PIP
(Table 5.1.12.3.12.3) Final Action: Accept in Principle

Submitter: Thomas J. Mraulak, Metropolitan Detroit Plumbing Industry
Recommendation: Revise text to read as follows:
Pressure dew point \( +4^\circ \text{C} \) \( (\approx 39 \, 35^\circ \text{F}) \).
Substantiation: In the 2005 standard the dew point was changed and it was missed in this section.
Committee Meeting Action: Accept in Principle
Change \( 0^\circ \text{C} \) should be \( 2^\circ \text{C} \).
Committee Statement: The change corrected an error.

99-337   Log #317  HEA-PIP
(Table 5.1.12.3.12.3) Final Action: Reject

Submitter: John M. Skinner, Medical Equipment Technology, Inc.
Recommendation: Revise text to read as follows:
Table 5.1.12.3.12.3 Contaminant Parameters for Medical Air.

***Insert Table 5.1.12.3.12.3 Contaminant Parameters for Medical Air here***

Substantiation: This testing is not needed currently.
Committee Meeting Action: Reject
Committee Statement: Measuring hydrocarbons is important to determine if there are any contaminants in the system from outside sources in the intake system.

99-338   Log #275  HEA-PIP
(Table 5.1.12.3.12.3) Final Action: Accept

Submitter: Keith Ferrari, Praxair, Tamara Brown
Recommendation: Add new section to 5.1.12.3.14.
5.1.12.3.14.4 Proportioning System for Medical Air USP
(A) The system apparatus shall be tested for proper function, including the changeover from primary to secondary (if applicable) and operation of the reserve, before the system is put in service.
(B) Tests shall include the purity of the air quality, and the test of the alarm sensors after calibration and setup per the manufacturers instructions.
(C) Tests shall be conducted at the sample port of the proportioning system.
(D) The operation of the control sensors and all quality monitoring sensors and controls, shall be checked for proper operation and function before the system is put into service.
Substantiation: Section 3.3.106 Medical Air Definition and Section 5.1.3.5 Level 1 Medical Air Supply Systems refer to Medical Air USP reconstituted from oxygen USP and oil free, dry Nitrogen NF. Currently, NFPA 99 does not define a system that reconstitutes Medical Air USP form Oxygen USP and Nitrogen NF.
If the new Section 5.1.3.5.4 Proportioning System for Medical Air USP is accepted, the section above will need to add to this line.
This is not original material; its reference/source is as follows:
References to International Standard ISO 7396-1 and Canadian Standards CSA – Z305.1
Committee Meeting Action: Accept
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Limit Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure dew point</td>
<td>4 °C (39 F)</td>
</tr>
<tr>
<td>Carbon monoxide</td>
<td>10 ppm</td>
</tr>
<tr>
<td>Carbon dioxide</td>
<td>500 ppm</td>
</tr>
<tr>
<td>Gaseous hydrocarbons</td>
<td>225 ppm (as methane)</td>
</tr>
<tr>
<td>Halogenated hydrocarbons</td>
<td>2 ppm</td>
</tr>
</tbody>
</table>
Reword to read:

5.1.12.3.14.3(E). The air quality tests in 5.1.12.3.14.3(D) shall be conducted after the medical air source system has been operating normally but with the source valve closed under a simulated load for an elapsed time of at least 24 hours. The aggregate run time on the compressors is not used to determine the elapsed time. Loading shall be simulated by continuously venting air at approximately 25% of the rated system capacity.

**Recommendation:** The intent of this provision is not to require the compressors to accumulate 24 hours of run time, but to have the system purged, dried down and in essentially the condition the first patient will experience. 24 hours at 25% load is sufficient to ensure this.

**Committee Meeting Action:** Accept in Principle

Reword 5.1.12.3.14.3 (E) to read as follows and add new (F) and (G):

(E). The air quality tests in 5.1.12.3.14.3(D) shall be conducted after the medical air source system has been operating normally but with the source valve closed under a simulated load for an elapsed time of at least 12 hours.

(F) The aggregate run time on the compressors shall not be used to determine the elapsed time.

(G) Loading shall be simulated by continuously venting air at approximately 25% of the rated system capacity.

Renumber existing (F) as (H)

**Committee Statement:** Revised to comply with the Manual of Style. A 12-hour load is considered adequate to determine the stability of the air compressor.

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**5.1.13**

**5.1.13.3.1 Medical Gas Systems annual testing can be performed by two (2) methods.**

**Method 1) Test each and every outlet / inlet, piece of source equipment, alarms and valves every year with a documented procedure.**

**Method 2) Test each zone with outlets / inlets testing only the terminal (final outlet / inlet of each zone. Testing terminal outlets / inlets can be performed for two (2) consecutive years with the requirement for testing each and every outlet / inlet every third (3) year.**

**Substantiation:** This will help NFPA Standards to be used by facilities to conform to The Joint Commission Standards.

**Committee Meeting Action:** Accept in Principle

Accept in Principle.

**Committee Statement:** See Committee Action on Proposal 99-341 (Log #CP251).

Technical Committee on Piping Systems,

**Recommendation:** Replace existing section 5.1.13 as follows:

5.1.13* Category 1 Operation and Management.

5.1.13.1 Special Precautions — Patient Gas, Vacuum, WAGD, and Medical Support Gas Systems.

5.1.13.1.1* Piping systems shall not be used for the distribution of flammable anesthetic gases.

5.1.13.1.2 Piping systems shall not be used as a grounding electrode.

5.1.13.1.3* Liquid or debris shall not be introduced into the medical–surgical vacuum or WAGD systems for disposal.

5.1.13.1.4* The medical–surgical vacuum and WAGD systems shall not be used for nonmedical applications (e.g., vacuum steam condensate return).

5.1.13.2 Maintenance of Medical Gas, Vacuum, WAGD, and Medical Support Gas Systems.

5.1.13.2.1* General. Health care facilities with installed medical gas, vacuum, WAGD, and/or medical support gas systems shall develop and document periodic maintenance programs for these systems and their subcomponents as appropriate to the equipment installed.

5.1.13.2.2 Maintenance Programs.

5.1.13.2.2.1 Inventories. Inventories of medical gas, vacuum, WAGD, and medical support gas systems shall include at least all source subsystems, control valves, alarms, manufactured assemblies containing patient gases, and outlets.

5.1.13.2.2.2* Inspection Schedules. Scheduled inspections for equipment and procedures shall be established through the risk assessment of the facility, developed with consideration of the original equipment manufacturer recommendations and others as required by the authority having jurisdiction.

5.1.13.2.2.3 Inspection Procedures. The facility shall be permitted to use any inspection procedure(s) or testing methods established through their own risk assessment.

5.1.13.2.2.4 Maintenance Schedules. Scheduled maintenance for equipment and procedures shall be established through the risk assessment of the facility, developed with consideration of the original equipment manufacturer recommendations and others as required by the authority having jurisdiction.

5.1.13.2.2.5 Qualifications. Persons maintaining these systems shall be qualified to perform these operations.

Appropriate qualification shall be demonstrated by either of the following:

1. Training and certification through the healthcare facility by which they are employed to work with specific equipment as installed in that facility

2. Credentialing to the requirements of ASSE 6040, Professional Qualification Standard for Medical Gas Maintenance Personnel[ROC-489]

5.1.13.2.3 Inspection and Testing Operations.

5.1.13.2.3.1 General. The elements in 5.1.13.2.2.1 through 5.1.15 shall be inspected or tested as part of the maintenance program as follows:

1. Medical air source:
   (a) Room temperature
   (b) Shaft seal condition
   (c) Filter condition
   (d) Presence of hydrocarbons
   (e) Room ventilation
   (f) Water quality, if so equipped
   (g) Intake location
   (h) Carbon monoxide monitor calibration
   (i) Air purity
   (j) Dew point

2. Medical vacuum source — exhaust location

3. WAGD source — exhaust location

4. Instrument air source — filter condition

5. Manifold sources (including systems complying with 5.1.3.5.10, 5.1.3.5.11, 5.1.3.5.12, and 5.1.3.5.15):
   (a) Ventilation
   (b) Enclosure labeling

6. Bulk cryogenic liquid source inspected in accordance with NFPA 55

7. Final line regulation for all positive-pressure systems — delivery pressure
5.1.13.2.3.2 Manufactured Assemblies Employing Flexible Connection(s) Between the User Terminal and the Piping System.

A) Nonstationary booms and articulating assemblies, other than head walls utilizing flexible connectors shall be tested for leaks at a minimum of once every 12 months.

B) The system pressure to nonstationary booms and articulating arms shall be maintained at operating pressure until each joint has been examined for leakage by effective means of leak detection that is safe for use with oxygen.

1) Safe working condition of the flexible assemblies shall be confirmed.

2) D.I.S.S. connectors internal to the boom and assemblies shall be checked for leakage.

C) Leaks, if any, shall be repaired (if permitted), or the components replaced (if required), and the equipment retested prior to placing the equipment back in service.

D) Additional testing of nonstationary booms or articulating arms shall be performed at intervals defined by documented performance data.

5.1.13.3 Medical Gas and Vacuum Systems Information and Warning Signs.

5.1.13.3.1 The gas content of medical gas and vacuum piping systems shall be labeled in accordance with 5.1.11.1.

5.1.13.3.2 Labels for shutoff valves shall be in accordance with 5.1.11.2 and updated when modifications are made changing the areas served.

5.1.13.4 Medical Gas and Vacuum Systems Maintenance and Record Keeping. See B.5.2.

5.1.13.4.1 Permanent records of all tests required by 5.1.12.3.1 through 5.1.12.3.14 shall be maintained in the organization’s files.

5.1.13.4.2 The supplier of the bulk cryogenic liquid system shall provide documentation of vaporizer(s) sizing criteria to the facility.

5.1.13.4.3 An annual review of bulk system capacity shall be conducted to ensure the source system has sufficient capacity.

5.1.13.4.4 Central supply systems for nonflammable medical gases shall conform to the following:

1) Be inspected annually

2) Be maintained by a qualified representative of the equipment owner

3) Have a record of the annual inspection available for review by the authority having jurisdiction [ROP 323]

5.1.13.4.5 A periodic testing procedure for nonflammable medical gas and vacuum and related alarm systems shall be implemented.

5.1.13.4.6 Whenever modifications are made that breach the pipeline, any necessary installer and verification test specified in 5.1.12 shall be conducted on the downstream portions of the medical gas piping system.

5.1.13.4.7 A maintenance program shall be established for the following:

1) The medical air compressor supply system in accordance with the manufacturer’s recommendations

2) The facility shall establish a testing and calibration procedure that assures carbon monoxide monitors are calibrated at least annually or more often if recommended by the manufacturer

3) Both the medical–surgical vacuum piping system and the secondary equipment attached to medical–surgical vacuum station inlets to ensure the continued good performance of the entire medical–surgical vacuum system

4) The WAGD system to assure performance

5.1.13.4.8 Audible and visual alarm indicators shall meet the following requirements:

1) Be periodically tested to determine that they are functioning properly

2) Have the records of the test maintained until the next test is performed[ROP 323]

5.1.13.4.9 Medical–surgical vacuum station inlet terminal performance, as required in 5.1.12.3.10.4, shall be tested as follows:

1) On a regular preventive maintenance schedule as determined by the facility maintenance staff

2) Based on flow of free air (NL/min or SCFM) into a station inlet while simultaneously checking the vacuum level
**Substantiation:** This material should be under the jurisdiction of the HEA-PIP committee. The PIP committee is asking the MED committee to delete section 9.8 as the PIP committee will add this material to Chapter 5.

A reference to ASSE 6040 was added because the committee feels maintenance of the system should be by a qualified person. ASSE 6040 requires a third party certification to assess the skills and knowledge of the maintainer. ECRI is aware of three fires in these surgical booms due to gas leaks in the presence of exposed electrical connections. There is currently no standard for the periodic inspection of these booms. Also since they are frequently moved, the gas and electrical systems enclosed in the boom are subject to excessive wear and loosening of the connections. Therefore the testing requirements for leaks should occur every year.

**Committee Meeting Action:** Accept
Carl Erickson,

Proposal to NFPA 99 committee for the purpose of including facility wide, annual medical gas inspection/testing in the NFPA 99, 2005, chapter 5.

Include under section 5.1.13 Level 1 Operation and Management of NFPA 99 2005 the following: annual inspection/testing of all medical gas components including source supplies, control valves, monitoring alarms and patient outlets shall be inspected, tested, and documented by credentialed personnel meeting the minimum requirements of ASSE 6030.

Annual inspection/testing of valves shall include as listed under 5.1.4, 5.1.12.3.4.1, 5.1.12.3.4 where correlation is compromised, 5.1.12.3.13 and sections 5.1.11.2.

Annual inspection/testing of warning alarms/signals shall include specifications listed under 5.1.9 except testing of area alarms high pressure activation point due to accessibility.

Annual inspection/testing of pressure/vacuum indicators shall include the specifications of 5.1.8.

Annual inspection/testing of station outlets/inlets shall include the specifications of 5.1.5 through 5.1.7, 5.1.12.3.10, 5.1.12.3.11.

Annual inspection/testing of the source equipment shall include as listed under 5.1.3, 5.1.12.3.14.2 with exceptions to 5.1.12.3.14.3(D, E, F).

Annual inspection/testing of warning signs shall include as listed under 5.1.13.2.

Annual inspection/testing of support gases shall include as listed under 5.1.14.

Substantiation: Due to the ongoing lack of enforcements of states, municipalities, etc., the verification process does not meet minimum standards. The inconsistencies are often identified by inspectors (not associated with the verifier) during periodic systemic inspections of the medical gas system. The inconsistencies commonly identify issues which vary in concern from minimal to severe. These issues commonly compromise patient safety. The NFPA 99 standard incorporates redundancies from equipment to testing to ensure patient safety. The periodic inspection is often a critical action which captures items that compromise patient safety.

The periodic inspection is a homogeneous action which focuses on the entire medical gas utility system, whereas verification often is a snapshot of a local area in the facility. These snapshots may also deny the facility of consistencies with regards to equipment, i.e.: Outlet/inlet connections (DISS, QC, etc.), manufacturer, alarm types, etc. The periodic inspector is responsible to communicate to facility personnel on the specific and overall performance of the medical gas utility system. The communication, or annual inspection report, often identifies equipment that may meet minimum requirements but may soon fail. This potential failure is attributed to equipment life expectancies, frequency of use, abuse, obsolescence, etc. Actions taken often prevent injury to patients and staff.

The medical gas utility system is often neglected until an emergency arises. At that time, patient safety is most compromised. These emergencies often cause the temporary absence of a critical life support gas/vacuum system. Moving from periodic to annual inspection will prevent many accidents and emergencies.

Annual inspections shall include all components of a medical gas utility system.

Source equipment varies from cryogenic storage/distribution of gases, high pressure storage/distribution of gases, manufacturing of pressure/vacuum. All source systems provide many opportunities to fail, especially if neglected.

Medical gas alarm systems shall include the master, area and local alarm systems. These systems vary from digital to analog to visual indicators, all providing opportunities for failure due to calibration neglect, power failure, sensor failure, etc.

Annual is a minimum recommendation, there are many types of equipment that require more frequent inspection and should be identified during an inspection.

Medical gas control valves including source, main, riser, service and zone (provided accessibility and existence). Verifications in existing facilities often only account for the proper identification of the associated zone valve, often neglecting the re-identification of the service, riser and source or main valves. All valves need to be identified for proper signage. Existing valves need to be exercised to assure competence. Gauge inspections are necessary to assure accuracy and competency. Accessibility to critical valves by unauthorized personnel must be identified as well as valves that need to be accessible at all times.

Outlet/inlet performance and condition must be tested. Vacuum inlet performance degrades rapidly with any misuse (body fluids, floor debris, etc.); positive pressure gases begin to fail due to internal component failure as well. This failure can be attributed to various types of debris including particulate and water, misuse, abuse (often outlets are used to support patient equipment), and product life expectancy.
All performance requirements specified in NFPA 99 chapter 5 should be applied to the identified components during the annual inspection.

Purity testing of all medical gases by use of off site or on site laboratory. Analysis results should be compared to the appropriate CGA of USP criteria.

Committee Meeting Action: Accept in Principle
Accept in Principle.

Committee Statement: See Committee Action on Proposal 99-341 (Log #CP251).
Dorothy Holland, Praxair Healthcare

Proposal to NFPA 99 committee for the purpose of including facility wide, annual medical gas inspection/testing in the NFPA 99, 2005, chapter 5.

Include under section 5.1.13 Level 1 Operation and Management of NFPA 99 2005 the following: annual inspection/testing of all medical gas components including source supplies, control valves, monitoring alarms and patient outlets shall be inspected, tested, and documented by credentialed personnel meeting the minimum requirements of ASSE 6030.

Annual inspection/testing of valves shall include as listed under 5.1.4, 5.1.12.3.4.1, 5.1.12.3.4 where correlation is compromised, 5.1.12.3.13 and sections 5.1.11.2.

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Annual inspection/testing of station outlets/inlets shall include the specifications of 5.1.5 through 5.1.7, 5.1.12.3.10, 5.1.12.3.11.

Annual inspection/testing of the source equipment shall include as listed under 5.1.3, 5.1.12.3.14.2 with exceptions to 5.1.12.3.14.3(D, E, F).

Annual inspection/testing of warning signs shall include as listed under 5.1.13.2.

Annual inspection/testing of support gases shall include as listed under 5.1.14.

Substantiation: Due to the ongoing lack of enforcements of states, municipalities, etc., the verification process does not meet minimum standards. The inconsistencies are often identified by inspectors (not associated with the verifier) during periodic systemic inspections of the medical gas system. The inconsistencies commonly identify issues which vary in concern from minimal to severe. These issues commonly compromise patient safety. The NFPA 99 standard incorporates redundancies from equipment to testing to ensure patient safety. The periodic inspection is often a critical action which captures items that compromise patient safety.

The periodic inspection is a homogeneous action which focuses on the entire medical gas utility system, whereas verification often is a snapshot of a local area in the facility. These snapshots may also deny the facility of consistencies with regards to equipment, i.e.: Outlet/inlet connections (DISS, QC, etc.), manufacturer, alarm types, etc. The periodic inspector is responsible to communicate to facility personnel on the specific and overall performance of the medical gas utility system. The communication, or annual inspection report, often identifies equipment that may meet minimum requirements but may soon fail. This potential failure is attributed to equipment life expectancies, frequency of use, abuse, obsolescence, etc. Actions taken often prevent injury to patients and staff.

The medical gas utility system is often neglected until an emergency arises. At that time, patient safety is most compromised. These emergencies often cause the temporary absence of a critical life support gas/vacuum system. Moving from periodic to annual inspection will prevent many accidents and emergencies.

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Annual is a minimum recommendation, there are many types of equipment that require more frequent inspection and should be identified during an inspection.

Medical gas control valves including source, main, riser, service and zone (provided accessibility and existence). Verifications in existing facilities often only account for the proper identification of the associated zone valve, often neglecting the re-identification of the service, riser and source or main valves. All valves need to be identified for proper signage. Existing valves need to be exercised to assure competence. Gauge inspections are necessary to assure accuracy and competency. Accessibility to critical valves by unauthorized personnel must be identified as well as valves that need to be accessible at all times.

Outlet/inlet performance and condition must be tested. Vacuum inlet performance degrades rapidly with any misuse (body fluids, floor debris, etc.); positive pressure gases begin to fail due to internal component failure as well. This failure can be attributed to various types of debris including particulate and water, misuse, abuse (often outlets are used to support patient equipment), and product life expectancy.
All performance requirements specified in NFPA 99 chapter 5 should be applied to the identified components during the annual inspection.

Purity testing of all medical gases by use of off site or on site laboratory. Analysis results should be compared to the appropriate CGA of USP criteria.

This is not original material; its reference/source is as follows:

Carl Erickson

Committee Meeting Action: Accept in Principle

Accept in Principle.

Committee Statement: See Committee Action on Proposal 99-341(Log #CP251).
99-344     Log #230  HEA-PIP
(5.1.13.x (New))

Final Action: Accept in Principle

Submitter: John Bogart, Praxair Healthcare Services


Include under section 5.1.13 Level 1 Operation and Management of NFPA 99 2005 the following: annual inspection/testing of all medical gas components including source supplies, control valves, monitoring alarms and patient outlets shall be inspected, tested, and documented by credentialed personnel meeting the minimum requirements of ASSE 6030.

Annual inspection/testing of valves shall include as listed under 5.1.4, 5.1.12.3.4.1, 5.1.12.3.4 where correlation is compromised, 5.1.12.3.13 and sections 5.1.11.2.

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Annual inspection/testing of station outlets/inlets shall include the specifications of 5.1.5 through 5.1.7, 5.1.12.3.10, 5.1.12.3.11.

Annual inspection/testing of the source equipment shall include as listed under 5.1.3, 5.1.12.3.14.2 with exceptions to 5.1.12.3.14.3(D, E, F).

Annual inspection/testing of support gases shall include as listed under 5.1.14.

Substantiation: Due to the ongoing lack of enforcements of states, municipalities, etc., the verification process does not meet minimum standards. The inconsistencies are often identified by inspectors (not associated with the verifier) during periodic systemic inspections of the medical gas system. The inconsistencies commonly identify issues which vary in concern from minimal to severe. These issues commonly compromise patient safety. The NFPA 99 standard incorporates redundancies from equipment to testing to ensure patient safety. The periodic inspection is often a critical action which captures items that compromise patient safety.

The periodic inspection is a homogeneous action which focuses on the entire medical gas utility system, whereas verification often is a snapshot of a local area in the facility. These snapshots may also deny the facility of consistencies with regards to equipment, i.e.: Outlet/inlet connections (DISS, QC, etc.), manufacturer, alarm types, etc. The periodic inspector is responsible to communicate to facility personnel on the specific and overall performance of the medical gas utility system. The communication, or annual inspection report, often identifies equipment that may meet minimum requirements but may soon fail. This potential failure is attributed to equipment life expectancies, frequency of use, abuse, obsolescence, etc. Actions taken often prevent injury to patients and staff.

The medical gas utility system is often neglected until an emergency arises. At that time, patient safety is most compromised. These emergencies often cause the temporary absence of a critical life support gas/vacuum system. Moving from periodic to annual inspection will prevent many accidents and emergencies.

Annual inspections shall include all components of a medical gas utility system.

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Medical gas alarm systems shall include the master, area and local alarm systems. These systems vary from digital to analog to visual indicators, all providing opportunities for failure due to calibration neglect, power failure, sensor failure, etc.

Annual is a minimum recommendation, there are many types of equipment that require more frequent inspection and should be identified during an inspection.

Medical gas control valves including source, main, riser, service and zone (provided accessibility and existence). Verifications in existing facilities often only account for the proper identification of the associated zone valve, often neglecting the re-identification of the service, riser and source or main valves. All valves need to be identified for proper signage. Existing valves need to be exercised to assure competence. Gauge inspections are necessary to assure accuracy and competency. Accessibility to critical valves by unauthorized personnel must be identified as well as valves that need to be accessible at all times.

Outlet/inlet performance and condition must be tested. Vacuum inlet performance degrades rapidly with any misuse (body fluids, floor debris, etc.); positive pressure gases begin to fail due to internal component failure as well. This failure can be attributed to various types of debris including particulate and water, misuse, abuse (often outlets are used to support patient equipment), and product life expectancy.
All performance requirements specified in NFPA 99 chapter 5 should be applied to the identified components during the annual inspection.

Purity testing of all medical gases by use of off site or on site laboratory. Analysis results should be compared to the appropriate CGA of USP criteria.

This is not original material; its reference/source is as follows:
Carl Erickson
Committee Meeting Action: Accept in Principle
Accept in Principle.
Committee Statement: See Committee Action on Proposal 99-341(Log #CP251).

99-345 Log #256 HEA-PIP
(5.1.13.1.5, Special Precautions)
Final Action: Accept in Principle

Submitter: Bill Marlowe, Praxair
Recommendation: Revise text to read as follows:
The medical-surgical ... or other non-medical or non-surgical applications (for example scope cleaning, decontamination, laser plume, etc).
Substantiation: Although it would be difficult to list all the “other” applications, a few examples of common applications that should not be connected to the medical –Surgical vacuum system would help define the “other non-medical or non-surgical applications”.
Committee Meeting Action: Accept in Principle
Accept in principle.
Committee Statement: See Committee Action on Committee Proposal 99-341(Log #CP251).
5.1.13.3 - Medical Gas Systems shall be tested annually by a credentialed ASSE 6030 Verifier. All components source equipment, Alarms, Valves, Outlets and Inlets shall be tested. The facility shall retain written or electronic copy of testing agency and findings.

Substantiation: This will help NFPA Standards to be used by facilities to conform to The Joint Commission Standards.

Committee Meeting Action: Accept in Principle

Add new section 5.1.15 and 5.2.14 as follows:

5.1.15* Category 1 Maintenance. Facilities shall have a routine maintenance program for their piped medical gas and vacuum systems.

5.2.14* Category 2 Maintenance. Facilities shall have a routine maintenance program for their piped medical gas and vacuum systems.

Add new A.5.1.15 and A.5.2.14.

A.5.1.15 Annual Surveys.

Medical gas and vacuum systems should be surveyed at least annually for the following items, and deficient items corrected.

Surveyors should meet the requirements of ASSE 6040 Professional Qualification Standard for Medical Gas Maintenance Personnel.

Survey of Medical Air and Instrument air sources should include but not be limited to:
(1) Dew Point monitor (operation and calibration)
(2) CO monitor (medical air only) (operation and calibration)
(3) After coolers (condition, operation of drains)
(4) Operating pressures (cut in, cut out and control pressures)
(5) All local alarms (verify presence of required alarms, perform electrical test, test lag alarm)
(6) Receiver elements (auto drain, manual drain, sight glass, pressure gauge)
(7) Filters (condition)
(8) Pressure regulators (condition, output pressure)
(9) Source valve (labeling)
(10) Intake (location and condition)
(11) Housekeeping around the compressors

Survey of Medical Vacuum and WAGD source(s) should include but not be limited to:
(1) Operating vacuum (cut in, cut out and control pressures)
(2) All local alarms (verify presence of required alarms, perform electrical test, test lag alarm)
(3) Receiver elements (manual drain, sight glass, vacuum gauge)
(4) Source valve (labeling)
(5) Exhaust (location and condition)
(6) Housekeeping around the pump

Survey of Medical Gas Manifold source(s) should include but not be limited to:
(1) Number of cylinders (damaged connectors)
(2) Cylinder leads (condition)
(3) Cascade (switching from one header to another)
(4) All local alarms (verify presence of required alarms, perform electrical test, test all alarms)
(5) Source valve (labeling)
(6) Relief valves (discharge location and condition)
(7) Leaks
(8) Security (door or gate locks and signage)
(9) Ventilation (general operation, housekeeping)
(10) Housekeeping around the manifolds

Survey of Medical Gas Area alarms:
(1) Locations (visible to staff)
(2) Signals (audible and visual - use test function)
(3) Activation at low pressure
(4) Housekeeping around the alarm
Survey of Medical Gas Master alarms:
(1) Locations (visible to appropriate staff)
(2) Signals (audible and visual - use test function)
(3) Activation at low pressure
(4) Housekeeping around the alarm
Survey of Zone valves:
(1) Locations (relationship to terminals controlled)
(2) Leaks
(3) Labeling
(4) Housekeeping around the alarm
Survey of Medical Gas Outlet/Inlets:
(1) Flow and function
(2) Latching/delatching
(3) Leaks
(4) General condition (noninterchangeable index in)
The facility should retain written or electronic copy of all findings and any corrections performed.
A.5.2.14 [same text as A.5.1.15]

Committee Statement: There should be required testing but the details of the testing should be informational and these recommendations were added to the annex.

99-347  Log #184  HEA-PIP
(5.1.14.1)  Final Action: Reject

Submitter: Dale Woodin, ASHE-American Society for Healthcare Engineering of the American Hospital Association (AHA)
Recommendation: Revise text to read as follows:
5.1.14 Level 1 Support Gases.

5.1.14.1 Applicability. Support gases (nitrogen and instrument air) shall be gases that are not used for respiration, but
are used for powering pneumatic devices (medical-surgical tools, equipment booms, pendants) related to patient care,
and/or where the gas comes into direct contact with patients in an invasive setting. Gasses such as compressed air for
equipment booms, patient table adjustment, sterilization equipment, cleaning and drying of tubing products, etc. need
not meet the requirements for a Medical Support Gas, however a Medical Support Gas shall not be prohibited from
serving these purposes as long as the use is for medical equipment purposes and not for plant or facility maintenance
purposes.
Substantiation: Provide a more specific definition that limits the application directly to invasive procedures.
This is not original material; its reference/source is as follows:
I am proposing this revision on behalf of the ASHE Medical Gas Workgroup chaired by Ed Tinsley
Committee Meeting Action: Reject
Committee Statement: The proposed wording is confusing and is not written in mandatory language. See 3.3.174 for
the definition of Support Gas. The TC on MEC has also addressed this subject in their proposed new chapter.
5.1.14.1.1 Support gases (nitrogen and instrument air) shall be permitted to be used for any medical support purpose (e.g., to remove excess moisture from instruments before further processing, or to operate medical-surgical tools, air-driven booms, pendants, or similar applications) and, if appropriate to the procedures, to be used in laboratories.

Substantiation: To clarify misperception throughout the industry (mostly promoted by equipment suppliers) that Support Gas is required to power booms, pendants and similar devices and make clear that any type air that can accomplish this equipment type’s needs is acceptable. Also to clarify that support gas is permitted to be used to blow dry medical instruments in Central Service and Surgical Instrument Processing departments.

Committee Meeting Action: Accept

(1) In those portions of systems intended to handle oxygen (and nitrous oxide) at gauge pressures greater than 2070 kPa (300 psi), interconnecting hose shall contain no polymeric materials.

Substantiation: Nitrous oxide, like oxygen, is an oxidizing gas. At pressures above 450 psi, adiabatic compression can occur and produce enough heat to cause combustion in any oxidizing gas. I am aware of at least one lined hose exploding on a nitrous oxide cylinder. In the UK, there was an explosion incident in a nitrous oxide cylinder that had contamination from hand creams ignite and explode the regulator. All of the major gas supply companies advise of the risk of explosion and fire on their MSDS sheets for nitrous oxide. The use of polymeric hose at high pressure for nitrous oxide should be prohibited.

Committee Meeting Action: Reject

Committee Statement: The submitter is encouraged to submit more detailed information regarding the extent of the problem and his specific incident. There is not enough scientific data at this time to make a change.

5.2.2 Nature of Hazards of Gas and Vacuum Systems. See Section 5.1.2.

Substantiation: Editorial.

Committee Meeting Action: Accept
Add new text as follows:

5.2.13.3.1 Permanent records of all tests required by 5.1.12.3.1 through 5.1.12.3.14 shall be maintained in the organization’s files.

5.2.13.3.2 The supplier of the bulk cryogenic liquid system shall provide documentation of vaporizer(s) sizing criteria to the facility.

5.2.13.3.3 An annual review of bulk system capacity shall be conducted to ensure the source system has sufficient capacity.

5.2.13.3.4 Central supply systems for nonflammable medical gases shall conform to the following:

(1) Be inspected annually
(2) Be maintained by a qualified representative of the equipment owner
(3) Have a record of the annual inspection available for review by the authority having jurisdiction

5.2.13.3.5 A periodic testing procedure for nonflammable medical gas/vacuum and related alarm systems shall be implemented.

5.2.13.3.6 Whenever modifications are made or maintenance is performed that breaches the system, the verification tests specified in 5.1.12.3 shall be conducted on the downstream portions of the medical gas piping system.

5.2.13.3.7 A maintenance program shall be established for the following:

(1) The medical air compressor supply system in accordance with the manufacturer’s recommendations.
(2) The facility shall establish a testing and calibration procedure that assures carbon monoxide monitors are calibrated at least annually or more often if recommended by the manufacturer.
(3) *Both the medical–surgical vacuum piping system and the secondary equipment attached to medical–surgical vacuum station inlets to ensure the continued good performance of the entire medical–surgical vacuum system.
(4) The WAGD system to assure performance.

5.2.13.3.8 Audible and visual alarm indicators shall meet the following requirements:

(1) Be periodically tested to determine that they are functioning properly
(2) Have the records of the test maintained until the next test is performed

5.2.13.3.9 Medical–surgical vacuum station inlet terminal performance, as required in 5.1.12.3.10.4, shall be tested as follows:

(1) On a regular preventive maintenance schedule as determined by the facility maintenance staff
(2) Based on flow of free air (NL/minor SCFM) into a station inlet while simultaneously checking the vacuum level.

Substantiation: The Medical Gas/Vacuum Systems Maintenance and Record Keeping (Refer to C.5.2)

5.2.13.3.1 Permanent records of all tests required by 5.1.12.3.1 through 5.1.12.3.14 shall be maintained in the organization’s files.

5.2.13.3.2 The supplier of the bulk cryogenic liquid system shall provide documentation of vaporizer(s) sizing criteria to the facility.

5.2.13.3.3 An annual review of bulk system capacity shall be conducted to ensure the source system has sufficient capacity.

5.2.13.3.4 Central supply systems for nonflammable medical gases shall conform to the following:

(1) Be inspected annually
(2) Be maintained by a qualified representative of the equipment owner
(3) Have a record of the annual inspection available for review by the authority having jurisdiction

5.2.13.3.5 A periodic testing procedure for nonflammable medical gas/vacuum and related alarm systems shall be implemented.

5.2.13.3.6 Whenever modifications are made or maintenance is performed that breaches the system, the verification tests specified in 5.1.12.3 shall be conducted on the downstream portions of the medical gas piping system.

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(1) On a regular preventive maintenance schedule as determined by the facility maintenance staff
(2) Based on flow of free air (NL/minor SCFM) into a station inlet while simultaneously checking the vacuum level.

Substantiation: The Medical Gas/Vacuum Systems Maintenance and Record Keeping (Refer to C.5.2)

5.2.13.3.1 Permanent records of all tests required by 5.1.12.3.1 through 5.1.12.3.14 shall be maintained in the organization’s files.

5.2.13.3.2 The supplier of the bulk cryogenic liquid system shall provide documentation of vaporizer(s) sizing criteria to the facility.

5.2.13.3.3 An annual review of bulk system capacity shall be conducted to ensure the source system has sufficient capacity.

5.2.13.3.4 Central supply systems for nonflammable medical gases shall conform to the following:

(1) Be inspected annually
(2) Be maintained by a qualified representative of the equipment owner
(3) Have a record of the annual inspection available for review by the authority having jurisdiction

5.2.13.3.5 A periodic testing procedure for nonflammable medical gas/vacuum and related alarm systems shall be implemented.

5.2.13.3.6 Whenever modifications are made or maintenance is performed that breaches the system, the verification tests specified in 5.1.12.3 shall be conducted on the downstream portions of the medical gas piping system.

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(1) The medical air compressor supply system in accordance with the manufacturer’s recommendations.
(2) The facility shall establish a testing and calibration procedure that assures carbon monoxide monitors are calibrated at least annually or more often if recommended by the manufacturer.
(3) *Both the medical–surgical vacuum piping system and the secondary equipment attached to medical–surgical vacuum station inlets to ensure the continued good performance of the entire medical–surgical vacuum system.
(4) The WAGD system to assure performance.

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(1) Be periodically tested to determine that they are functioning properly
(2) Have the records of the test maintained until the next test is performed

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(1) On a regular preventive maintenance schedule as determined by the facility maintenance staff
(2) Based on flow of free air (NL/minor SCFM) into a station inlet while simultaneously checking the vacuum level.

Substantiation: The Medical Gas/Vacuum Systems Maintenance and Record Keeping (Refer to C.5.2)

5.2.13.3.1 Permanent records of all tests required by 5.1.12.3.1 through 5.1.12.3.14 shall be maintained in the organization’s files.

5.2.13.3.2 The supplier of the bulk cryogenic liquid system shall provide documentation of vaporizer(s) sizing criteria to the facility.

5.2.13.3.3 An annual review of bulk system capacity shall be conducted to ensure the source system has sufficient capacity.

5.2.13.3.4 Central supply systems for nonflammable medical gases shall conform to the following:

(1) Be inspected annually
(2) Be maintained by a qualified representative of the equipment owner
(3) Have a record of the annual inspection available for review by the authority having jurisdiction

5.2.13.3.5 A periodic testing procedure for nonflammable medical gas/vacuum and related alarm systems shall be implemented.

5.2.13.3.6 Whenever modifications are made or maintenance is performed that breaches the system, the verification tests specified in 5.1.12.3 shall be conducted on the downstream portions of the medical gas piping system.

5.2.13.3.7 A maintenance program shall be established for the following:

(1) The medical air compressor supply system in accordance with the manufacturer’s recommendations.
(2) The facility shall establish a testing and calibration procedure that assures carbon monoxide monitors are calibrated at least annually or more often if recommended by the manufacturer.
(3) *Both the medical–surgical vacuum piping system and the secondary equipment attached to medical–surgical vacuum station inlets to ensure the continued good performance of the entire medical–surgical vacuum system.
(4) The WAGD system to assure performance.

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(1) Be periodically tested to determine that they are functioning properly
(2) Have the records of the test maintained until the next test is performed

5.2.13.3.9 Medical–surgical vacuum station inlet terminal performance, as required in 5.1.12.3.10.4, shall be tested as follows:

(1) On a regular preventive maintenance schedule as determined by the facility maintenance staff
(2) Based on flow of free air (NL/minor SCFM) into a station inlet while simultaneously checking the vacuum level.

Substantiation: The Medical Gas/Vacuum Systems Maintenance and Record Keeping (Refer to C.5.2)

5.2.13.3.1 Permanent records of all tests required by 5.1.12.3.1 through 5.1.12.3.14 shall be maintained in the organization’s files.

5.2.13.3.2 The supplier of the bulk cryogenic liquid system shall provide documentation of vaporizer(s) sizing criteria to the facility.

5.2.13.3.3 An annual review of bulk system capacity shall be conducted to ensure the source system has sufficient capacity.

5.2.13.3.4 Central supply systems for nonflammable medical gases shall conform to the following:

(1) Be inspected annually
(2) Be maintained by a qualified representative of the equipment owner
(3) Have a record of the annual inspection available for review by the authority having jurisdiction

5.2.13.3.5 A periodic testing procedure for nonflammable medical gas/vacuum and related alarm systems shall be implemented.

5.2.13.3.6 Whenever modifications are made or maintenance is performed that breaches the system, the verification tests specified in 5.1.12.3 shall be conducted on the downstream portions of the medical gas piping system.

5.2.13.3.7 A maintenance program shall be established for the following:

(1) The medical air compressor supply system in accordance with the manufacturer’s recommendations.
(2) The facility shall establish a testing and calibration procedure that assures carbon monoxide monitors are calibrated at least annually or more often if recommended by the manufacturer.
(3) *Both the medical–surgical vacuum piping system and the secondary equipment attached to medical–surgical vacuum station inlets to ensure the continued good performance of the entire medical–surgical vacuum system.
(4) The WAGD system to assure performance.

5.2.13.3.8 Audible and visual alarm indicators shall meet the following requirements:

(1) Be periodically tested to determine that they are functioning properly
(2) Have the records of the test maintained until the next test is performed

5.2.13.3.9 Medical–surgical vacuum station inlet terminal performance, as required in 5.1.12.3.10.4, shall be tested as follows:

(1) On a regular preventive maintenance schedule as determined by the facility maintenance staff
(2) Based on flow of free air (NL/minor SCFM) into a station inlet while simultaneously checking the vacuum level.
J. Richard Wagner, Poole & Kent Corporation

Recommendation: Reorganize Section 5.3 (Level 3) as follows:

***Include-L195-Rec***

Substantiation: To separate the requirements for Level 3 medical gases, gas-powered device supply systems, and Level 3 vacuum and separately list the common requirements under "General Requirements".

Committee Meeting Action: Accept in Principle

***INSERT 99_L195_CA HERE***

Committee Statement: A task group reviewed the proposed material and revised the draft to make it read better and combine areas that were redundant. The revisions were further reviewed by the entire committee and more changes were made. The reasons for specific changes can be seen below:

5.3.1.1: Chapter 4 describes Category 1 through 4 facilities.
5.3.6.3.6(1): The brazer must have the equivalent procedure, not the new employer.
Existing 5.3.6.20.6 removed: The referenced sections do not have specific requirements for heating, cooling, or ventilation.
5.3.6.21.8 (1): There is no requirement for exactly 2070 kPa. There is a "more than" and a "less than"
5.3.6.22.2: The text implies that 2 or more are normally required.
5.3.6.23.1.2: Reference is made to both inspection and testing reports.
5.3.6.23.2.4: Delete "various". There are only two Category 3 medical gases.
5.3.6.23.3.2 (B): Using source equipment and the system gas for verification must be permitted for each specific system being tested.
5.3.6.23.3.2.(C): The subject of the section is automatic changeover. The section applies to the source equipment. The source equipment can be put into service before the entire system.
5.3.6.23.3.3 (3): The reference is to the source shutoff valve.
5.3.6.23.3.4: There is only one verifier cross-connection pressure differential test method.
5.3.6.23.3.5: There is only one verifier cross-connection pressure differential test method.
5.3.6.23.3.5 (A): To make the initial step consistent for the individual pressurization test and the pressure differential test.
5.3.6.23.3.13: To list all of the components that need to have their labeling and identification verified.
5.3.7.1.2: To correct an apparent editing error or typo.
5.3.7.2.3.3: To add the material standard for solder, which is listed in Chapter 2.
5.3.7.6.4: Delete extra unnecessary words.
5.3.7.7.4: Delete reference to nitrogen in a section on compressed air.
5.3.7.7.8: Delete extra unnecessary words.
Delete existing 5.3.8.3.5.2 and 5.3.8.3.6.2:
Protective enclosures are not required for any underground piping, including plastic.
5.3.8.3.10.1: Indirect connections do not necessarily have pipe connections.
5.3.9.2.6.6: Plastic systems have plastic piping.
5.3.13.1.3(12), 5.3.13.1.4(10): There are hot pipes other than steam. There are other sources of heat.
5.3.13.3.1: Procedures "which are designed to" do not produce results. Personnel must prevent utilization of the wrong gas, not the Safety Systems. Chapter 9 is for Heating, should be Chapter 11 – Gas Equipment.
5.3.13.4.4: Ice and snow usually happen during the winter. Direct rays of the sun can create high temperatures in moderate climates.
5.3.13.6: Labeling and identification of should comply with all requirements of 5.3.11, not just gas content per 5.3.11.1. Redundant use of the term "Category 3" was resolved.
5.3.6.2.6: To make only indirect reference to memory metal and axially swaged fittings, which are not likely to be
5.3 Level 3 Piped Gas and Vacuum Systems
5.3.1 Applicability
5.3.1.1 These requirements apply to health care facilities that qualify to install Level 3 systems as referenced in Chapters 13 through 21.
5.3.1.2 Level 3 medical gas systems include oxygen and nitrous oxide.
5.3.1.3 Level 3 gas-powered device supply systems include compressed air and nitrogen.
5.3.1.4 Level 3 vacuum systems are either the wet or dry type.
5.3.1.5 An existing Level 3 system that is not in strict compliance with the requirements of this standard shall be permitted to continue in use as long as the authority having jurisdiction has determined that such use does not constitute a distinct hazard to life.
5.3.2 Nature of Hazards of Gas and Vacuum Systems. Potential fire and explosion hazards associated with Level 3 gas and vacuum systems shall be considered in the design, installation, testing, operation, and maintenance of the systems.
5.3.3 Level 3 Medical Gas Supply Systems (oxygen and nitrous oxide)
5.3.3.1 General Requirements. The general requirements for Level 3 medical gas systems and the installation of piping are in 5.3.6.
5.3.3.2 Locations of Medical Gas Source Equipment
5.3.3.2.1 Medical gas source equipment shall be permitted to be installed indoors or outdoors.
5.3.3.2.2 Enclosures shall serve no other purpose than to contain the medical gas source equipment.
5.3.3.2.3 Storage of full and/or empty gas cylinders shall be permitted in the same enclosure.
5.3.3.2.4 If enclosures are outdoors or remote from the treatment facility(s) that they serve, they shall be kept locked.
5.3.3.2.5 Heating (where required) shall be by steam, hot water, or other indirect means.
5.3.3.2.6 Where enclosures are located near sources of heat, such as furnaces, incinerators, or boiler rooms, the enclosures shall be of construction that protects the gas cylinders from reaching temperatures of 54°C (130°F).
5.3.3.3 Indoor Locations
5.3.3.3.1 Enclosures shall be constructed of an assembly of building materials that provide a fire resistance rating of at least 1 hour.
5.3.3.3.2 Enclosures shall not communicate directly with anesthetizing locations or storage locations for flammable anesthetizing agents.
5.3.3.4 Outdoor Locations. Facilities that are adjacent to a building wall shall be located such that the distance to any window or door of the adjacent building is greater than 7.62 m (25 ft).
5.3.3.5 Ventilation
5.3.3.5.1 Enclosures for Level 3 medical gases (i.e. oxygen and nitrous oxide) shall have dedicated mechanical ventilation systems that draw air from within 0.3 m (1 ft) of the floor, operate continuously, and are provided with a source of makeup air.
5.3.3.5.2 In indoor locations, makeup air openings shall not be located in an exit access corridor.
5.3.3.5.3 The power supply for mechanical ventilation equipment shall conform to the requirements of an essential electrical system as described in Chapter 4 of this Standard.
5.3.3.6 Level 3 Medical Gas Source Equipment
5.3.3.6.1 Mechanical means shall be provided to ensure that the gas cylinders are connected to the correct gas distribution piping system.
5.3.3.6.1.1 Cylinder valve outlets for oxygen and nitrous oxide shall comply with CGA V-1, Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections (ANSI B57.1, CSA B96).
5.3.3.6.1.2 Threaded connections to manifolds shall comply with CGA V-5, Diameter-Index Safety System (Non-Interchangeable Low Pressure Connections for Medical Gas Applications).
5.3.3.6.2 A shutoff valve or check valve shall be provided downstream of each pressure regulator.
5.3.3.6.3 A pressure relief valve set at 50% above the normal line pressure shall be located downstream of the shutoff valve or check valve in 5.3.3.6.2.
5.3.3.6.4 Pressure relief valves shall be brass, bronze, or stainless steel and designed for oxygen service.
5.3.3.6.5 Flexible connectors shall have a gauge pressure rating not less than 6895 kPa (1000 psi).
5.3.3.6.6 Flexible connectors of other than all-metal construction that connect manifolds to the gas distribution piping shall not exceed 1.52 m (5 ft) in length and shall not penetrate walls, floors, ceilings, or partitions.
5.3.3.6.7 Medical gas source systems that serve a single treatment facility shall include one bank containing two cylinders of oxygen and (if used) one bank containing two cylinders of nitrous oxide, each cylinder containing at least an average day's supply.
5.3.3.6.7.1 The two cylinders for each gas service shall be manifolded so that either cylinder can supply the distribution piping system.
5.3.3.6.7.2 Where the source equipment is remote from the treatment facility, when an "in use" cylinder is unable to supply the system, the manifold shall automatically switch to the "reserve" cylinder.
5.3.3.6.7.3 Where the source equipment is not remote and is accessible from the treatment facility, when an "in use" cylinder is unable to supply the system, the manifold may be manually (or automatically) switched to the "reserve" cylinder.
5.3.3.6.8 Medical gas source systems that serve multiple treatment facilities shall include one bank containing two cylinders of oxygen and (if used) one bank containing two cylinders of nitrous oxide, each cylinder containing at least an average day's supply.
5.3.3.6.8.1 The two cylinders for each gas service shall be manifolded so that either cylinder can supply the distribution piping system.
5.3.3.6.8.2 When an "in use" cylinder is unable to supply the system, the manifold shall automatically switch to the "reserve" cylinder.
5.3.3.7 Level 3 Medical Gas Distribution Piping
5.3.3.7.1 Tubes shall be hard-drawn seamless copper ASTM B819, Standard Specification for Seamless Copper Tube for Medical Gas Tube, medical gas tube, Type L or K.
5.3.3.7.2 Tubes, valves, fittings, station outlets, and other piping components shall have been cleaned for oxygen by the manufacturer prior to installation in accordance with
CGA 4.1, *Cleaning Equipment for Oxygen Service*, except that fittings shall be permitted to be cleaned by a supplier or agency other than the manufacturer.

5.3.3.7.3 Joints for tubes, turns, offsets, and other changes in direction shall be made with brazed wrought copper capillary fittings complying with one of the following:

2. ASME B16.50 *Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings*.
3. ASME B16.22, *Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings* with socket depths equal to or greater than ASME B16.50 braze-joint pressure fittings.

5.3.3.7.4 Cast copper alloy fittings shall not be used with brazed joints.

5.3.3.8 Qualification of Brazing Procedures and Brazing

5.3.3.8.1 Brazing procedures and brazer performance for the installation of Level 3 brazed piping shall be qualified the same as for Level 1 piping, in accordance with either Section IX, Welding and Brazing Qualifications, of the ASME *Boiler and Pressure Vessel Code*, or AWS B2.2, *Standard for Brazing Procedure and Performance Qualification*, both as modified by

5.3.3.8.2 through 5.3.3.8.7.

5.3.3.8.2 Brazers shall be qualified by visual examination of the test coupon followed by sectioning.

5.3.3.8.3 The brazing procedure specification shall address cleaning, joint clearance, overlap, internal purge gas, purge gas flow rate, and filler metal.

5.3.3.8.4 The brazing procedure qualification record and the record of brazer performance qualification shall document the filler metal used, cleaning, joint clearance, overlap, internal purge gas and flow rate during brazing of the coupon, and the absence of internal oxidation in the completed coupon.

5.3.3.8.5 Brazing procedures qualified by a technically competent group or agency shall be permitted under the following conditions:

1. The brazing procedure specification and the procedure qualification record meet the requirements of this standard.
2. The employer obtains a copy of both the brazing procedure specification and the supporting qualification records from the group or agency and signs and dates these records, thereby accepting responsibility for the qualifications that were performed by the group or agency.
3. The employer qualifies at least one brazer following each brazing procedure specification used.

5.3.3.8.6 An employer shall be permitted to accept brazer qualification records of a previous employer under the following conditions:

1. The brazer has been qualified following the same or an equivalent procedure that the new employer uses.
2. The new employer obtains a copy of the record of brazer performance qualification tests from the previous employer and signs and dates these records, thereby accepting responsibility for the qualifications performed by the previous employer.

5.3.3.8.7 Performance qualifications of brazers shall remain in effect indefinitely unless the brazer does not braze with the qualified procedure for a period exceeding 6 months, or there is a specific reason to question the ability of the brazer.

5.3.3.9 Brazed Joints

5.3.3.9.1 Brazed tube joints shall be the socket type.
5.3.3.9.2 Brazed joints shall be made using a brazing alloy that exhibits a melting temperature in excess of 538°C (1000°F) to retain the integrity of the piping system in the event of fire exposure.
5.3.3.9.3 Filler metals shall bond with and be metallurgically compatible with the base metal being joined.
5.3.3.9.4 Filler metals shall comply with ANSI/AWS A5.8, Specification for Filler Metals for Brazing and Braze Welding.
5.3.3.9.5 Copper-to-copper joints shall be brazed using a copper-phosphorus or copper-phosphorus-silver brazing filler metal (BCuP series) without flux.
5.3.3.9.6 Joints to be brazed in place shall be accessible for necessary preparation, assembly, heating, filler application, cooling, cleaning, and inspection.
5.3.3.10 Cutting Tube Ends
5.3.3.10.1 Tube ends shall be cut square using a sharp tubing cutter to avoid deforming the tube.
5.3.3.10.2 The cutting wheels on tubing cutters shall be free from grease, oil, or other lubricant not recommended for oxygen service.
5.3.3.10.3 The cut ends of the tube shall be deburred with a sharp, clean deburring tool, taking care to prevent chips from entering the tube.
5.3.3.11 Cleaning Joints for Brazing
5.3.3.11.1 The interior surfaces of tubes, fittings, and other components that are cleaned for oxygen service shall be stored and handled to avoid contamination prior to assembly and brazing.
5.3.3.11.2 If the interior surfaces of fitting sockets that were cleaned for oxygen service become contaminated prior to brazing, they shall be re-cleaned for oxygen in accordance with 5.3.3.11.9.
5.3.3.11.3 The exterior surfaces of tube ends shall be cleaned prior to brazing to remove any oxides and surface dirt and to roughen the surfaces to prepare them for brazing.
5.3.3.11.4 Non-abrasive pads shall be used to clean the exterior surfaces of tube ends.
5.3.3.11.5 The use of steel wool or sand cloth shall be prohibited.
5.3.3.11.6 The cleaning process shall not result in grooving the surfaces to be joined.
5.3.3.11.7 After being abraded, the surfaces shall be wiped using a clean, lint-free white cloth.
5.3.3.11.8 Tubes, fittings, valves, and other components shall be visually examined internally before being joined to verify that they have not become contaminated for oxygen service and that they are free of obstructions or debris.
5.3.3.11.9 The interior surfaces of tube ends, fittings, and other components that were cleaned for oxygen service, but become contaminated prior to being installed, shall be permitted to be re-cleaned on-site by the installer by thoroughly scrubbing the interior surfaces with a clean, hot water/alkaline solution, such as sodium carbonate or tri-sodium phosphate, mixed 450 g to 11 L (1 lb to 3 gal) of potable water and thoroughly rinsing them with clean, hot potable water.
5.3.3.11.10 Other aqueous cleaning solutions shall be permitted to be used for the on-site recleaning permitted in 5.3.3.11.9, provided that they are as recommended in CGA Pamphlet G-4.1, *Cleaning Equipment for Oxygen Service*, and are listed in CGA Pamphlet O2-DIR, *Directory of Cleaning Agents for Oxygen Service*. 

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5.3.3.11 Material that has become contaminated internally and is not clean for oxygen service shall not be installed.
5.3.3.12 Joints shall be brazed within eight (8) hours after being cleaned for brazing.
5.3.3.12 Brazing Dissimilar Metals
5.3.3.12.1 Flux shall only be used when brazing dissimilar metals, such as copper and bronze or brass, using a silver (Bag series) brazing filler metal.
5.3.3.12.2 Surfaces shall be cleaned for brazing in accordance with 5.3.3.11.
5.3.3.12.3 Flux shall be applied sparingly to minimize contamination of the inside of the tube with flux.
5.3.3.12.4 The flux shall be applied and worked over the cleaned surfaces to be brazed using a stiff, stainless steel bristle brush to insure complete coverage and wetting of the surfaces with flux.
5.3.3.12.5 Where possible, short sections of copper tube shall be brazed onto the non-copper component and the interior of the subassembly shall be cleaned of flux prior to installation in the system.
5.3.3.12.6 On joints DN20 (NPS 3/4) (7/8 in. O.D.) size and smaller, flux-coated brazing rods shall be permitted to be used in lieu of applying flux to the surfaces to be joined.
5.3.3.13 Nitrogen Purge
5.3.3.13.1 While being brazed, joints shall be continuously purged with oil-free dry nitrogen NF to prevent the formation of copper oxide on the inside surface of the joint.
5.3.3.13.2 The source of the nitrogen purge gas shall be shall be monitored and the installer shall be audibly alerted when the content is low.
5.3.3.13.3 The nitrogen purge gas flow rate shall not high enough to produce a positive pressure in the piping system.
5.3.3.13.4 The nitrogen purge gas flow shall be controlled by the use of a pressure regulator and flow meter, or combination thereof.
5.3.3.13.5 Pressure regulators alone shall not be used to control nitrogen purge gas flow rates.
5.3.3.13.6 During and after installation, openings in the piping system shall be kept capped or plugged to maintain a nitrogen atmosphere within the piping and to prevent debris or other contaminants from entering the system.
5.3.3.13.7 While a joint is being brazed, a discharge opening shall be provided on the opposite side of the joint from where the nitrogen purge gas is being introduced.
5.3.3.13.8 The flow of nitrogen purge gas shall be maintained until the joint is cool to the touch.
5.3.3.13.9 After the joint has cooled, the purge discharge opening shall be plugged or capped to prevent contamination of the inside of the tube and maintain the nitrogen atmosphere within the piping system.
5.3.3.13.10 The final connection of new piping to an existing in-use medical gas pipeline shall be permitted to be made without the use of a nitrogen purge.
5.3.3.13.11 After a final connection in a Level 3 medical gas system has been made without a nitrogen purge, an outlet in the immediate downstream zone of the affected portion(s) of both new and existing in-use piping shall be tested in accordance with 5.3.10.8, Verifier Final Tie-In Test.
5.3.3.14 Assembling and Heating Brazed Joints
5.3.3.14.1 Tube ends shall be inserted fully into the depth of the fitting socket.
5.3.3.14.2 Where flux is permitted, joints shall be heated slowly until the flux has liquefied.

5.3.3.14.3 After flux has liquefied or where flux is not permitted to be used, the joint shall be heated quickly to the brazing temperature, taking care not to overheat the joint.

5.3.3.14.4 Techniques for heating joints, applying the brazing filler metal, and making the horizontal, vertical, and large-diameter joints shall be as described in sections on Applying Heat and Brazing Horizontal and Vertical Joints in Chapter VII, Brazed Joints in the CDA Copper Tube Handbook.

5.3.3.15 Inspection of Brazed Joints

5.3.3.15.1 After brazing, the outside of all joints shall be cleaned by washing with water and a wire brush to remove any residue and permit clear visual inspection of the joint.

5.3.3.15.2 Where flux has been used, the wash water shall be hot.

5.3.3.15.3 Each joint shall be visually inspected after cleaning the outside surfaces.

5.3.3.15.4 Joints exhibiting the following conditions shall not be permitted:
   (1) Flux or flux residue (when flux or flux-coated Bag rods are used with dissimilar metals)
   (2) Base metal melting or erosion
   (3) Unmelted filler metal
   (4) Failure of the filler metal to be clearly visible all the way around the joint at the interface between the socket and the tube
   (5) Cracks in the tube or component
   (6) Cracks in the filler metal
   (7) Failure of the joint to hold the test pressure under the installer-performed initial pressure test (5.3.9.2.3) and standing pressure test (5.3.9.2.7).

5.3.3.15.5 Joints that are identified as defective under conditions 5.3.3.15.4 (2) or (5) shall be replaced.

5.3.3.15.6 Joints that are found to be defective under conditions 5.3.3.15.4 (1), (3), (4), (6) or (7) shall be permitted to be repaired, except that no joint shall be reheated more than once before being replaced.

5.3.3.16 Installation of Level 3 Medical Gas Piping

5.3.3.16.1 General Requirements. The general requirements for the installation of Level 3 medical gas system piping are in 5.3.6.

5.3.3.16.2 Minimum Pipe Sizes. The minimum sizes of Level 3 oxygen and nitrous oxide piping shall be as follows:
   (1) Mains, branches, and drops to individual service outlets in Level 3 oxygen piping systems shall be not less than DN10 (NPS 3/8 in.) (1/2 in. O.D.) size, but at least one size larger than the piping for nitrous oxide.
   (2) Mains, branches, and drops to individual service outlets in Level 3 nitrous oxide piping systems shall be not less than DN8 (NPS 1/4 in.) (3/8 in. O.D.) size.

5.3.3.16.3 Location of Piping. Oxygen and nitrous oxide piping shall not be located where subject to contact with oil.

5.3.3.16.4 Branch Takeoffs. Runouts for horizontal piping for oxygen and nitrous oxide shall be taken off above the centerline of the main or branch pipe and rise vertically at an angle of not more than 45 degrees from vertical.

5.3.4 Level 3 Gas-Powered Device Supply Systems (compressed air and nitrogen)
5.3.4.1 General Requirements. The general requirements for gas-powered device supply systems and the installation of piping are in 5.3.6.

5.3.4.2 Location of Level 3 Gas-Powered Device Source Equipment

5.3.4.2.1 Air compressors for Level 3 gas-powered devices shall be installed in a designated mechanical equipment area, ventilated, and with required utilities (e.g., electrical power, drains, lighting, etc.).

5.3.4.2.2 Where nitrogen is used as a backup supply for a compressed air gas system, the nitrogen cylinders shall be permitted to be located in the compressor equipment room.

5.3.4.3 Level 3 Gas-Powered Device Source Equipment

5.3.4.3.1 Level 3 gas-powered devices supply systems shall be used where compressed air is required to drive dynamic devices used for patient treatment.

5.3.4.3.2 A gas-powered devices supply system shall be permitted to be used to supply power to gas-driven devices for scavenging, but only where the exhaust of the scavenging device is a closed vent to the outside of the building.

5.3.4.3.3 Level 3 gas-powered devices supply systems shall be obtained from and be installed under the supervision of a manufacturer(s) or supplier(s) familiar with proper practices for its construction and use.

5.3.4.3.4 Level 3 gas-powered devices supply systems shall include the following:
   (1) Disconnect switch(es)
   (2) Motor-starting device(s)
   (3) Motor overload protection device(s)
   (4) One or more compressors
   (5) For single, duplex, or multiple compressor systems, a means for activation/deactivation of each individual compressor
   (6) When multiple compressors are used, manual or automatic means to alternate individual compressors
   (7) When multiple compressors are used, manual or automatic means to activate the additional unit(s) should the in-service unit(s) be incapable of maintaining adequate pressure
   (8) Intake filter–muffler(s) of the dry type
   (9) Receiver(s) with drain plug or a manual drain or an automatic drain
   (10) Shutoff valves
   (11) Air dryer(s) that maintain 40 percent relative humidity at operating pressure and temperature
   (12) In-line final particulate filters rated at 5 microns, 98 percent efficiency, with filter status indicator to ensure the delivery of compressed air with a maximum allowable 0.05 ppm liquid oil
   (13) Pressure regulator(s)
   (14) Pressure relief valve
   (15) Pressure indicator
   (16) Moisture indicator
   (17) Oil indicator

5.3.4.3.5 Cylinders shall be permitted to be used to supplement or act as a reserve for the compressor source.

5.3.4.4 Receiver(s).
5.3.4.4.1 Receiver(s) shall have the capacity to prevent short cycling of the compressor(s).
5.3.4.4.2 Receiver(s) shall comply with Section VIII, Unfired Pressure Vessels, of the ASME Boiler and Pressure Vessel Code.
5.3.4.5 Moisture Indicator
5.3.4.5.1 The moisture indicator shall be located in the active air stream prior to or after the receiver and upstream of any system pressure regulators.
5.3.4.5.2 The moisture indicator shall indicate (i.e., by color change, digital readout, or other method understood by the user) when the relative humidity of the compressed air exceeds 40 percent at line pressure and temperature.
5.3.4.6 Oil Indicator.
5.3.4.6.1 The oil indicator shall be located downstream of the receiver.
5.3.4.6.2 The oil indicator shall measure (i.e., by color change, digital readout, or other method understood by the user) an oil concentration of 0.05 ppm ± 0.03 ppm in air at a gauge pressure of 550 kPa to 690 kPa (80 psi to 100 psi).
5.3.4.7 Source of Compressor Intake Air.
5.3.4.7.1 Air sources for a compressor(s) located inside the building shall meet the following requirements:
   (1) Be located within a room where no chemical-based material is stored or used and that is not an operatory
   (2) Not be taken from a room or space in which there is an open or semi-open discharge from a Level 3 vacuum or scavenging system
5.3.4.7.2 Air sources for a compressor(s) located outside the building shall be drawn from locations where no contamination from vacuum or scavenging system discharges or particulate matter is anticipated.
5.3.4.8 Cylinder Gas Reserves/Supplements to Compressor Sources.
5.3.4.8.1 When used, cylinder reserves/supplements for compressor sources shall be a system of cylinders and necessary supply equipment that will permit supplying the required supply gas as an alternative to the compressor supplied air.
5.3.4.8.2 When the content of one primary cylinder is unable to supply the normal operating pressures, the secondary cylinder(s) shall be activated manually or automatically.
5.3.4.8.3 When used, cylinder gas reserves/supplements to compressor sources shall be piped into the system through a check valve and shutoff valve located in each supply line prior to the tee connection to the main line.
5.3.4.8.4 The designed operating pressure shall be below a gauge pressure of 1100 kPa (160 psi).
5.3.4.8.5 Reserves/supplements to compressor source systems shall either have regulator(s) mounted on the individual cylinder(s) or the cylinder(s) may be connected to a manifold via pigtail with pressure regulated at the manifold.
5.3.4.8.6 When nitrogen is used as the gas in a reserves/supplements to a compressor source, the following shall be permitted to apply:
   (1) The volume of nitrogen connected and in storage shall not be considered in the limit of Level 3 and the ventilation of enclosures.
   (2) Nitrogen gas cylinders shall be permitted to be stored in compressor rooms.
   (3) The gas used shall be oil-free, dry Nitrogen NF.
5.3.4.9 Piping for Level 3 Gas-Powered Devices.
5.3.4.9.1 Tubing
5.3.4.9.1.1 Tubing shall be one of the following:
   (1) ASTM B 819, *Standard Specification for Seamless Copper Tube for Medical Gas Systems*, medical gas tube (Type K or L)
   (2) ASTM B 88, *Standard Specification for Seamless Copper Water Tube*, water tube (Type K or L)
5.3.4.9.1.2 Tubing shall be hard temper except that annealed (soft temper) shall be permitted where installed within floor slabs or underground within buildings according to 5.3.6.5.7 or underground outside of buildings according to 5.3.6.5.8.
5.3.4.9.2 Fittings
   Fittings for Level 3 gas-powered device supply shall be either
   (1) brazed or soldered fittings complying with ASME B16.22, *Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings*
   (2) brazed fittings complying with ASME B16.50, *Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings*.
   (3) brazed fittings complying with ASME B16.22, *Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings* with socket depths equal to or greater than ASME B16.50 braze-joint pressure fittings.
5.3.4.9.3 Joints
5.3.4.9.3.1 Joints for Level 3 gas-powered device supply piping shall be brazed, soldered, or threaded (where threaded joints are permitted in 5.3.6.5.9).
5.3.4.9.3.2 Where joints are brazed, they shall comply with the requirements for Level 3 medical gas piping in 5.3.3.7 through 5.3.3.15.
5.3.4.9.3.3 Soldered joints in Level 3 gas-powered supply piping shall be made in accordance with ASTM B 828, *Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings*, using a “lead-free” solder filler metal containing not more than 0.2 percent lead by volume.
5.3.4.10 Installation of Level 3 Gas-Powered Device Piping
5.3.4.10.1 General Requirements. The general requirements for the installation of Level 3 gas-powered device piping are in 5.3.6.
5.3.4.10.2 Pipe Sizes. Mains, branches, and drops to individual service outlets in Level 3 piping systems for gas powered devices shall not be the same as the sizes used for oxygen and nitrous oxide.
5.3.4.10.3 Location Piping for Level 3 gas-powered devices shall be located in accordance with the following:
5.3.4.10.3.1 Piping shall be permitted to be installed at the following locations:
   (1) Aboveground within buildings, exposed or concealed within walls and ceilings
   (2) Underground within buildings
   (3) In rooms for Level 3 gas-powered devices source equipment
   (4) In rooms for secondary electrical distribution panels having maximum voltage ratings of 600 volts
   (5) Underground outdoors
5.3.4.10.3.2 Piping shall not be installed in electrical switchgear rooms, transformer rooms, elevator shafts, and areas having open flames.

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5.3.5 Level 3 Vacuum Systems
5.3.5.1 General Requirements  The general requirements for Level 3 vacuum systems and the installation of piping are in 5.3.6.
5.3.5.2 Location of Level 3 Vacuum Source Equipment. Vacuum pumps for Level 3 vacuum systems shall be installed in a designated mechanical equipment area, ventilated, and with required utilities (e.g., electrical power, drains, lighting, etc.).
5.3.5.3 Level 3 Vacuum Source Equipment.
5.3.5.3.1 Level 3 vacuum sources shall include the following:
   (1) A vacuum pump or pumps suited for wet or dry service as intended in the system design
   (2) If intended for wet service, a liquid/air separator
5.3.5.4 Drainage from Vacuum Equipment. None of the following requirements for drainage in Level 3 vacuum systems are intended to supersede provisions of local codes.
5.3.5.4.1 Liquids drained from a Level 3 vacuum source shall be directly connected to a sanitary drainage system through a trapped and vented drain.
5.3.5.4.2 Where the drainage is from a waste holding tank on the suction side of the vacuum source, the following requirements shall be met:
   (1) A check valve shall be installed in the drain line from the holding tank.
   (2) The trap in the building drainage system shall be the deep-seal type that is conventionally vented within the plumbing system.
   (3) An additional vent shall be installed between the holding tank drain check valve and the drain trap, on the inlet side of the trap, to close and seal the check valve while the holding tank is operating under vacuum and collecting waste.
   (4) The additional vent described in 5.3.5.4.2 (3) shall be permitted to be connected to the plumbing system vents.
   (5) Both of the vents in 5.3.5.4.2 (3) and 5.3.5.4.2 (4) shall extend vertically to not less than 152 mm (6 in.) above the top of the holding tank before turning horizontal.
   (6) The trap and drain branch shall be not less than two pipe sizes larger than the waste pipe from the separator, but not less than DN50 (NPS 2).
   (7) The trap seal shall be not less than 100 mm (4 in.) deep.
   (8) The vent for the vacuum check valve shall be not less than one-half the size of the check valve.
   (9) The vent for the trap shall be not less than one-half the size of the trap and drain branch.
5.3.5.4.3 Where the drainage is at a positive pressure from an air/waste separator on the discharge side of the vacuum source, the following requirements shall be met:
   (1) The trap in the building drainage system shall be the deep-seal type that is conventionally vented within the plumbing system.
   (2) The trap vent shall extend vertically to not less than 152 mm (6 in.) above the top of the separator before turning horizontal.
   (3) The trap and drain branch shall be not less than two pipe sizes larger than the waste pipe from the separator, but not less than DN40 (NPS 1½).
(4) The vent shall be the full size of the trap and drain.
(5) The trap seal shall be at least two times the exhaust back pressure in the separator, but not less than 100 mm (4 in.) deep.

5.3.5.5 Vacuum Exhaust Discharge The exhaust discharge from Level 3 vacuum sources shall comply with the following:

(1) The gas discharge shall be piped to the outside.
(2) The discharge point shall be chosen to minimize the hazards of noise.
(3) The discharge point shall be remote from any door, window, or other opening into the building.
(4) The discharge point shall be located at a different level than air intakes.
(5) The discharge point shall not be located where affected by prevailing winds, adjacent buildings, topography, or other obstacles to the rapid dispersion of the exhaust gases.
(6) The discharge point shall be protected against the entry of insects, vermin, debris, and precipitation.
(7) The discharge piping shall be sized to prevent back pressure greater than the pump manufacturer's recommendations.
(8)* Where multiple pumps discharge through a common pipe, each pump shall be fitted with a check valve, a manual isolation valve, or shall be arranged to permit capping the individual pump exhausts when a pump is removed for service.
(9) Where multiple pumps discharge through a common pipe, piping shall be arranged following the pump manufacturer's recommendations.

5.3.5.6 Piping for Level 3 Vacuum Systems.
5.3.5.6.1 Tubing and Pipe
5.3.5.6.1.1 Piping for Level 3 vacuum shall be copper or plastic.
5.3.5.6.1.2 Copper tubing shall be one of the following:
   (1) ASTM B 819, Standard Specification for Seamless Copper Tube for Medical Gas Systems, medical gas tube, Type K or L.
   (2) ASTM B 88, Standard Specification for Seamless Copper Water Tube, water tube, Type K or L.
   (3) ASTM B 280, Standard Specification for Seamless Copper Tubing for Air Conditioning and Refrigeration Field Service, ACR tube (O.D. size)
5.3.5.6.1.3 Copper tubing shall be hard temper except that annealed (soft temper) shall be permitted where installed within floor slabs or underground within buildings according to 5.3.6.5.7 or underground outside of buildings according to 5.3.6.5.8.
5.3.5.6.1.4 Plastic pipe shall be poly (vinyl chloride) (PVC) plastic, schedule 40 minimum, complying with ASTM D1785, Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
5.3.5.6.2 Fittings
5.3.5.6.2.1 Fittings for copper Level 3 gas-powered device supply piping shall be either
   (1) brazed or soldered fittings complying with ASME B16.22, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings
   (2) brazed fittings complying with ASME B16.50, Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings.
(3) brazed fittings complying with ASME B16.22, *Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings* with socket depths equal to or greater than ASME B16.50 braze-joint pressure fittings.

5.3.5.6.2.2 Fittings for plastic vacuum piping systems shall be poly (vinyl chloride) (PVC) plastic, schedule 40 minimum, complying with ASTM D2466, *Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40*, or ASTM 2467, *Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80*.

5.3.5.6.3 Joints

5.3.5.6.3.1 Joints for Level 3 gas-powered device supply piping shall be brazed, soldered, solvent cemented, or threaded (where threaded joints are permitted in 5.3.6.5.9).

5.3.5.6.3.2 Where joints in copper tubing are brazed, they shall comply with the requirements for Level 3 medical gas piping in 5.3.3.6 through 5.3.3.15.

5.3.5.6.3.3 Soldered joints for copper tubing shall be made in accordance with ASTM B 828, *Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings*, using a “lead-free” solder filler metal containing not more than 0.2 percent lead by volume.

5.3.5.6.3.4 Joints in plastic piping shall be solvent cemented in accordance with ASTM D2672, *Joints in IPS PVC Pipe Using Solvent Cement*.

5.3.5.7 Installation of Level 3 Vacuum Piping

5.3.5.7.1 General Requirements. The general requirements for the installation of Level 3 vacuum piping are in 5.3.6.

5.3.5.7.2 Pipe Sizes. Mains, branches, and drops to individual service outlets in Level 3 vacuum piping systems shall not be the same as the sizes used for oxygen and nitrous oxide.

5.3.5.7.3 Location. Level 3 vacuum piping shall be located in accordance with the following:

- (1) Aboveground within buildings, exposed or concealed within walls and ceilings
- (2) Underground within buildings
- (3) In rooms for Level 3 gas-powered devices source equipment
- (4) In rooms for secondary electrical distribution panels having maximum voltage ratings of 600 volts
- (5) Underground outdoors

5.3.6 General Requirements for Level 3 Gas and Vacuum Systems

5.3.6.1 Scope. Level 3 gas and vacuum systems include the following:

- (1) Medical gas systems (oxygen and nitrous oxide) per 5.3.3.
- (2) Gas-powered device supply systems (compressed air and nitrogen) per 5.3.4.
- (3) Level 3 vacuum systems per 5.3.5.

5.3.6.2 Qualification of Installers. The installation of Level 3 gas and vacuum systems shall be made by qualified, competent technicians who are experienced in making such installations.

5.3.6.3 Pipe Sizing. Piping systems shall be designed and sized to deliver the required flow rates at the utilization pressures.
5.3.6.4 Protection of Piping.
5.3.6.4.1 Piping shall be protected against freezing, corrosion, and physical damage.
5.3.6.4.2 Piping exposed in corridors and other locations where subject to physical damage from the movement of carts, stretchers, beds, portable equipment, or vehicles shall be protected.
5.3.6.4.3 Underground piping within buildings or embedded in concrete floors or walls shall be installed in a continuous conduit in accordance with 5.3.6.5.7.
5.3.6.4.4 Underground piping outside of buildings shall comply with the requirements of 5.3.6.5.8

5.3.6.5 Pipe Support
5.3.6.5.1 Piping shall be supported from the building structure in accordance with MSS Standard Practice SP-69, *Pipe Hangers and Support – Selection and Application*.
5.3.6.5.2 Hangers and supports shall comply with MSS Standard Practice SP-58, *Pipe Hangers and Supports – Materials, Design, and Manufacture*.
5.3.6.5.3 Hangers and supports for copper tube shall be sized for copper tube.
5.3.6.5.4 In potentially damp locations, copper tube hangers and supports that are in contact with the tube shall be plastic-coated or otherwise electrically insulated from the tube.
5.3.6.5.5 The maximum support spacing for copper tube shall be in accordance with Table 5.3.6.5.5.

**Table 5.3.6.5.5 Maximum Copper Tube Support Spacing**

<table>
<thead>
<tr>
<th>Hanger Spacing</th>
<th>Pipe Size</th>
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<th>feet</th>
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<td>DN8 (NPS 1/4)  (3/8 in. O.D.)</td>
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<td>6</td>
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<tr>
<td>5.3.6.5.6</td>
<td>DN 20 (NPS 3/4) (7/8 in. O.D.)</td>
<td>2130</td>
<td>7</td>
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<tr>
<td>5.3.6.5.6</td>
<td>DN25 (NPS 1) (1-1/8 in. O.D.)</td>
<td>2440</td>
<td>8</td>
</tr>
<tr>
<td>5.3.6.5.6</td>
<td>DN32 (NPS 1-1/4) (1-3/8 in. O.D.)</td>
<td>2740</td>
<td>9</td>
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<tr>
<td>5.3.6.5.6</td>
<td>DN40 (NPS 1-1/2) (1-5/8 in/ O.D.) and larger</td>
<td>3050</td>
<td>10</td>
</tr>
<tr>
<td>5.3.6.5.6</td>
<td>Every floor, but not to exceed</td>
<td>4570</td>
<td>15</td>
</tr>
</tbody>
</table>

5.3.6.5.6 The maximum support spacing for schedule 40 plastic pipe shall be in accordance with Table 5.3.6.5.6.

**Table 5.3.6.5.6 Maximum Plastic Pipe Support Spacing**

<table>
<thead>
<tr>
<th>Hanger Spacing</th>
<th>Pipe Size</th>
<th>mm</th>
<th>feet</th>
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<tr>
<td>5.3.6.5.6</td>
<td>DN15 (NPS 1/2) 1220 4.00</td>
<td>1220</td>
<td>4.00</td>
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<tr>
<td>5.3.6.5.6</td>
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<td>1220</td>
<td>4.00</td>
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<tr>
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<td>4.33</td>
</tr>
<tr>
<td>5.3.6.5.6</td>
<td>DN32 (NPS 1-1/4) 1320 4.33</td>
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<td>4.33</td>
</tr>
<tr>
<td>5.3.6.5.6</td>
<td>DN40 (NPS 1-1/2) 1420 4.66</td>
<td>1420</td>
<td>4.66</td>
</tr>
<tr>
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<tr>
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<td>DN65 (NPS 2-1/2) and larger 1520 5.00</td>
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<td>5.00</td>
</tr>
<tr>
<td>5.3.6.5.6</td>
<td>Every floor, but not to exceed 3040 10.00</td>
<td>3040</td>
<td>10.00</td>
</tr>
</tbody>
</table>

5.3.6.5.7 Piping Within Concrete Floor Slabs and Underground Within Buildings
5.3.6.5.7.1 The piping shall be installed in one (or more) continuous conduits that are of sufficient size to permit subsequent installation, removal, and replacement of the gas and/or vacuum lines.
5.3.6.5.7.2 Each tube pulled into a conduit shall be a continuous length having no joints within the conduit.

5.3.6.5.8 Underground Piping Outside of Buildings
5.3.6.5.8.1 Buried piping outside of buildings shall be installed below the local level of frost penetration.
5.3.6.5.8.2 The installation procedure for underground piping shall protect the piping from physical damage while being backfilled.
5.3.6.5.8.3 If the underground piping is protected by a conduit, cover, or other enclosure, the following requirements shall be met:
   (1) Access during construction shall be provided at the joints for visual inspection and leak testing.
   (2) The conduit, cover, or enclosure shall be self draining and not retain groundwater in prolonged contact with copper tubing.
5.3.6.5.8.4 Buried piping that will be subject to surface loads shall be buried at a depth that will protect the piping and/or its enclosure from excessive stresses.
5.3.6.5.8.5 The minimum backfill cover above the top of the piping or its enclosure shall be 900 mm (36 in.) except that the minimum cover shall be permitted to be reduced to 450 mm (18 in.) where physical damage is otherwise prevented.
5.3.6.5.8.6 Trenches shall be excavated so that the piping or its enclosure has firm, substantially continuous bearing on the bottom of the trench.
5.3.6.5.8.7 Backfill shall be clean and compacted so as to protect and uniformly support the piping or its enclosure.
5.3.6.5.8.8 A continuous warning tape or marker shall be placed immediately above the piping or its enclosure to clearly identify the pipeline by specific name.
5.3.6.5.8.9 A continuous warning means shall also be placed above the pipeline at approximately one-half the depth of bury.
5.3.6.5.8.10 Where buried piping is extended into a building through a wall sleeve, the ends of the sleeve shall be sealed watertight to prevent the entrance of groundwater into the building.
5.3.6.5.9 Threaded Joints Threaded joints in Level 3 medical gas systems, gas-powered device supply systems, and vacuum systems shall comply with the following:
   (1) Be limited to connections to pressure indicators, alarm devices, and source equipment
   (2) Have tapered threads complying with ASME B1.20.1, *Pipe Threads, General Purpose, Inch*
   (3) Be made up with polytetrafluoroethylene (such as Teflon™) tape or other thread sealant recommended for oxygen service, with the sealant applied to the male threads only.
5.3.6.5.10 Prohibited Joints The following joints shall be prohibited:
   (1) Flared and compression connections, including connections to station outlets and inlets, alarm devices, and other components
   (2) Other straight-threaded connections, including unions.
5.3.6.5.11 Special Fittings. The following special fittings shall be permitted to be used in lieu of brazed joints:
   (1) Memory-metal couplings having temperature and pressure rated joints not less than that of a brazed joint.
(2) Listed or approved metallic gas tube fittings that, when made up, provide a permanent joint having the mechanical, thermal, and sealing integrity of a brazed joint.
(3) Axially swaged, elastic strain preload fittings providing metal to metal seals having pressure and temperature ratings not less than that of a brazed joint and when complete are permanent and non-separable.

5.3.6.5.12 Hose and Flexible Connectors
5.3.6.5.12.1 Hose and flexible connectors, both metallic and nonmetallic, shall be no longer than necessary and shall not penetrate or be concealed in walls, floors, ceilings, or partitions.
5.3.6.5.12.2 Flexible connectors, metallic or nonmetallic, shall have a minimum burst gage pressure of 6895 kPa (1000 psi).

5.3.6.5.13 Seismic Restraint. Where required, Level 3 gas and vacuum piping shall be seismically restrained against earthquakes in accordance with the applicable building code.

5.3.6.6 Emergency Shutoff Valves
5.3.6.6.1 Where a central gas supply is remote from the system use points, the main supply line shall be provided with a shutoff valve so located in the single treatment facility as to be accessible from use-point locations in an emergency.
5.3.6.6.2 Where a central supply is remote from a single treatment facility, the main supply line shall be provided with a shutoff valve so located in the single treatment facility as to be accessible from use-point locations in an emergency.
5.3.6.6.2.1 Such valves shall be labeled to indicate the gas controlled and shall shut off only the gas to that single treatment facility.
5.3.6.6.2.2 A remotely activated shutoff at the supply cylinder(s) shall not be used for emergency shutoff. For clinical purposes, such a remote actuator shall not fail-close in the event of a loss of electric power. If remote actuators are the type that fail-open, it shall be mandatory that cylinder shutoff valves be closed whenever the system is not in use.
5.3.6.6.3 Where a central gas supply system supplies two single treatment facilities, each facility shall be provided with a shutoff valve so located in each treatment facility as to be accessible from the use-point locations in an emergency.
5.3.6.6.3.1 Such valves shall be labeled to indicate the gas controlled and shall shut off only the gas to that single treatment facility.
5.3.6.6.3.2 A remotely activated shutoff at the supply manifold shall not be used for emergency shutoff valves for dual treatment facility installations. For clinical purposes, such a remote actuator shall not fail-close in the event of a loss of electric power. If remote actuators are the type that fail-open, it shall be mandatory that cylinder shutoff valves be closed whenever the system is not in use.
5.3.6.6.4 Each riser supplied from a main line shall be provided with a shutoff valve adjacent to the riser connection. Riser valves shall be accessible and not obstructed.

5.3.6.7 Level 3 Warning Systems
5.3.6.7.1 Warning systems for medical gases (i.e., oxygen and nitrous oxide) in Level 3 facilities shall conform to the alarm functions of a Level 1 facility as required in 5.1.9, except as follows:
   (1) Area and local alarms shall not be required.
   (2) Warning systems shall be permitted to have a single alarm panel.
(3) The alarm panel shall be located in an area of continuous surveillance while the facility is in operation.
(4) Pressure switches/sensors that monitor main line pressure shall be mounted at the source equipment with a pressure indicator(s) (lamp or LED) at the alarm panel. The audible and non-cancelable alarm visual signals shall indicate if the pressure in the main line increases or decreases 20 percent from the normal operating pressure. Visual indicators shall remain until the situation that caused the alarm is resolved.
(5) When automatic changeover of source gases is required, the changeover alarm shall have a secondary indicator to suit the arrangement of the source equipment.
(6) A cancelable audible indication of each alarm condition that produces a sound at the alarm panel shall re-initiate the audible signal if another alarm condition occurs while the audible is silenced.
(7) Pressure switches/sensors shall be installed downstream from any emergency shutoff valves required by 5.3.6.6 and shall comply with 5.3.6.7.1 (4) and 5.3.6.7.1 (5).
5.3.6.7.2 Warning systems shall not be required for the following:
(1) Level 3 gas-powered device supply systems (compressed air and nitrogen)
(2) Level 3 vacuum systems
5.3.7 System Use and Instructions
5.3.7.1 Prohibited System Interconnections
5.3.7.1.1 Two or more systems for Level 3 medical gas, gas-powered device gas, or vacuum shall not be interconnected for testing or any other reason.
5.3.7.1.2 Leak testing shall be accomplished by separately charging and testing each individual piping system.
5.3.7.2 Changes in System Use
5.3.7.2.1 Where a Level 3 positive-pressure gas piping distribution system originally used or constructed for use at one pressure or for one gas is converted for operation at another pressure or for another gas, all provisions of 5.3 shall apply.
5.3.7.2.2 Piping for Level 3 gas-powered devices or Level 3 vacuum shall not be permitted to be converted for use as a Level 3 medical gas piping system for oxygen or nitrous oxide.
5.3.7.3 System and Equipment Manufacturer's Instructions
5.3.7.3.1 The installation of individual components shall be made in accordance with the system or equipment manufacturer's instructions.
5.3.7.3.2 Such instructions shall include directions and information deemed necessary by the manufacturer for attaining proper operation, testing, and maintenance of the system.
5.3.7.3.3 Copies of the manufacturer's instructions shall be left with the system owner.
5.3.8 Labeling and Identification
5.3.8.1 Pipe Labeling
5.3.8.1.1 Piping shall be labeled by stenciling or adhesive markers that identify the system.
5.3.8.1.2 Pipe labels shall show the name of the gas/vacuum system or the chemical symbol.
5.3.8.1.3 Where positive-pressure gas piping systems operate at pressures other than the standard gauge pressure of 345 kPa to 380 kPa (50 psi to 55 psi) or a gauge pressure of 1100 kPa to 1275 kPa (160 psi to 185 psi) for nitrogen, the pipe labels shall also include the nonstandard operating pressure in addition to the name or symbol of the gas.
5.3.8.1.4 Pipe labels shall be located as follows:

(1) At intervals of not more than 6.1 m (20 ft)
(2) At least once in or above every room
(3) On both sides of walls or partitions penetrated by the piping
(4) At least once in every story height traversed by the risers

5.3.8.2 Identification of Shutoff Valves
5.3.8.2.1 Shutoff valves shall be identified as to the following:
(1) The name or chemical symbol for the specific system
(2) The name of the room(s) or area(s) served
(3) A caution to not close (or open) the valve except in an emergency

5.3.8.2.2 Where positive-pressure gas piping systems operate at pressures other than the standard gauge pressure of 345 kPa to 380 kPa (50 psi to 55 psi) or a gauge pressure of 1100 kPa to 1275 kPa (160 psi to 185 psi) for nitrogen, the valve identification shall also include the nonstandard operating pressure in addition to the name or symbol of the gas.

5.3.8.3 Identification of Service Outlets and Inlets
5.3.8.3.1 Service outlets and inlets shall be identified as to the name or chemical symbol for the specific gas or vacuum provided.
5.3.8.3.2 Where positive-pressure gas piping systems operate at pressures other than the standard gauge pressure of 345 kPa to 380 kPa (50 psi to 55 psi) or a gauge pressure of 1100 kPa to 1275 kPa (160 psi to 185 psi) for nitrogen, the station identification shall also include the nonstandard operating pressure in addition to the name or symbol of the gas.

5.3.9 Performance Criteria and Testing — Level 3 (Medical Gas, Gas-Powered Devices, Vacuum).
5.3.9.1 General.
5.3.9.1.1 Inspection and testing shall be performed on all new piped gas systems, additions, renovations, temporary installations, or repaired systems, to assure the facility, by a documented procedure, that all applicable provisions of this document have been adhered to and system integrity has been achieved or maintained.
5.3.9.1.2 Inspection and testing shall include all components of the system or portions thereof including, but not limited to, medical gas source(s), compressed air source systems (e.g., compressors, dryers, filters, regulators), alarms and monitoring safeguards, pipelines, isolation valves, and service outlets and inlets.
5.3.9.1.3 All systems that are breached and components that are subjected to additions, renovations, or replacement (e.g., new medical gas sources, compressors, dryers, alarms) shall be inspected and tested.
5.3.9.1.4 Systems shall be deemed breached at the point of pipeline intrusion by physical separation or by system component removal, replacement, or addition.
5.3.9.1.5 Breached portions of the systems subject to inspection and testing shall be confined to only the specific altered zone and components in the immediate zone or area that is located upstream for vacuum systems and downstream for pressure gases at the point or area of intrusion.
5.3.9.1.6 The inspection and testing reports shall be submitted directly to the party that contracted for the testing, who shall submit the report through channels to the responsible authority and any others that are required.
5.3.9.1.7 Reports shall contain detailed listings of all findings and results.
5.3.9.1.8 The responsible facility authority shall review these inspection and testing records prior to the use of any systems to assure that all findings and results of the inspection and testing have been successfully completed.
5.3.9.1.9 All documentation pertaining to inspections and testing shall be maintained on-site within the facility.
5.3.9.1.10 Before piping systems are initially put into use, the Level 3 health care facility authority shall be responsible for ascertaining that the gas/vacuum delivered at each outlet/inlet is that shown on the outlet/inlet label and that the proper connecting fittings are installed for the specific gas/vacuum. *(See 5.3.9.1.11)*
5.3.9.1.11 Acceptance of the verifier's reports required under 5.3.10, System Verification, shall be permitted to satisfy the requirements of 5.3.9.1.10.

5.3.9.2 Initial Tests.
5.3.9.2.1 General.
5.3.9.2.1.1 The tests required by 5.3.9.2 shall be performed prior to the tests listed in 5.3.9.3, System Verification, by one or more of the following:
   (1) The installer
   (2) A representative of the system supplier
   (3) A representative of the system manufacturer
5.3.9.2.1.2 The test gas for positive-pressure gas systems shall be oil-free, dry Nitrogen NF.
5.3.9.2.1.3 Where manufactured assemblies are to be installed, the tests required under 5.3.9.2 shall be performed as follows:
   (1) After completion of the distribution piping
   (2) Prior to installation or connection of manufactured assemblies supplied through flexible hoses or flexible tubing
   (3) At all station outlets/inlets on manufactured assemblies supplied through copper tubing
5.3.9.2.2 Initial Blow Down. Piping in Level 3 positive-pressure gas distribution systems shall be blown clear by means of oil-free, dry Nitrogen NF as follows:
   (1) After installation of the distribution piping
   (2) Before installation of station outlets and other system components (i.e., pressure alarm devices, pressure indicators, pressure relief valves, manifolds, source equipment)
5.3.9.2.3 Initial Pressure Test for Positive-Pressure Level 3 Gas Systems and Copper Level 3 Vacuum Piping.
5.3.9.2.3.1 Each section of the piping in Level 3 positive-pressure gas piping systems and copper Level 3 vacuum systems shall be pressure tested using oil-free, dry Nitrogen NF.
5.3.9.2.3.2 Initial pressure tests shall be conducted as follows:
   (1) After installation of station outlets/inlets rough-in assemblies. Test caps shall be permitted to be used.
   (2) Prior to the installation of components of the distribution piping system that would be damaged by the test pressure (i.e., pressure/vacuum alarm devices, pressure/vacuum indicators, line pressure relief valves).
5.3.9.2.3.3 Where Level 3 vacuum piping systems include plastic piping, they shall be inspected to assure that there are no visible cross-connections to positive-pressure gas piping systems prior to applying test pressures to the positive-pressure systems.
5.3.9.2.3.4 The source shutoff valves for all piping systems shall remain closed during these tests.
5.3.9.2.3.5 The test pressure for positive-pressure gas piping shall be 1.5 times the system working pressure, but not less than a gauge pressure of 1035 kPa (150 psi).
5.3.9.2.3.6 The test pressure for copper Level 3 vacuum piping shall be a gauge pressure of 105 kPa (15 psi).
5.3.9.2.3.7 The test pressure shall be maintained until each joint has been examined for leakage by means of soapy water or other equally effective means of leak detection.
5.3.9.2.3.8 Leaks, if any, shall be located, replaced (if permitted) or repaired (if required), and retested.
5.3.9.2.4 Initial Leak Tests - PVC Level 3 Vacuum Piping. Plastic Level 3 vacuum piping shall be leak-tested under vacuum conditions.
5.3.9.2.4.1 Plastic Level 3 vacuum piping shall not be tested with compressed gas.
5.3.9.2.4.2 Leak tests shall be conducted after installation of station inlets.
5.3.9.2.4.3 The piping being tested shall be subjected to a vacuum of not less than 485 mm (19 in.) gauge HgV, using either the vacuum source equipment or a vacuum test pump.
5.3.9.2.4.4 The test vacuum shall be maintained until each joint has been examined for leakage.
5.3.9.2.5 Initial Cross-Connection Test. The installer shall determine that no cross-connections exist between the various Level 3 gas and vacuum piping systems.
5.3.9.2.5.1 All Level 3 gas and vacuum piping systems shall be at atmospheric pressure.
5.3.9.2.5.2 Face plates for outlets/inlets shall be installed.
5.3.9.2.5.3 Level 3 vacuum piping systems shall be subjected to a vacuum of not less than 485 mm (19 in.) gauge HgV, using either the vacuum source equipment or a test pump.
5.3.9.2.5.4 Each individual system gas outlet and vacuum inlet in each piping system shall be checked to determine that the vacuum is present only at the inlets for the vacuum system being tested.
5.3.9.2.5.5 The vacuum piping system shall be relieved to atmospheric pressure.
5.3.9.2.5.6 The test gas for all positive-pressure gas piping systems shall be oil-free, dry Nitrogen NF.
5.3.9.2.5.7 Sources of test gas and vacuum shall be disconnected from all piping systems except for the one system being tested.
5.3.9.2.5.8 The positive-pressure gas system being tested shall be pressurized to a gauge pressure of 345 kPa (50 psi) with oil-free, dry Nitrogen NF.
5.3.9.2.5.9 Each individual system gas outlet and vacuum inlet in each installed piping system shall be checked to determine that the test gas is being dispensed only from the outlets in the piping system being tested.
5.3.9.2.5.10 The cross-connection test shall be repeated for each installed positive-pressure gas piping system.
5.3.9.2.5.11 The proper labeling and identification of system outlets/inlets shall be confirmed during these tests.
5.3.9.2.6 Initial Piping Purge Test. The outlets in each Level 3 positive-pressure gas piping system shall be purged to remove any particulate matter from the distribution piping.
5.3.9.2.6.1 The test gas shall be oil-free, dry Nitrogen NF.
5.3.9.2.6.2 Using appropriate adapters, each outlet shall be purged with an intermittent high-volume flow of test gas until the purge produces no discoloration in a clean white cloth.
5.3.9.2.6.3 The purging shall be started at the furthest outlet in the system and proceed towards the source equipment.
5.3.9.2.7 Initial Standing Pressure Test for Positive-Pressure Gas Piping. After successful completion of the initial pressure tests under 5.3.9.2.3, Level 3 positive-pressure gas distribution piping shall be subjected to a standing pressure test.
5.3.9.2.7.1 Tests shall be conducted after the installation of station outlet valve bodies and face plates, and other distribution system components (i.e., pressure alarm devices, pressure indicators, and line pressure relief valves).
5.3.9.2.7.2 The source valve shall be closed during this test.
5.3.9.2.7.3 The piping systems shall be subjected to a 24-hour standing pressure test using oil-free, dry Nitrogen NF.
5.3.9.2.7.4 Test pressures shall be 20 percent above the normal system operating line pressure.
5.3.9.2.7.5 At the conclusion of the tests, there shall be no change in the test pressure greater than a gauge pressure of 35 kPa (5 psi).
5.3.9.2.7.6 Leaks, if any, shall be located, repaired (if permitted), replaced (if required), and retested.
5.3.9.2.8 Initial Standing Vacuum Test for Vacuum Systems. Level 3 vacuum systems, with either plastic or copper piping, shall be subjected to a standing vacuum test.
5.3.9.2.8.1 The piping system shall be subjected to a vacuum of not less than 485 mm (19 in.) gauge HgV for 24 hours, using either the vacuum source equipment or a test source.
5.3.9.2.8.2 During the test, the source of test vacuum shall be disconnected from the piping system.
5.3.9.2.8.3 At the conclusion of the test, the vacuum shall not have reduced to less than 300 mm (12 in.) HgV.
5.3.9.2.8.4 Leaks, if any, shall be located, repaired (if permitted), replaced (if required), and retested.
5.3.10 System Verification.
5.3.10.1 General.
5.3.10.1.1 Verification tests shall be conducted on Level 3 medical gases (e.g., oxygen and nitrous oxide).
5.3.10.1.2 Verification tests shall be performed only after all tests required in 5.3.9.2, Initial Tests, have been completed on all positive-pressure and vacuum piping systems.
5.3.10.1.3 The test gas shall be oil-free, dry Nitrogen NF or the system gas where permitted.
5.3.10.1.4 Verification testing shall be conducted by a party technically competent and experienced in the field of medical gas and vacuum system verification and meeting the requirements of ASSE 6030, Professional Qualifications Standard for Medical Gas Systems Verifiers.
5.3.10.1.5 Verification testing shall be performed by a party other than the installing contractor.
5.3.10.1.6 All verification tests required under 5.3.10 shall be performed after installation of any manufactured assemblies supplied through flexible hose or tubing.
5.3.10.1.7 Where manufactured assemblies include multiple possible connection points for terminals, each possible position shall be tested independently.
5.3.10.1.8 For small projects affecting a limited number of areas where the use of nitrogen is impractical, the system gas shall be permitted to be used for the following tests:

(1) Standing pressure (5.3.10.2)
(2) Cross-connection (5.3.10.3)
(3) Warning system (5.3.10.4)
(4) Piping purge (5.3.10.5)
(5) Piping particulate (5.3.10.6)
(6) Piping purity (5.3.10.7)
(7) Operational pressure (5.3.10.9)

5.3.10.1.9 All verification test results shall be reported as required in 5.3.9.1.
5.3.10.2 Verifier Standing Pressure Test. Level 3 medical gas piping systems (i.e., oxygen and nitrous oxide) shall be subjected to a 10-minute standing pressure test at operating line pressure using the following procedures:
   (1) After the system is filled with oil-free, dry Nitrogen NF or the system gas, the source valve and any zone valves shall be closed.
   (2) The piping system downstream of the valves shall show no decrease in pressure after 10 minutes.
   (3) Any leaks found shall be located, repaired (if permitted), replaced (if required), and retested.
5.3.10.3 Verifier Cross-Connection Test. After closing of walls and completion of the requirements of 5.3.9.2, Initial Tests, it shall be determined that no cross-connections exist between the Level 3 medical gas systems and any of the other positive-pressure and vacuum piping systems by use of the following method:
   (1) Shut off the source of test gas for all positive-pressure gas piping systems and reduce systems to atmospheric pressure.
   (2) Using oil-free, dry Nitrogen NF, or the system gas, pressurize one of the Level 3 medical gas piping systems to a gauge pressure of 345 kPa (50 psi).
   (3) Test each positive-pressure gas outlet and Level 3 vacuum inlet using appropriate adapters to verify that the test gas pressure is present only at the outlets in the Level 3 medical gas piping system being tested.
   (4) After it has been verified that a Level 3 medical gas piping system is free of cross-connections, disconnect the source of test gas and reduce the piping to atmospheric pressure.
   (5) Proceed to test each Level 3 medical gas piping system until each is verified to be free of cross-connections.
5.3.10.4 Verifier Level 3 Warning System Tests.
5.3.10.4.1 All warning systems that are installed for Level 3 medical gases shall be verified to ensure that all components function correctly prior to placing the system into service.
5.3.10.4.2 Permanent records of these tests shall be maintained.
5.3.10.4.3 Warning systems that are part of an addition to an existing piping system shall be tested prior to connection of the new piping to the existing system.
5.3.10.4.4 Tests of warning systems for new installations shall be performed after the verifier's cross-connection testing (5.3.10.3), but before purging the piping (5.3.10.5) and performing the remaining verification tests (5.3.10.6 through 5.3.10.12).
5.3.10.4.5 Test gases shall be either oil-free, dry Nitrogen NF, or the gas of system designation.
5.3.10.4.6 The audible and non-cancelable alarm signals in each single treatment facility shall be checked to verify that they are in a location that will be continuously attended while the facility is in operation.
5.3.10.4.7 The operation of the Level 3 line pressure alarms required by 5.3.6.7.1 shall be verified.
5.3.10.4.8 The operation of the Level 3 changeover alarms required by 5.3.6.7.1 (5) shall be verified.
5.3.10.4.9 Audible and non-cancelable visual signals shall indicate whenever automatic changeover occurs or is about to occur.
5.3.10.4.10 Where Level 3 medical gas systems include other alarm features that are not mandatory under 5.3.3 or 5.3.6.7, they shall be functionally tested in accordance with their intended purpose and the equipment manufacturer's recommendations.
5.3.10.5 Verifier Piping Purge Test. In order to remove any traces of particulate matter deposited in the pipelines as a result of construction, a heavy, intermittent purging of each Level 3 medical gas (i.e., oxygen and nitrous oxide) pipeline shall be done.
5.3.10.5.1 The appropriate adapter shall be obtained from the facility or manufacturer, and high purge rates of at least 230 SLPM (8 SCFM) shall be put on each outlet.
5.3.10.5.2 After the purge is started, it shall be rapidly interrupted several times until the purge produces no discoloration in a white cloth loosely held over the adapter during the purge.
5.3.10.5.3 In order to avoid possible damage to the outlet and its components, this test shall not be conducted using any implement other than the correct adapter.
5.3.10.6 Verifier Piping Particulate Test. The cleanliness of the piping in each Level 3 medical gas system (i.e., oxygen and nitrous oxide) shall be verified as follows:
   (1) The test shall be performed using oil-free, dry Nitrogen NF or the system gas.
   (2) A minimum of 1000 L (35 ft$^3$) of gas shall be filtered through a clean, white 0.45-micron filter at a minimum flow rate of 100 SLPM (3.5 SCFM).
   (3) Each zone shall be tested at the outlet most remote from the source.
   (4) The filter shall accrue no more than 0.001 g (1 mg) of matter from any outlet tested.
5.3.10.7 Verifier Piping Purity Test. For each Level 3 medical gas system (i.e., oxygen and nitrous oxide), the purity of the piping system shall be verified as follows:
   (1) These tests shall be performed with oil-free, dry Nitrogen NF or the system gas.
   (2) The tests shall be for total hydrocarbons (as methane) and halogenated hydrocarbons, and compared with the source gas.
   (3) This test shall be performed at the outlet most remote from the source.
   (4) The difference between the two tests shall in no case exceed the following:
      (a) Total hydrocarbons, 1 ppm
      (b) Halogenated hydrocarbons, 2 ppm
(5) A test shall be conducted at the outlet most remote from the source and the moisture concentration shall not exceed 500 ppm or an equivalent pressure dew point of -12°C (10°F) at 345 kPa (50 psig).

5.3.10.8 Verifier Final Tie-In Test.
5.3.10.8.1 Prior to the connection of any new Level 3 medical gas piping to its source of supply, including extensions or additions to an existing piping system, the verification tests in 5.3.10.2 through 5.3.10.7 shall be successfully performed on the new work.
5.3.10.8.2 Each joint in the final connection between the new work and the existing system shall be leak-tested with the gas of system designation by means of soapy water or other means effective for use with oxygen.
5.3.10.8.3 For Level 3 medical gases, immediately after the final connection is made and leak-tested, the specific altered zone and components in the immediate zone or area that is downstream from the point or area of intrusion shall be purged per 5.3.10.5.
5.3.10.8.4 Before the new work is used for patient care, the following tests shall be performed for all Level 3 medical gas (i.e., oxygen and nitrous oxide) systems:
   (1) Operational pressure (5.3.10.9)
   (2) Gas concentration (5.3.10.10)
5.3.10.8.5 Permanent records of these tests shall be maintained in accordance with 5.3.12.7.1.
5.3.10.9 Verifier Operational Pressure Test. Operational pressure tests shall be performed at each station outlet in Level 3 medical gas piping systems (i.e., oxygen and nitrous oxide) where the user makes connections and disconnections.
5.3.10.9.1 Tests shall be performed using either oil-free, dry Nitrogen NF or the gas of system designation.
5.3.10.9.2 Medical gas outlets (i.e., oxygen and nitrous oxide) shall deliver 100 SLPM (3.5 SCFM) with a pressure drop of no more than 35 kPa (5 psi) and static pressure of 345 kPa to 380 kPa (50 psi to 55 psi).
5.3.10.10 Verifier Gas Concentration Test. After purging each Level 3 medical gas piping system with the gas of system designation, the following shall be performed:
   (1) Each medical gas outlet (i.e., oxygen and nitrous oxide) shall be analyzed for concentration of gas, by volume.
   (2) Analysis shall be conducted with instruments designed to measure the specific gas dispensed.
   (3) Allowable concentrations shall be as follows:
       (a) Oxygen 99 percent oxygen ≥
       (b) Nitrous oxide 99 percent nitrous oxide
5.3.10.11 Verification of Labeling. The presence and correctness of labeling required by this standard for all Level 3 gas and vacuum components (i.e., station outlets/inlets, shutoff valves, and alarm panels) shall be verified.
5.3.10.12 Source Equipment Verification.
5.3.10.12.1 General. Source equipment verification for Level 3 medical gases shall be performed following the installation of the interconnecting pipelines, accessories, and source equipment.
5.3.10.12.2 Use of Source Equipment for Pipeline Verification Tests. Where the source equipment and system gas is used for verification testing of the distribution piping, the source equipment shall be verified prior to verification of the distribution piping.

5.3.10.12.3 Source Equipment for Level 3 Medical Gases (oxygen and nitrous oxide). The system apparatus shall be tested for proper function, including the changeover from primary to secondary supply (with its changeover signal), before the system is put into service.

5.3.11 Final Testing of Level 3 Systems for Gas-Powered Devices and Vacuum.

5.3.11.1 General.

5.3.11.1.1 Final testing of gas-powered device systems and vacuum systems shall be performed only after all tests required by 5.3.9.2, Initial Tests, have been performed.

5.3.11.1.2 The tests required by 5.3.11.2 through 5.3.11.8 shall be performed by one or more of the following:

(1) The installer
(2) A representative of the system supplier
(3) A representative of the system manufacturer
(4) A system verifier per 5.3.10.1.4 and 5.3.10.1.5

5.3.11.1.3 The test gas shall be oil-free, dry Nitrogen NF or the system gas where permitted.

5.3.11.2 Final Standing Pressure Test (Level 3 Gas-Powered Devices). Each gas-powered device piping system shall be subjected to a 10-minute standing pressure test at operating line pressure using the following procedures:

(1) After the system is filled with oil-free, dry Nitrogen NF or the system gas, the source valve and any zone valves shall be closed.
(2) The piping system downstream of the valves shall show no decrease in pressure after 10 minutes.
(3) Any leaks found shall be located, repaired (if permitted), replaced (if required), and retested.

5.3.11.3 Final Standing Vacuum Test (Level 3 Vacuum). Each Level 3 vacuum piping system shall be subjected to a 10-minute standing vacuum test at operating line vacuum using the following procedures:

(1) After the system has stabilized at the operating line vacuum, the source valve and any zone valves shall be closed.
(2) The piping system upstream of the valves shall show no decrease in vacuum after 10 minutes.
(3) Leaks, if any, shall be located, repaired (if permitted), replaced (if required), and retested.

5.3.11.4 Final Cross-Connection Test (for Level 3 Gas-Powered Devices and Vacuum). After closing of walls and completion of the requirements of 5.3.9.2, Initial Tests, it shall be determined that no cross-connections exist between the piping systems for gas-powered devices and Level 3 vacuum using the following method:

(1) Where facilities have more than one gas or vacuum system, test each system separately.
(2) Shut off the source of test gas for all gas-powered device piping systems and reduce them to atmospheric pressure.
(3) Operate each Level 3 vacuum system at the normal system vacuum, using the source equipment.

(4) Each gas-powered device gas outlet and Level 3 vacuum inlet shall be tested with appropriate adapters to verify that vacuum is present only at the vacuum inlets in the system being tested and not at any gas-powered device gas outlets or inlets of other vacuum systems.

(5) Shut down the vacuum source equipment and slowly break the vacuum in the vacuum piping system, increasing its pressure to atmospheric.

(6) Test each Level 3 vacuum system until all are determined to be free of cross-connections.

(7) Using oil-free, dry Nitrogen NF or the system gas, pressurize the gas-powered device piping system to a gauge pressure of 345 kPa (50 psi).

(8) Test each gas-powered device gas outlet using appropriate adapters to verify that the test gas pressure is present only at the outlets in the gas-powered device system being tested.

(9) After it has been determined that a gas-powered device piping system is free of cross-connections, disconnect the source of test gas and reduce the piping to atmospheric pressure.

(10) Proceed to test each gas-powered device piping system until all are determined to be free of cross-connections.

5.3.11.5 Final Piping Purge Test (for Level 3 Gas-Powered Devices). In order to remove any traces of particulate matter deposited in the pipelines as a result of construction, a heavy, intermittent purging of each gas-powered device pipeline shall be done.

5.3.11.5.1 The appropriate adapter shall be obtained from the facility or manufacturer, and high purge rates shall be put on each outlet.

5.3.11.5.2 After the purge is started, it shall be rapidly interrupted several times until the purge produces no discoloration in a white cloth loosely held over the adapter during the purge.

5.3.11.5.3 In order to avoid possible damage to the outlet and its components, this test shall not be conducted using any implement other than the correct adapter.

5.3.11.6 Final Tie-In Test (for Level 3 Gas-Powered Devices and Vacuum).

5.3.11.6.1 Prior to the connection of any new piping to its source of supply, including extensions or additions to an existing piping system, the final tests in 5.3.11.2 through 5.3.11.5 shall be successfully performed on the new work.

5.3.11.6.2 Each joint in the final connection between new work and an existing system shall be leak-tested with the gas of system designation or vacuum at the normal operating pressure by means of soapy water or other means effective for use with oxygen.

5.3.11.6.3 For gas-powered device piping, immediately after the final connection is made and leak-tested, the specific altered zone and components in the immediate zone or area that is downstream from the point or area of intrusion shall be purged per 5.3.11.5.

5.3.11.7 Labeling (for Level 3 Gas-Powered Devices and Vacuum). The presence and correctness of labeling required by this standard for all Level 3 gas-powered device and vacuum system components (e.g., station outlets/inlets and shutoff valves) shall be checked.

5.3.11.8 Source Equipment Testing (for Level 3 Gas-Powered Devices and Vacuum).
5.3.11.8.1 General. Source equipment checks for Level 3 gas-powered devices and Level 3 vacuum shall be performed following the installation of the interconnecting pipelines, accessories, and source equipment.

5.3.11.8.2 Use of Source Equipment for Pipeline Verification Tests. Where the source equipment and system gas or vacuum is used for final testing of the distribution piping, the source equipment shall be checked out and placed in operation prior to testing the distribution piping.

5.3.11.8.3 Compliance with Manufacturer's Instructions. The source equipment for Level 3 gas-powered device system(s) and vacuum systems shall be checked out and placed in operation according to the manufacturer's instructions.

5.3.12 Operation and Management of Level 3 Systems.

5.3.12.1 Special Precautions for Handling Oxygen Cylinders and Manifolds. Handling of oxygen cylinders and manifolds shall be based on CGA G-4, Oxygen.

5.3.12.1.1 Oxygen cylinders, containers, and associated equipment shall be protected from contact with oil or grease. Specific precautions shall include the following:

1. Oil, grease, or readily flammable materials shall never be permitted to come in contact with oxygen cylinders, valves, regulators, gauges, or fittings.

2. Regulators, fittings, or gauges shall never be lubricated with oil or any other flammable substance.

3. Oxygen cylinders or apparatus shall never be handled with oily or greasy hands, gloves, or rags.

5.3.12.1.2 Equipment associated with oxygen shall be protected from contamination. Specific precautions shall include the following:

1. Particles of dust and dirt shall be cleared from cylinder valve openings by slightly opening and closing the valve before applying any fitting to the cylinder.

2. The high-pressure valve on the oxygen cylinder shall be opened before bringing the apparatus to the patient or the patient to the apparatus.

3. An oxygen cylinder shall never be draped with any materials such as hospital gowns, masks, or caps.

4. Cylinder-valve protection caps, where provided, shall be kept in place and be hand-tightened, except when cylinders are in use or connected for use.

5. Valves shall be closed on all empty cylinders in storage.

5.3.12.1.3 Cylinders shall be protected from damage. Specific procedures shall include the following:

1. Oxygen cylinders shall be protected from abnormal mechanical shock, which is liable to damage the cylinder, valve, or safety device.

2. Oxygen cylinders shall not be stored near elevators, gangways, or in locations where heavy moving objects will strike them or fall on them.

3. Cylinders shall be protected from the tampering of unauthorized individuals.

4. Cylinders or cylinder valves shall not be repaired, painted, or altered.

5. Safety relief devices in valves or cylinders shall never be tampered with.

6. Valve outlets clogged with ice shall be thawed with warm — not boiling — water.

7. A torch flame shall never be permitted under any circumstances to come in contact with cylinder valves or safety devices.

8. Sparks and flame shall be kept away from cylinders.
(9) Even if they are considered to be empty, cylinders shall never be used as rollers, supports, or for any purpose other than that for which the supplier intended them.

(10) Large cylinders (exceeding size E) and containers larger than 45 kg (100 lb) weight shall be transported on a proper hand truck or cart complying with Chapter 9.

(11) Freestanding cylinders shall be properly chained or supported in a proper cylinder stand or cart.

(12) Cylinders shall not be supported by radiators, steam pipes, or heat ducts.

5.3.12.1.4 Cylinders and their contents shall be handled with care. Specific procedures shall include the following:

(1) Oxygen fittings, valves, regulators, or gauges shall never be used for any service other than that of oxygen.

(2) Gases of any type shall never be mixed in an oxygen cylinder or any other cylinder.

(3) Oxygen shall always be dispensed from a cylinder through a pressure regulator.

(4) The cylinder valve shall be opened slowly, with the face of the gauge on the regulator pointed away from all persons.

(5) Oxygen shall be referred to by its proper name, oxygen, not air, and liquid oxygen referred to by its proper name, not liquid air.

(6) Oxygen shall never be used as a substitute for compressed air.

(7) The markings stamped on cylinders shall not be tampered with because it is against federal statutes to change these markings without written authority from the Bureau of Explosives.

(8) Markings used for the identification of contents of cylinders shall not be defaced or removed, including decals, tags, stenciled marks, and the upper half of shipping tag.

(9) The owner of the cylinder shall be notified if any condition has occurred that might permit any foreign substance to enter a cylinder or valve, giving details and cylinder number.

(10) Neither cylinders nor containers shall be placed in proximity to radiators, steam pipes, heat ducts, or other sources of heat.

(11) Very cold cylinders or containers shall be handled with care to avoid injury

5.3.12.1.5 Oxygen equipment that is defective shall not be used until one of the following has been performed:

(1) It has been repaired by competent in-house personnel.

(2) It has been repaired by the manufacturer or his or her authorized agent.

(3) It has been replaced.

5.3.12.1.6 Regulators that are in need of repair or cylinders having valves that do not operate properly shall never be used.

5.3.12.2 Special Precautions for Making Cylinder and Container Connections.

5.3.12.2.1 Wrenches and tools used to connect equipment shall be manufactured of material of adequate strength.

5.3.12.2.2 Cylinder valves shall be opened and connected in accordance with the following procedure:

(1) Make certain that apparatus and cylinder valve connections and cylinder wrenches are free of foreign materials.

(2) Turn the cylinder valve outlet away from personnel. Stand to the side — not in front and not in back. Before connecting the apparatus to cylinder valve, momentarily open cylinder valve to eliminate dust.
(3) Make connection of apparatus to cylinder valve. Tighten connection nut securely with a wrench.
(4) Release the low-pressure adjustment screw of the regulator completely.
(5) Slowly open cylinder valve to full open position.
(6) Slowly turn in the low-pressure adjustment screw on the regulator until the proper working pressure is obtained.
(7) Open the valve to the utilization apparatus.
5.3.12.2.3 Connections for containers shall be made in accordance with the container manufacturer's operating instructions.
5.3.12.3 Special Precautions for the Care of Safety Mechanisms.
5.3.12.3.1 Personnel using cylinders and containers and other equipment covered in this chapter shall be familiar with the Pin-Index Safety System (see Chapter 9) and the Diameter-Index Safety System (see Chapter 9); both are designed to prevent utilization of the wrong gas.
5.3.12.3.2 Safety relief mechanisms, non-interchangeable connectors, and other safety features shall not be removed or altered.
5.3.12.4 Special Precautions — Storage of Cylinders and Containers.
5.3.12.4.1 Storage shall be planned so that cylinders can be used in the order in which they are received from the supplier.
5.3.12.4.2 If stored within the same enclosure, empty cylinders shall be segregated from full cylinders.
5.3.12.4.3 Empty cylinders shall be marked to avoid confusion and delay if a full cylinder is needed quickly.
5.3.12.4.4 Cylinders stored in the open shall be protected against the following conditions:
   (1) Extremes of weather and from the ground beneath to prevent rusting
   (2) Accumulations of ice or snow during winter
   (3) Continuous exposure to direct rays of the sun in those localities where extreme temperatures prevail in summer
5.3.12.5 Special Precautions — Level 3 Gas and Vacuum Piping Systems.
5.3.12.5.1 Level 3 gas piping systems shall not be used for the distribution of flammable anesthetic gases.
5.3.12.5.2 Piping systems for Level 3 gases shall not be used as grounding electrodes.
5.3.12.5.3 Level 3 vacuum piping shall not be used for vacuum steam condensate return or other non-medical vacuum applications.
5.3.12.5.4 Every Level 3 facility shall establish a procedure for manually turning off the gas supply at the cylinder valves at the end of the work day, or when the facility is not in use.
5.3.12.5.5 No other method such as emergency shutoff valves or remote actuators (see 5.3.6.6) shall be used to turn off the gas supply.
5.3.12.6 Gas/Vacuum Systems Information and Warning Signs. The gas content of medical gas piping systems shall be labeled according to 5.3.8.1.
5.3.12.7 Gas/Vacuum Systems Maintenance and Record Keeping.
5.3.12.7.1 Permanent records of all tests required by Section 5.3 shall be maintained in the organization's files.
5.3.12.7.2 A periodic testing procedure for nonflammable medical gas/vacuum and related alarm systems shall be implemented.

5.3.12.7.3 Whenever modifications are made or maintenance is performed that breaches the system, the tests specified in 5.3.9 shall be conducted on the downstream portions of the medical gas piping system.

5.3.12.7.4 A maintenance program shall be established for the following:
   (1) Relief valves in accordance with applicable codes or manufacturer’s recommendations
   (2) The medical air compressor supply system in accordance with the manufacturer's recommendations
   (3) The vacuum source and accessories in accordance with the manufacturer’s recommendations
   (4) Both the vacuum piping system and the secondary equipment attached to vacuum station inlets to ensure the continued good performance of the entire vacuum system
   (5) The scavenger system to assure performance

5.3.12.7.5 Audible and visual alarm indicator(s) shall meet the following requirements:
   (1) Be periodically tested to determine that they are functioning properly
   (2) Have the records of the test maintained until the next test is performed
5.3* Category 3 Piped Gas and Vacuum Systems.

5.3.1* Applicability.
5.3.1.1 These requirements shall apply to health care facilities that qualify to install Category 3 systems as defined in Chapter 4.

5.3.1.1.1 The total of all gases in cylinders or containers, except nitrogen, connected and in storage at one time does not exceed 85 m³ (3000 ft³) at standard temperature and pressure (STP), except that 142 m³ (5000 ft³) (STP) shall be permitted if oxygen is stored in a DOT Specification 4L (cryogenic liquid) cylinder.

5.3.1.2 The system(s) supplies not more than two adjoining single treatment facilities.

5.3.1.3 Category 3 medical gas systems shall only be oxygen and nitrous oxide.
5.3.1.4 Category 3 gas-powered device supply systems shall be compressed air and nitrogen.
5.3.1.5 Category 3 vacuum and scavenging systems shall be either the wet or dry type.
5.3.1.6 An existing Category 3 system that is not in strict compliance with the requirements of this code shall be permitted to continue in use as long as the authority having jurisdiction has determined that such use does not constitute a distinct hazard to life.

5.3.2 Nature of Hazards of Gas and Vacuum Systems. Potential fire and explosion hazards associated with Category 3 gas and vacuum systems shall be considered in the design, installation, testing, operation, and maintenance of the systems.

5.3.3 Seismic Restraint. Where required, Category 3 gas and vacuum equipment and piping shall be seismically restrained against earthquakes in accordance with the applicable building code.

5.3.4 Protection Against Cross-Connections. All connections within Category 3 medical gas (i.e., oxygen and nitrous oxide) shall be gas-specific to prevent cross-connections with other piping systems, including vacuum, water, and drive gas.

5.3.5 Systems with Nonstandard Operating Pressures. Station outlets and piped outlets for Category 3 medical gas and gas-powered dispensing devices having nonstandard operating pressures shall comply with the following additional requirements:
(1) Be gas-specific.
(2) Be pressure-specific where a single gas is piped at more than one operating pressure.
(3) Be a D.I.S.S. connection if operated at a gauge pressure in excess of 550 kPa (80 psi).
(4) Be designed to prevent the removal of the adapter until the pressure has been relieved, if operated at a gauge pressure between 1380 kPa and 2070 kPa (200 psi and 300 psi).

5.3.6 Category 3 Medical Gas Supply Systems (i.e. Oxygen and Nitrous Oxide).

5.3.6.1 Installer Qualifications.
5.3.6.1.1 Installers of Category 3 medical gas systems (i.e., oxygen and nitrous oxide) shall be certified in accordance with ASSE 6010, Professional Qualification Standard for Medical Gas Systems Installers.

5.3.6.1.2 Installers of medical gas (i.e. oxygen and nitrous oxide) shall not use their certification...
to oversee installation by non-certified personnel.

5.3.6.2 Category 3 Medical Gas Distribution Piping (i.e. Oxygen and Nitrous Oxide).

5.3.6.2.1 Tubes shall be hard-drawn seamless copper ASTM B 819, Standard Specification for Seamless Copper Tube for Medical Gas Systems, Medical Gas Tube, Not Less Than Type L.

5.3.6.2.2 Tubes, valves, fittings, station outlets, and other piping components shall have been cleaned for oxygen by the manufacturer prior to installation in accordance with CGAG 4.1, Cleaning Equipment for Oxygen Service, except that fittings shall be permitted to be cleaned by a supplier or agency other than the manufacturer.

5.3.6.2.3 Joints for tubes, turns, offsets, and other changes in direction shall be made with brazed wrought copper capillary fittings complying with one of the following:

1. ASME B16.22, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings
2. ASME B16.50, Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings
3. ASME B16.22, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings, with socket depths equal to or greater than ASME B16.50 brazed joint pressure fittings[ROC-499]

5.3.6.2.4 Cast copper alloy fittings shall not be used with field-brazed joints.

5.3.6.2.5 Threaded joints in Category 3 medical gas systems (i.e., oxygen and nitrous oxide) shall comply with the following:

1. Be limited to connections to pressure indicators, alarm devices, and source equipment
2. Have tapered threads complying with ASME B1.20.1, Pipe Threads, General Purpose, Inch
3. Be made up with polytetrafluoroethylene (such as Teflon™) tape or other thread sealant recommended for oxygen service, with the sealant applied to the male threads only

5.3.6.2.6 The following joints shall be prohibited in Category 3 medical gas piping (i.e., oxygen and nitrous oxide):

1. Flared and compression connections, including connections to station outlets, alarm devices, and other components
2. Push-lock connections
3. Straight-threaded connections, including unions

5.3.6.2.7 Special purpose fittings shall be permitted in Category 1 medical gas piping systems can be used in Category 3 medical gas piping systems.

5.3.6.3 Qualification of Brazing Procedures and Brazing.

5.3.6.3.1 Brazing procedures and brazer performance for the installation of Category 3 medical gas piping shall be qualified the same as for Category 1 piping, in accordance with either Section IX, “Welding and Brazing Qualifications,” of the ASME Boiler and Pressure Vessel Code, or AWS B2.2, Standard for Brazing Procedure and Performance Qualification, both as modified by 5.3.6.3.2 through 5.3.6.3.7.

5.3.6.3.2 Brazers shall be qualified by visual examination of the test coupons followed by sectioning.

5.3.6.3.3 The brazing procedure specification shall address cleaning, joint clearance, overlap, internal purge gas, purge gas flow rate, and filler metal.

5.3.6.3.4 The brazing procedure qualification record and the record of brazer performance
qualification shall document the filler metal used, cleaning, joint clearance, overlap, internal purge gas and flow rate during brazing of the coupon, and the absence of internal oxidation in the completed coupon.

5.3.6.3.5 Brazing procedures qualified by a technically competent group or agency shall be permitted under the following conditions:

(1) The brazing procedure specification and the procedure qualification record meet the requirements of this code.

(2) The employer obtains a copy of both the brazing procedure specification and the supporting qualification records from the group or agency and signs and dates these records, thereby accepting responsibility for the qualifications that were performed by the group or agency.

(3) The employer qualifies at least one brazer following each brazing procedure specification used.

5.3.6.3.6 An employer shall be permitted to accept brazer qualification records of a previous employer under the following conditions:

(1) The brazer has been qualified following the same procedure that the new employer uses, or an equivalent procedure.

(2) The new employer obtains a copy of the record of brazer performance qualification tests from the previous employer and signs and dates these records, thereby accepting responsibility for the qualifications performed by the previous employer.

5.3.6.3.7 Performance qualifications of brazers shall remain in effect indefinitely unless the brazer does not braze with the qualified procedure for a period exceeding 6 months or there is a specific reason to question the ability of the brazer.

5.3.6.4 Brazed Joints.

5.3.6.4.1 Brazed tube joints shall be the socket type.

5.3.6.4.2 Brazed joints shall be made using a brazing alloy that exhibits a melting temperature in excess of 538°C (1000°F) to retain the integrity of the piping system in the event of fire exposure.

5.3.6.4.3 Filler metals shall bond with and be metallurgically compatible with the base metal being joined.

5.3.6.4.4 Filler metals shall comply with ANSI/AWS A5.8, Specification for Filler Metals for Brazing and Braze Welding.

5.3.6.4.5 Copper to copper joints shall be brazed using a copper–phosphorus or copper–phosphorus–silver brazing filler metal (BCuP series) without flux.

5.3.6.4.6 Joints to be brazed in place shall be accessible for necessary preparation, assembly, heating, filler application, cooling, cleaning, and inspection.

5.3.6.5 Cutting Tube Ends.

5.3.6.5.1 Tube ends shall be cut square using a sharp tubing cutter to avoid deforming the tube.

5.3.6.5.2 The cutting wheels on tubing cutters shall be free from grease, oil, or other lubricant not recommended for oxygen service.

5.3.6.5.3 The cut ends of the tube shall be rolled smooth or deburred with a sharp, clean deburring tool, taking care to prevent chips from entering the tube.

5.3.6.6 Cleaning Joints for Brazing.

5.3.6.6.1 The interior surfaces of tubes, fittings, and other components that are cleaned for oxygen service shall be stored and handled to avoid contamination prior to assembly and brazing.
5.3.6.6.2 The exterior surfaces of tube ends shall be cleaned prior to brazing to remove any oxides and surface dirt and to roughen the surfaces to prepare them for brazing.
5.3.6.6.3 Nonabrasive pads shall be used to clean the exterior surfaces of tube ends.
5.3.6.6.4 The use of steel wool, sand cloth, or wire brushes shall be prohibited.
5.3.6.6.5 The cleaning process shall not result in grooving the surfaces to be joined.
5.3.6.6.6 After being abraded, the surfaces shall be wiped using a clean, lint-free white cloth.
5.3.6.6.7 Tubes, fittings, valves, and other components shall be visually examined internally before being joined to verify that they have not become contaminated for oxygen service and that they are free of obstructions or debris.
5.3.6.6.8 Material that has become contaminated internally and is not clean for oxygen service shall not be installed.
5.3.6.6.9 Joints shall be brazed within 8 hours after being cleaned for brazing.

5.3.6.7 Brazing Dissimilar Metals.
5.3.6.7.1 Flux shall only be used when brazing dissimilar metals, such as copper and bronze or brass, using a silver (BAg series) brazing filler metal.
5.3.6.7.2 Cast metals shall not be field-brazed.
5.3.6.7.3 Surfaces shall be cleaned for brazing in accordance with 5.3.6.6.
5.3.6.7.4 Flux shall be applied sparingly to minimize contamination of the inside of the tube with flux.
5.3.6.7.5 The flux shall be applied and worked over the cleaned surfaces to be brazed using a stiff bristle brush to ensure complete coverage and wetting of the surfaces with flux.
5.3.6.7.6 Where possible, short sections of copper tube shall be brazed onto the non-copper component, and the interior of the subassembly shall be cleaned of flux prior to installation in the system.
5.3.6.7.7 On joints DN20 (NPS 3/4 in. O.D.) size and smaller, flux-coated brazing rods shall be permitted to be used in lieu of applying flux to the surfaces to be joined.

5.3.6.8* Nitrogen Purge.
5.3.6.8.1 While being brazed, joints shall be continuously purged with oil-free, dry nitrogen NF to prevent the formation of copper oxide on the inside surface of the joint.
5.3.6.8.2 The source of the nitrogen purge gas shall be monitored and the installer shall be audibly alerted when the content is low.
5.3.6.8.3 The nitrogen purge gas flow rate shall not be high enough to produce a positive pressure in the piping system.
5.3.6.8.4 The nitrogen purge gas flow rate shall be controlled by the use of both a pressure regulator and a flowmeter, or a combination thereof.
5.3.6.8.5 Pressure regulators alone shall not be used to control nitrogen purge gas flow rates.
5.3.6.8.6 During and after installation, openings in the piping system shall be kept capped or plugged to maintain a nitrogen atmosphere within the piping and to prevent debris or other contaminants from entering the system.
5.3.6.8.7 While a joint is being brazed, a discharge opening shall be provided on the opposite side of the joint from where the nitrogen purge gas is being introduced.
5.3.6.8.8 The flow of nitrogen purge gas shall be maintained until the joint is cool to the touch.
5.3.6.8.9 After the joint has cooled, the purge discharge opening shall be plugged or capped to prevent contamination of the inside of the tube and maintain the nitrogen atmosphere within the piping system.

5.3.6.9 Assembling and Heating Brazed Joints.
5.3.6.9.1 Tube ends shall be inserted either fully into the depth of the fitting socket or to a mechanically limited depth that is not less than the minimum cup depth (overlap) specified in ASME B16.50, Standard Specification for Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings.

5.3.6.9.2 Where flux is permitted, joints shall be heated slowly until the flux has liquefied.

5.3.6.9.3 After flux has liquefied or where flux is not permitted to be used, the joint shall be heated quickly to the brazing temperature, taking care not to overheat the joint.

5.3.6.9.4 Techniques for heating joints, applying the brazing filler metal, and making the horizontal, vertical, and large-diameter joints shall be as described in sections on applying heat and brazing horizontal and vertical joints in Chapter VII, “Brazed Joints,” in the CDA Copper Tube Handbook.

5.3.6.10 Inspection of Brazed Joints.

5.3.6.10.1 After brazing, the outside of all joints shall be cleaned by washing with water and a wire brush to remove any residue and permit clear visual inspection of the joint.

5.3.6.10.2 Where flux has been used, the wash water shall be hot.

5.3.6.10.3 Each joint shall be visually inspected after cleaning the outside surfaces.

5.3.6.10.4 Joints exhibiting the following conditions shall not be permitted:

(1) Flux or flux residue (when flux or flux-coated BAg rods are used with dissimilar metals)
(2) Base metal melting or erosion
(3) Unmelted filler metal
(4) Failure of the filler metal to be clearly visible all the way around the joint at the interface between the socket and the tube
(5) Cracks in the tube or component
(6) Cracks in the filler metal
(7) Failure of the joint to hold the test pressure under the installer-performed initial pressure test (5.3.6.23.2.3) and standing pressure test (5.3.6.23.2.6)

5.3.6.10.5 Joints that are identified as defective under conditions 5.3.6.10.4(2) or (5) shall be replaced.

5.3.6.10.6 Joints that are found to be defective under conditions 5.3.6.10.4(1), (3), (4), (6), or (7) shall be permitted to be repaired, except that no joint shall be reheated more than once before being replaced.

5.3.6.11 Installation of Category 3 Medical Gas Piping (Oxygen and Nitrous Oxide).

5.3.6.11.1 Pipe Sizing. Piping systems shall be designed and sized to deliver the required flow rates at the utilization pressures.

5.3.6.11.2* Minimum Pipe Sizes. The minimum sizes of Category 3 oxygen and nitrous oxide piping shall be as follows:

(1) Category 3 oxygen piping systems shall be not less than DN10 (NPS 3/8 in.) (1/2 in. O.D.) size.
(2) Category 3 nitrous oxide piping systems shall be not less than DN8 (NPS ¼ in.) (1/8 in. O.D.) size.

5.3.6.11.3 Location of Piping. Oxygen and nitrous oxide piping shall not be located where subject to contact with oil.

5.3.6.11.4 Protection of Piping.

5.3.6.11.4.1 Piping shall be protected against freezing, corrosion, and physical damage.

5.3.6.11.4.2 Piping exposed in corridors and other locations where subject to physical damage
from the movement of carts, stretchers, beds, portable equipment, or vehicles shall be protected.

5.3.6.12 Pipe Support.
5.3.6.12.1 Piping shall be supported from the building structure in accordance with MSS Standard Practice SP-69, Pipe Hangers and Support — Selection and Application.
5.3.6.12.2 Hangers and supports shall comply with MSS Standard Practice SP-58, Pipe Hangers and Supports — Materials, Design, and Manufacture.
5.3.6.12.3 Hangers and supports for copper tube shall be sized for copper tube.
5.3.6.12.4 In potentially damp locations, copper tube hangers and supports that are in contact with the tube shall be plastic-coated or otherwise electrically insulated from the tube.
5.3.6.12.5 The maximum support spacing for copper tube shall be in accordance with Table 5.3.6.12.5.

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Hanger Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mm</td>
</tr>
<tr>
<td>DN8 (NPS ¼) (3/8 in. O.D.)</td>
<td>1520</td>
</tr>
<tr>
<td>DN10 (NPS 3/8) (5/8 in. O.D.)</td>
<td>1830</td>
</tr>
<tr>
<td>DN15 (NPS ½) (5/8 in. O.D.)</td>
<td>1830</td>
</tr>
<tr>
<td>DN20 (NPS ¾) (7/8 in. O.D.)</td>
<td>2130</td>
</tr>
<tr>
<td>DN25 (NPS 1) (1 1/8 in. O.D.)</td>
<td>2440</td>
</tr>
<tr>
<td>DN32 (NPS 1¼) (1 3/8 in. O.D.)</td>
<td>2740</td>
</tr>
<tr>
<td>DN40 (NPS 1½) (1 5/8 in/O.D.) and larger</td>
<td>3050</td>
</tr>
<tr>
<td>Vertical risers, all sizes</td>
<td></td>
</tr>
<tr>
<td>Every floor, but not to exceed</td>
<td>4570</td>
</tr>
</tbody>
</table>

5.3.6.13 Underground Piping Outside of Buildings.
5.3.6.13.1 Buried piping outside of buildings shall be installed below the local level of frost penetration.
5.3.6.13.2 The installation procedure for underground piping shall prevent physical damage to the piping while being backfilled.
5.3.6.13.3 If the underground piping is protected by a conduit, cover, or other enclosure, the following requirements shall be met:

1. Access during construction shall be provided at the joints for visual inspection and leak testing.
2. The conduit, cover, or enclosure shall be self-draining and not retain groundwater in prolonged contact with copper tubing.
5.3.6.13.4 Buried piping that will be subject to surface loads shall be buried at a depth that will protect the piping and/or its enclosure from excessive stresses.
5.3.6.13.5 The minimum backfill cover above the top of the piping or its enclosure shall be 900 mm (36 in.) except that the minimum cover shall be permitted to be reduced to 450 mm (18 in.) where there is no potential for damage from surface loads or surface conditions.
5.3.6.13.6 Trenches shall be excavated so that the piping or its enclosure has firm, substantially continuous bearing on the bottom of the trench.
5.3.6.13.7 Backfill shall be clean, free from material that can damage the pipe and compacted.
5.3.6.13.8 A continuous warning tape or marker shall be placed immediately above the piping or its enclosure to clearly identify the pipeline by specific name.
5.3.6.13.9 A continuous warning means shall also be placed above the pipeline at approximately one-half the depth of bury.
5.3.6.13.10 Where buried piping is extended into a building through a wall sleeve, the outdoor end of the sleeve shall be sealed watertight to prevent the entrance of groundwater into the building.

5.3.6.14 Underground Piping Within Buildings.
5.3.6.14.1 The installation procedure for underground piping shall prevent physical damage to the piping while being backfilled.
5.3.6.14.2 If the underground piping is protected by a conduit, cover, or other enclosure, access shall be provided at the joints during construction for visual inspection and leak testing.
5.3.6.14.3 The piping shall be backfilled with clean sand or gravel.

5.3.6.15 Piping Within Floor Slabs Prohibited. Category 3 medical gas piping (i.e., oxygen and nitrous oxide) shall not be installed within floor slabs.

5.3.6.16 Hose and Flexible Connectors.
5.3.6.16.1 Hoses and flexible connectors, both metallic and nonmetallic, shall be no longer than necessary and shall not penetrate or be concealed in walls, floors, ceilings, or partitions.
5.3.6.16.2 Hoses and flexible connectors, metallic or nonmetallic, shall have a minimum burst gauge pressure of 6895 kPa (1000 psi).
5.3.6.16.3 Medical gas hoses and flexible connectors shall be oxygen compatible.
5.3.6.16.4 Hoses and flexible connectors shall be clearly identified as to the gas content.
5.3.6.16.5 Hoses and flexible connectors for Category 3 medical gases (i.e., oxygen and nitrous oxide) shall be gas-specific and not be permitted to conduct any other gas, gas mixture, or liquid.

5.3.6.17* Category 3 Medical Gas Station Outlets (Oxygen and Nitrous Oxide).
5.3.6.17.1* Each station outlet for Category 3 medical gases shall be gas-specific, whether the outlet connection is threaded or is a noninterchangeable quick-coupler.
5.3.6.17.2 Each station outlet shall consist of a primary and secondary valve (or assembly).
5.3.6.17.3 Each secondary valve (or assembly) shall close automatically to stop the flow of gas when the primary valve (or assembly) is removed.

5.3.6.18 Piped Outlets for Connection to Category 3 Medical Gas-Dispensing Devices.
5.3.6.18.1 Piped outlets for connection to Category 3 medical gas-dispensing devices shall be gas-specific.
5.3.6.18.2 Piped outlets shall include a check valve and be capped until connected to the gas-dispensing device.
5.3.6.18.3 Where piped outlets are connected to gas-dispensing devices by flexible tubing, the tubing shall have a minimum burst gauge pressure of 6895 kPa (1000 psi) and be rated for oxygen use.
5.3.6.18.4 All connections between piped outlets and gas-dispensing devices shall be gas-specific to prevent cross-connections.

5.3.6.19 Emergency Shutoff Valves.
5.3.6.19.1* Where a central Category 3 medical gas (i.e., oxygen and nitrous oxide) supply is remote from a single treatment facility, the main supply line shall be provided with an emergency shutoff valve so located in the single treatment facility as to be accessible from all use-point locations in an emergency.
5.3.6.19.2 Where a central Category 3 medical gas (i.e., oxygen and nitrous oxide) supply system
supplies two treatment facilities, each facility shall be provided with an emergency shutoff valve so located in the treatment facility as to be accessible from all use-point locations in an emergency.

5.3.6.19.3 Such valves shall be labeled to indicate the gas controlled and shall shut off only the gas to the treatment facility that they serve.

5.3.6.19.4 A remotely activated shutoff valve at a supply manifold shall not be used for emergency shutoff. For clinical purposes, such a remote valve actuator shall not fail-closed in the event of a loss of electric power. Where remote actuators are the type that fail-open, it shall be mandatory that cylinder shutoff valves be closed whenever the system is not in use.

5.3.6.20 Locations of Medical Gas Source Equipment (i.e. Oxygen and Nitrous Oxide).

5.3.6.20.1 Medical gas source equipment shall be permitted to be installed indoors or outdoors.

5.3.6.20.2 Enclosures shall serve no other purpose than to contain the medical gas source equipment (i.e., oxygen and nitrous oxide), except that nitrogen source equipment in 5.3.7.7 and compressed air cylinders in 5.3.7.6 shall be permitted in the enclosure.

5.3.6.20.3 Storage of full and/or empty gas cylinders shall be permitted in the same enclosure.

5.3.6.20.4 Air compressors, vacuum pumps, and other equipment shall not be located in enclosures for medical gas cylinders (i.e., oxygen and nitrous oxide source equipment).

5.3.6.20.5 If enclosures are outdoors or remote from the treatment facility(s) that they serve, they shall be kept locked.

5.3.6.20.6 Cylinders in use and in storage shall be prevented from reaching temperatures in excess of 54 deg C (130 deg F). Nitrous oxide cylinders shall be prevented from reaching temperatures lower than -7 deg C (20 deg F).

5.3.6.20.7 Only gas cylinders, reusable shipping containers, and their accessories shall be permitted to be stored in rooms containing central supply systems or gas cylinders.

5.3.6.20.8 No flammable materials, cylinders containing flammable gases, or containers containing flammable liquids shall be stored in rooms with gas cylinders.

5.3.6.20.9 Indoor enclosures shall not communicate directly with medical gas (i.e., oxygen and nitrous oxide) use points or storage locations for oxidizers.

5.3.6.20.10 Outdoor enclosures that are adjacent to a building wall shall be located such that the distance to any window or door of the adjacent building is greater than 3.05 m (10 ft).

5.3.6.20.11 Enclosures for Category 3 medical gas source equipment shall be provided with doors or gates.

5.3.6.21 Category 3 Medical Gas Source Equipment (Oxygen and Nitrous Oxide).

5.3.6.21.1 Mechanical means shall be provided to ensure that the medical gas source equipment is connected to the correct medical gas distribution piping system.

5.3.6.21.2 Cylinder valve outlets for oxygen and nitrous oxide shall comply with CGA V-1, Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections.

5.3.6.21.3 Threaded connections to manifolds shall comply with CGA V-5, Diameter-Index Safety System (Non-Interchangeable Low Pressure Connections for Medical Gas Applications).

5.3.6.21.4 A check valve shall be provided downstream of each pressure regulator.

5.3.6.21.5 A pressure relief valve set at 50 percent above the normal line pressure shall be located downstream of the check valve in 5.3.6.21.4.

5.3.6.21.6 Pressure relief valves shall be brass, bronze, or stainless steel and designed for oxygen service.

5.3.6.21.7 Hoses and flexible connectors shall have a gauge pressure rating not less than 6895 kPa (1000 psi).
5.3.6.21.8 Materials used in central supply systems shall meet the following requirements:

(1) In those portions of systems intended to handle oxygen at gauge pressures equal to or greater than 2413 kPa (350 psi), interconnecting hose shall contain no polymeric materials.

(2) In those portions of systems intended to handle oxygen or nitrous oxide material construction shall be compatible with oxygen under the temperatures and pressures to which the components can be exposed.

(3) If potentially exposed to cryogenic temperatures, materials shall be designed for low temperature service.

(4) If intended for outdoor installation, materials shall be installed per the manufacturer’s requirements.

5.3.6.21.9 Flexible connectors of other than all-metal construction that connect manifolds to the gas distribution piping shall not exceed 1.52 m (5 ft) in length and shall not penetrate walls, floors, ceilings, or partitions.

5.3.6.21.10 Medical gas source equipment that serves one or two treatment facilities shall include two banks of one or more cylinders of oxygen and (if used) two banks of one or more cylinders of nitrous oxygen, each bank containing at least an average day's supply.

5.3.6.21.11 The two banks of each medical gas source shall be manifolded so that either bank can supply its distribution piping system.

5.3.6.21.12 Where the source equipment is remote from a single treatment facility, when an “in use” bank is unable to supply the system, the manifold shall automatically switch to the secondary bank.

5.3.6.21.13 Where the source equipment serves multiple treatment facilities, when an “in use” bank is unable to supply the system, the manifold shall automatically switch to the secondary bank.

5.3.6.21.14 Where the source equipment is not remote and is accessible from a single treatment facility served, when an “in use” bank is unable to supply the system, the manifold can be manually (or automatically) switched to the secondary bank.

5.3.6.22 Category 3 Warning Systems.

5.3.6.22.1 Warning systems for medical gas systems (i.e., oxygen and nitrous oxide) in Category 3 facilities shall provide the following alarms:

(1) Oxygen main line pressure low
(2) Oxygen main line pressure high
(3) Oxygen changeover to secondary bank or about to changeover (if automatic)
(4) Nitrous oxide main line pressure low
(5) Nitrous oxide main line pressure high
(6) Nitrous oxide changeover to secondary bank or about to changeover (if automatic)

5.3.6.22.2 Warning systems shall have at least one single alarm panel in each treatment facility served by the medical gas source equipment.

5.3.6.22.3 Alarm panels shall be located in an area of continuous surveillance while the facility is in operation.

5.3.6.22.4 Pressure switches/sensors that monitor main line pressure shall be mounted at the source equipment with pressure alarm indicators (lamp or LED) at the alarm panel.

5.3.6.22.5 Audible and noncancelable alarm visual signals shall indicate if the pressure in the main line increases or decreases 20 percent from the normal operating pressure.

5.3.6.22.6 Visual indications shall remain until the situation that caused the alarm is resolved.
5.3.6.22.7 Pressure switches/sensors shall be installed downstream of any emergency shutoff valves and any other shutoff valves in the system and shall cause an alarm for the medical gas if the pressure decreases or increases 20 percent from the normal operating pressure.

5.3.6.22.8 A cancelable audible indication of each alarm condition that produces a sound at the alarm panel shall re-initiate the audible signal if another alarm condition occurs while the audible signal is silenced.

5.3.6.23 Performance Criteria and Testing — Category 3 Medical Gases (Oxygen and Nitrous Oxide).

5.3.6.23.1 General.

5.3.6.23.1.1 Inspection and testing shall be performed on all new piped medical gas systems (i.e., oxygen and nitrous oxide) additions, renovations, temporary installations, or repaired systems to assure the facility, by a documented procedure, that all applicable provisions of this code have been adhered to and system integrity has been achieved or maintained.

5.3.6.23.1.2 The inspection and testing reports shall be submitted directly to the party that contracted for the testing, who shall submit the report through channels to the responsible authority and any others that are required.

5.3.6.23.1.3 Reports shall contain detailed listings of all findings and results.

5.3.6.23.1.4 The responsible facility authority shall review these inspection and testing records prior to the use of any systems to assure that all findings and results of the inspection and testing have been successfully completed.

5.3.6.23.1.5 All documentation pertaining to inspections and testing shall be maintained on-site within the facility.

5.3.6.23.1.6 The responsible facility authority shall review these inspection and testing records prior to the use of all systems to assure that all findings and results of the inspection and testing have been successfully completed.

5.3.6.23.2 Initial Tests for Category 3 Medical Gases (i.e. Oxygen and Nitrous Oxide).

5.3.6.23.2.1 General.

(A) The initial tests required by 5.3.6.23.2 shall be performed prior to the verification tests listed in 5.3.6.23.3 by one or more of the following, who shall be qualified under ASSE 6010, Professional Qualification Standard for Medical Gas Systems Installers:

1. The installer
2. A representative of the system supplier
3. A representative of the system manufacturer
4. A medical gas systems verifier qualified under 5.3.6.23.3.1(A)

(B) The test gas for medical gas systems shall be oil-free, dry nitrogen NF.

(C) Where manufactured assemblies are to be installed, the tests required under 5.3.6.23.2 shall be performed as follows:

1. After completion of the distribution piping
2. Prior to installation or connection of manufactured assemblies having internal flexible hoses or flexible tubing
3. At all station outlets on manufactured assemblies supplied through copper tubing

(D) Where plastic vacuum and scavenging piping systems are installed, they shall be visually inspected for cross-connections to positive-pressure systems prior to applying positive test pressures to the copper piping systems.

5.3.6.23.2.2 Initial Piping Blow Down. Piping in Category 3 medical gas distribution systems
shall be blown clear by a means of oil-free, dry nitrogen NF after installation of the distribution piping but before installation of station outlets and other system components (i.e., pressure alarm devices, pressure indicators, pressure relief valves, manifolds, source equipment).

**5.3.6.23.2.3 Initial Pressure Test.**

(A) Each section of the piping in Category 3 medical gas piping systems shall be pressure tested by a party qualified under 5.3.6.23.2.1(A), using oil-free, dry nitrogen NF.

(B) Initial pressure tests shall be conducted as follows:

1. After blow down of the distribution piping.
2. After installation of station outlets/inlets rough-in assemblies. Test caps shall be permitted to be used.
3. Prior to the installation of components of the distribution piping system that would be damaged by the test pressure (e.g., pressure/vacuum alarm devices, pressure/vacuum indicators, line pressure relief valves).

(C) The source shutoff valves for the piping systems shall remain closed during these tests.

(D) The test pressure for medical gas piping shall be 1.5 times the system working pressure but not less than a gauge pressure of 1035 kPa (150 psi).

(E)* The test pressure shall be maintained until each joint has been examined for leakage by means of an electronic leak detector or a leak detectant that is safe for use with oxygen and does not contain ammonia.

(F) The method of leak testing shall not contain ammonia, which is known to cause stress cracking in copper and copper's alloys.

(G) Leaks, if any, shall be located, repaired (if permitted) or replaced (if required) by the installer, and retested.

**5.3.6.23.2.4 Initial Cross-Connection Test.** A party qualified under 5.3.6.23.2.1(A) shall determine that no cross-connections exist between the various medical gas piping systems (i.e., oxygen and nitrous oxide).

(A) The Category 3 medical gas piping systems shall be at atmospheric pressure.

(B) Face plates for gas outlets shall be installed.

(C) The test gas for medical gas piping systems shall be oil-free, dry nitrogen NF.

(D) The source of test gas shall be connected only to the medical gas piping system being tested.

(E) The medical gas system being tested shall be pressurized to a gauge pressure of 345 kPa (50 psi).

(F) Each individual system gas outlet in each installed medical gas piping system (i.e., oxygen and nitrous oxide) shall be checked to determine that the test gas is being dispensed only from the outlets in the medical gas piping system being tested.

(G) The cross-connection test shall be repeated for each installed medical gas piping system.

(H) The proper labeling and identification of system outlets shall be confirmed during these tests.

**5.3.6.23.2.5 Initial Piping Purge Test.** The outlets in each Category 3 medical gas piping system shall be purged by a party qualified under 5.3.6.23.2.1(A) to remove any particulate
matter from the distribution piping.

(A) The test gas shall be oil-free, dry nitrogen NF.

(B) Using appropriate adapters, each outlet shall be purged with an intermittent high-volume flow of test gas until the purge produces no discoloration in a clean white cloth.

(C) The purging shall be started at the furthest outlet in the system and proceed towards the source equipment.

5.3.6.23.2.6 Initial Standing Pressure Test. [ROC-499] After successful completion of the initial pressure tests under 5.3.6.23.2.3, Category 3 medical gas distribution piping shall be subjected to a standing pressure test by a party qualified under 5.3.6.23.2.1(A).

(A) Tests shall be conducted after the installation of station outlet valve bodies and face plates, and other distribution system components (e.g., pressure alarm devices, pressure indicators, and line pressure relief valves).

(B) The source valve shall be closed during this test.

(C) The piping systems shall be subjected to a 24-hour standing pressure test using oil-free, dry nitrogen NF.

(D) Test pressures shall be 20 percent above the normal system operating line pressure.

(E) At the conclusion of the tests, there shall be no change in the test pressure greater than a gauge pressure of 35 kPa (5 psi).

(F) Leaks, if any, shall be located, repaired (if permitted) or replaced (if required) by the installer, and retested.

5.3.6.23.3 System Verification for Category 3 Medical Gases (i.e. Oxygen and Nitrous Oxide).

5.3.6.23.3.1 General.

(A) Verification tests shall be conducted on Category 3 medical gases (i.e., oxygen and nitrous oxide) by a party technically competent and experienced in the field of medical gas and vacuum system verification and meeting the requirements of ASSE 6030, Professional Qualifications Standard for Medical Gas Systems Verifiers.

(B) Verification testing shall be performed by a party other than the installing contractor, the system supplier, or the system manufacturer.

(C) Verification tests shall be performed only after all tests required in 5.3.6.23.2, have been successfully completed on the medical gas piping systems.

(D) The test gas shall be oil-free, dry nitrogen NF or the system gas where permitted.

(E) All verification tests required under 5.3.6.23.3 shall be performed after installation of any manufactured assemblies having internal hose or tubing.

(F) Where manufactured assemblies with internal tubing or hoses include multiple possible connection points for terminals, each possible connection point shall be tested independently.

(G) For small projects affecting a limited number of areas, where the use of nitrogen is impractical, the system gas shall be permitted to be used for the following tests:

1. Standing pressure (5.3.6.23.3.3)
2. Cross-connection by individual pressurization (5.3.6.23.3.4)
3. Cross-connection by pressure differential (5.3.6.23.3.5)
4. Warning system (5.3.6.23.3.6)
5. Piping purge (5.3.6.23.3.7)
6. Piping particulate (5.3.6.23.3.8)
7. Piping purity (5.3.6.23.3.9)
8. Operational pressure (5.3.6.23.3.10)
All verification test results shall be reported as required in 5.3.6.23.3.1.

5.3.6.23.3.2 Source Equipment Verification.
(A) General. Source equipment verification for Category 3 medical gases (i.e., oxygen and nitrous oxide) shall be performed following the installation of the interconnecting pipelines, accessories, and source equipment.
(B) Use of Source Equipment for Pipeline Verification Tests. Where the source equipment and system gas is permitted to be used for verification testing of the distribution piping, the source equipment shall be verified prior to verification of the distribution piping.
(C) Automatic Changeover. Where medical gas sources include automatic changeover to a secondary bank, the system apparatus shall be tested for proper function, including the changeover from primary to secondary supply (with its changeover alarm signal) before the source equipment is put into service.

5.3.6.23.3.3 Verifier Standing Pressure Test. Category 3 medical gas piping systems (i.e., oxygen and nitrous oxide) shall be subjected to a 10-minute standing pressure test at operating line pressure using the following procedures:
(1) The system source shutoff valve shall be closed unless it is being used as the test gas.
(2) After the system is filled with oil-free, dry nitrogen NF or the system gas, the test source valve shall be closed.
(3) The piping system downstream of the valve shall show no decrease in pressure after 10 minutes.
(4) Any leaks shall be located by the installer, repaired by the installer (if permitted), replaced by the installer (if required), and retested by the verifier.

5.3.6.23.3.4 Verifier Cross-Connection Test by Individual Pressurization. After closing of walls and completion of the requirements of 5.3.6.23.2, it shall be determined that no cross-connections exist between the Category 3 medical gas systems (i.e., oxygen and nitrous oxide) by either use of the following individual pressurization methods or by the pressure differential method in 5.3.6.23.3.5:
(1) Reduce the pressure in all Category 3 medical gas systems to atmospheric
(2) Pressurize one of the Category 3 medical gas piping systems to a gauge pressure of 345 kPa (50 psi) using oil-free, dry nitrogen NF or the system gas
(3) Test each medical gas outlet using appropriate adapters to verify that the test gas pressure is present only at the outlets in the Category 3 medical gas piping system being tested
(4) After it has been verified that a Category 3 medical gas piping system is free of cross-connections, disconnect the source of test gas and reduce the piping to atmospheric pressure
(5) Proceed to test each Category 3 medical gas piping system until each is verified to be free of cross-connections

5.3.6.23.3.5 Verifier Cross-Connection Test by Pressure Differential. After closing of walls and completion of the requirements of 5.3.6.23.2, it shall be determined that no cross-connections exist between the Category 3 medical gas systems (i.e., oxygen and nitrous oxide) by either use of the pressure differential method in 5.3.6.23.3.5(A) through (F) or by the individual pressurization method in 5.3.6.23.3.4.
(A) Reduce the pressure in all Category 3 medical gas systems to atmospheric
(B) The test gas shall be oil-free, dry nitrogen NF or the system gas.
(C) The test gas pressures shall be gauge pressures of 345 kPa (50 psi) for oxygen and 275 kPa
(40 psi) for nitrous oxide, simultaneously maintaining these nominal pressures throughout the test.

(D) Following the adjustment of system pressures in accordance with 5.3.6.23.3.5(C), each station outlet for each medical gas system shall be tested using the gas-specific connection for each system with a test gauge attached to verify that the correct test pressure is present at each outlet of each system.

(E) Each test gauge used in performing this test shall be calibrated with the pressure indicators for the line pressure regulators that provide the test pressures.

(F) Each station outlet shall be identified by label (and color marking, if used), and the pressure indicated on the test gauge shall be that listed in 5.3.6.23.3.5(C) for the system being tested.

5.3.6.23.3.6 Verifier Warning System Tests.

(A) All warning systems that are installed for Category 3 medical gases (i.e., oxygen and nitrous oxide) shall be verified to ensure that all components function correctly prior to placing the system into service.

(B) Permanent records of these tests shall be maintained.

(C) Warning systems that are part of an addition to an existing piping system shall be tested prior to connection of the new piping to the existing system.

(D) Tests of warning systems for new installations shall be performed after the verifier's cross-connection testing (5.3.6.23.3.4 or 5.3.6.23.3.5), but before purging the piping (5.3.6.23.3.7) and performing the remaining verification tests (5.3.6.23.3.8 through 5.3.6.23.3.10).

(E) Test gases shall be either oil-free, dry nitrogen NF or the system gas.

(F) The audible and noncancelable alarm signals in each treatment facility shall be checked to verify that they are in a location that will be continuously attended while the facility is in operation.

(G) The operation of the Category 3 medical gas line pressure alarms required by 5.3.6.22.1 shall be verified.

(H) The operation of the Category 3 changeover alarms, if provided under 5.3.6.22.1, shall be verified.

(I) If automatic changeover is provided under 5.3.6.21.12 or 5.3.6.21.13, audible and noncancelable visual signals shall indicate whenever automatic changeover occurs or is about to occur.

(J) Where Category 3 medical gas systems (i.e., oxygen and nitrous oxide) include other alarm features that are not mandatory in 5.3.6.21, they shall be functionally tested in accordance with their intended purpose and the equipment manufacturer's recommendations.

5.3.6.23.3.7 Verifier Piping Purge Test.

(A) In order to remove any traces of particulate matter deposited in the pipelines as a result of construction, a heavy, intermittent purging of each Category 3 medical gas (i.e., oxygen and nitrous oxide) pipeline shall be done.

(B) The appropriate adapter shall be obtained from the facility or manufacturer, and high purge rates shall be put on each outlet.

(C) After the purge is started, it shall be rapidly interrupted several times until the purge produces no discoloration in a white cloth loosely held over the adapter during the purge.

(D) In order to avoid possible damage to the outlet and its components, this test shall not be conducted using any implement other than the correct adapter.

5.3.6.23.3.8 Verifier Piping Particulate Test. The cleanliness of the piping in each Category 3 medical gas system (i.e., oxygen and nitrous oxide) shall be verified as follows:
The test shall be performed using oil-free, dry nitrogen NF or the system gas.

A minimum of 1000 L (35 ft\(^3\)) of gas shall be filtered through a clean, white 0.45 micron filter at a minimum flow rate of 100 SLPM (3.5 SCFM).

Each zone shall be tested at the outlet most remote from the source.

The filter shall accrue no more than 0.001 g (1 mg) of matter from any outlet tested.

**5.3.6.23.3.9* Verifier Piping Purity Test.** For each Category 3 medical gas system (i.e., oxygen and nitrous oxide), the purity of the piping system shall be verified as follows:

1. These tests shall be performed with oil-free, dry nitrogen NF or the system gas.
2. The outlet most remote from the source shall be tested for total non-methane hydrocarbons and compared to the source gas.
3. If the system gas is used as the source gas, it shall be tested at the source equipment.
4. The difference between the two tests shall in no case exceed 5 ppm of total non-methane hydrocarbons.
5. The difference between the two tests shall in no case exceed 5 ppm halogenated hydrocarbons.
6. The moisture concentration of the outlet test shall not exceed 500 ppm or an equivalent pressure dew point of -12°C (10°F) at a gauge pressure of 345 kPa (50 psi).

**5.3.6.23.3.10 Verifier Operational Pressure Test.**

(A) Operational pressure tests shall be performed at each station outlet in Category 3 medical gas piping systems (i.e., oxygen and nitrous oxide) where the user makes connections and disconnections.

(B) Tests shall be performed using either oil-free, dry nitrogen NF or the system gas.

(C) Medical gas outlets (i.e., oxygen and nitrous oxide) shall deliver 50 SLPM (1.8 SCFM) with a pressure drop of not more than 35 kPa (5 psi) and static pressure of 345 kPa to 380 kPa (50 psi to 55 psi).

**5.3.6.23.3.11* Verifier Gas Concentration Test.** After purging each Category 3 medical gas piping system with the gas of system designation, the following shall be performed:

1. Each medical gas outlet (i.e., oxygen and nitrous oxide) shall be analyzed for concentration of gas, by volume.
2. Analysis shall be conducted with instruments designed to measure the specific gas dispensed.
3. Allowable concentrations shall be as follows:
   (a) Oxygen ≥99 percent oxygen
   (b) Nitrous oxide ≥99 percent nitrous oxide

**5.3.6.23.3.12 Verifier Final Tie-In Test.**

(A) Prior to the connection of any new piping in extensions or additions to an existing piping system, the final tests in 5.3.6.23.3 shall be successfully performed on the new work.

(B) Each joint in the final connection between the new work and the existing system shall be leak-tested with the gas of system designation at the normal operating pressure by means of an electronic leak detector or a leak detectant that is safe for use with oxygen and does not contain
ammonia..

(C) Vacuum joints shall be tested using an ultrasonic leak detector or other means that will permit detection of leaks in an active vacuum system.

(D) Immediately after a final connection is made and leak-tested, the specific altered zone and components in the immediate zone or area that is downstream from the point or area of intrusion shall be purged per 5.3.6.23.3.7.

5.3.6.23.3.13 Verification of Labeling. The labeling and identification of source equipment, shutoff valves, alarm panels, and station outlets for Category 3 medical gas systems (i.e., oxygen and nitrous oxide) shall be verified.

5.3.7* Category 3 Gas-Powered Device Supply Systems (Compressed Air and Nitrogen).

5.3.7.1 General Requirements.

5.3.7.1.1 Category 3 gas-powered device supply systems shall be used to drive dynamic devices, dry surfaces for patient treatment, drive vacuum turbines, remove excess moisture from instruments before further processing, and for other general compressed gas uses in Category 3 facilities.

5.3.7.1.2 Category 3 gas-powered device supply systems shall be permitted to be used to supply power to gas-driven devices for scavenging, but only where the exhaust of the scavenging device is a closed vent to the outside of the building.

5.3.7.1.3* Category 3 gas-powered device supply systems shall be furnished by the equipment manufacturer(s) or supplier(s) who shall be familiar with the proper application of the equipment and shall supervise its installation.

5.3.7.1.4 Installers of Category 3 gas-powered device supply systems shall be experienced in the installation and testing of such systems and the requirements of this code.

5.3.7.2 Piping for Gas-Powered Devices.

5.3.7.2.1 Tubes.

5.3.7.2.1.1 Tubes shall be one of the following:

1. ASTM B 819, Standard Specification for Seamless Copper Tube for Medical Gas Systems, medical gas tube, not less than Type L
2. ASTM B 88, Standard Specification for Seamless Copper Water Tube, water tube, not less than Type L
3. ASTM B 280, Standard Specification for Seamless Copper Tubing for Air Conditioning and Refrigeration Field Service, ACR tube (O.D. size)

5.3.7.2.1.2 Tubing shall be hard temper or annealed (soft temper).

5.3.7.2.2 Fittings. Fittings for Category 3 gas-powered device supply piping shall be one of the following:

1. Brazed or soldered fittings complying with ASME B16.22, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings
2. Brazed fittings complying with ASME B16.50, Wrought Copper and Copper Alloy Brazed-Joint Pressure Fittings
3. Brazed fittings complying with ASME B16.22, Wrought Copper and Copper Alloy Brazed-Joint Pressure Fittings
Solder-Joint Pressure Fittings, with socket depths equal to or greater than ASME B16.50 braze-joint pressure fittings
(4) Flared fittings complying with ASME B16.26, Cast Copper Alloy Fittings for Flared Copper Tubes
(5) Compression fittings (¾ in. maximum size)
(6) Special purpose fittings that are permitted for Category 1 medical gas piping.

5.3.7.2.3.1 Joints for Category 3 gas-powered device supply piping shall be brazed, soldered, threaded, flared, or the compression type.
5.3.7.2.3.2 Where joints are brazed, they shall comply with the requirements for Category 3 medical gas piping in 5.3.6.1 through 5.3.6.10.
5.3.7.2.3.3 Soldered joints in Category 3 gas-powered supply piping shall be made in accordance with ASTM B 828, Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings, using a “lead-free” solder filler metal containing not more than 0.2 percent lead by volume that complies with ASTM B 32, Standard Specification for Solder Metal.

5.3.7.3 Installation of Gas-Powered Device Piping.
5.3.7.3.1 Pipe Sizing. Piping systems shall be designed and sized to deliver the required flow rates at the utilization pressures.
5.3.7.3.2 Protection of Piping. Piping shall be protected in accordance with 5.3.6.11.4.
5.3.7.3.3 Pipe Support. Pipe support shall be in accordance with 5.3.6.12.
5.3.7.3.4 Underground Piping Outside of Buildings. Buried piping outside of buildings shall be in accordance with 5.3.6.13.
5.3.7.3.5 Underground Piping Within Buildings. Underground piping within buildings shall be in accordance with 5.3.6.14.
5.3.7.3.6 Piping Within Floor Slabs.
5.3.7.3.6.1 Category 3 gas-powered device piping (i.e., compressed air and nitrogen) that is installed within floor slabs shall be enclosed in a conduit, flexible plastic tubing, or other means to prevent contact between the copper tubing and concrete.
5.3.7.3.6.2 During construction, access shall be provided at any joints for visual inspection and leak testing.
5.3.7.4 Valves in Gas-Powered Device Piping. Shutoff valves shall be permitted to be installed.
5.3.7.5 Location of Gas-Powered Device Source Equipment.
5.3.7.5.1 Source equipment for Category 3 gas-powered devices shall be one or more of the following:
   (1) One or more air compressors
   (2) One or more air compressors with compressed air cylinders
   (3) Nitrogen cylinders
5.3.7.5.2 Air compressors for Category 3 gas-powered devices shall be installed in a designated mechanical equipment area, heated and ventilated in accordance with 5.1.3.3.2 and 5.1.3.3.3 and have required utilities (e.g., electrical power, drains, lighting, etc.).
5.3.7.5.3 Where nitrogen or compressed air in cylinders is used, the cylinders shall be permitted to be located in a compressor equipment room.
5.3.7.5.4 Nitrogen and compressed air cylinders shall be permitted to be located in enclosures for Category 3 medical gases (i.e., oxygen and nitrous oxide).

5.3.7.6 Air Compressor Source Equipment.

5.3.7.6.1 General. Category 3 compressed air compressor supply systems shall include the following:

(1) Disconnect switch(es)
(2) Motor-starting device(s)
(3) Motor overload protection device(s)
(4) One or more compressors
(5) For single, duplex, or multiple compressor systems, a means for activation/de-activation of each individual compressor
(6) When multiple compressors are used, manual or automatic means to alternate individual compressors
(7) When multiple compressors are used, manual or automatic means to activate the additional unit(s) should the in-service unit(s) be incapable of maintaining adequate pressure
(8) Intake filter–muffler(s) of the dry type
(9) Receiver(s) with a manual or automatic drain
(10) Shutoff valves
(11) Compressor discharge check valve(s) (for multiple compressors)
(12) Air dryer(s) that maintain a minimum of 40 percent relative humidity at operating pressure and temperature
(13) In-line final particulate/coalescing filters rated at 0.01 micron with filter status indicator to ensure the delivery of compressed air with a maximum allowable 0.05 ppm liquid oil
(14) Pressure regulator(s)
(15) Pressure relief valve
(16) Pressure indicator
(17) Moisture indicator

5.3.7.6.2 Receiver(s).

5.3.7.6.2.1 Receiver(s) shall have the capacity to prevent short cycling of the compressor(s).

5.3.7.6.2.2 Receiver(s) shall comply with Section VIII, “Unfired Pressure Vessels,” of the ASME Boiler and Pressure Vessel Code.

5.3.7.6.3* Moisture Indicator.

5.3.7.6.3.1 The moisture indicator shall be located in the active air stream prior to or after the receiver and upstream of any system pressure regulators.

5.3.7.6.3.2 The moisture indicator shall indicate (i.e., by color change, digital readout, or other method understood by the user) when the relative humidity of the compressed air exceeds 40 percent at line pressure and temperature.

5.3.7.6.4 Pressure Relief Valve Discharge. Pressure relief valves for compressed air systems having less than 84,950 L (3000 ft³) at standard temperature and pressure (STP) shall be permitted to discharged locally indoors in a safe manner that will and not restrict the flow.

5.3.7.6.5* Source of Compressor Intake Air.

5.3.7.6.5.1 Air sources for a compressor(s) located inside the building shall meet the following requirements:

(1) Be located within a space where no chemical-based materials are stored or used
(2) Be located in a space that is not used for patient medical treatment
5.3.7.6.5.2 Air sources for a compressor(s) located outside the building shall be drawn from locations where no contamination from vacuum or scavenging system discharges or particulate matter is anticipated.

5.3.7.7 Compressed Air Cylinder Source Equipment.

5.3.7.7.1 Compressed air cylinders shall be permitted to be installed in enclosures for Category 3 medical gases (i.e., oxygen and nitrous oxide) as described in 5.3.6.20.2 or in a mechanical room.

5.3.7.7.2 Compressed air cylinder source equipment shall include the following:

1. One or more cylinders of compressed air, each providing at least an average day's supply
2. A manifold if primary and secondary cylinders are provided
3. A line pressure regulating valve
4. A check valve downstream from the pressure regulating valve
5. A pressure relief valve set at 50 percent above the normal line pressure and located downstream from the check valve in (4)

5.3.7.7.3 Mechanical means shall be provided to ensure that the compressed air cylinder gas source equipment is connected to the correct gas distribution piping system.

5.3.7.7.4 Threaded connections to manifolds shall comply with CGA V-5, Diameter-Index Safety System (Non-Interchangeable Low Pressure Connections for Medical Gas Applications).

5.3.7.7.5 Flexible connectors shall have a gauge pressure rating not less than 6895 kPa (1000 psi).

5.3.7.7.6 Flexible connectors of other than all-metal construction that connect manifolds to the gas distribution piping shall not exceed 1.52 m (5 ft) in length and shall not penetrate walls, floors, ceilings, or partitions.

5.3.7.7.7 Pressure relief valves for compressed air cylinder systems having less than 84,950 L (3000 ft³) at STP shall be permitted to discharged locally indoors in a safe manner that will not restrict the flow.

5.3.7.8* Nitrogen Source Equipment.

5.3.7.8.1 Nitrogen source equipment shall be permitted to be installed in enclosures for Category 3 medical gases (i.e., oxygen and nitrous oxide) as described in 5.3.6.20.2 or in a mechanical room.

5.3.7.8.2 Nitrogen source equipment shall include the following:

1. One or more cylinders of nitrogen NF, each providing at least an average day's supply
2. A manifold if primary and secondary cylinders are provided
3. A line pressure regulating valve
4. A check valve downstream from the pressure regulating valve
5. A pressure relief valve set at 50 percent above the normal line pressure and located downstream from the check valve in (4)
6. The pressure relief valve discharge piped to outdoors at a point that will not create a probable hazard and is turned down to prevent the entry of rain or snow

5.3.7.8.3 Mechanical means shall be provided to ensure that the nitrogen gas source equipment is connected to the correct gas distribution piping system.

5.3.7.8.4 Cylinder valve outlets for nitrogen shall comply with CGA V-1, Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections.
5.3.7.8.5 Threaded connections to manifolds shall comply with CGA V-5, *Diameter-Index Safety System (Non-Interchangeable Low Pressure Connections for Medical Gas Applications)*.

5.3.7.8.6 Flexible connectors shall have a gauge pressure rating not less than 6895 kPa (1000 psi).

5.3.7.8.7 Flexible connectors of other than all-metal construction that connect manifolds to the gas distribution piping shall not exceed 1.52 m (5 ft) in length and shall not penetrate walls, floors, ceilings, or partitions.

5.3.8 Category 3 Vacuum and Scavenging Systems.

5.3.8.1 General Requirements.

5.3.8.1.1 Category 3 vacuum and scavenging systems shall be furnished by equipment manufacturer(s) or supplier(s) who are familiar with the proper application of the equipment and shall be installed under their supervision.

5.3.8.1.2 Installers of Category 3 vacuum and scavenging systems shall be experienced in the installation and testing of such systems and the requirements of this code.

5.3.8.1.3 Any water supply and drain piping associated with vacuum or scavenging source equipment shall comply with the locally adopted plumbing code.

5.3.8.2 Piping for Vacuum and Scavenging Systems.

5.3.8.2.1 Piping for Category 3 vacuum and scavenging shall be copper, PVC plastic, or CPVC plastic.

5.3.8.2.2 Copper piping shall comply with the requirements for Category 3 gas-powered supply piping as follows:

1. Copper tubing shall be in accordance with 5.3.7.2.1.
2. Copper fittings shall be in accordance with 5.3.7.2.2.
3. Joints in copper tubing shall be in accordance with 5.3.7.2.3.

5.3.8.2.3 PVC plastic piping shall be in accordance with the following:

1. PVC plastic pipe shall be Schedule 40 or Schedule 80, complying with ASTM D 1785, *Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedule 40, 80, and 120*.
2. PVC plastic fittings shall be Schedule 40 or Schedule 80 to match the pipe, complying with ASTM D 2466, *Poly (Vinyl Chloride) (PVC) Pipe Fittings, Schedule 40*, or ASTM D 2467, *Poly (Vinyl Chloride) (PVC) Pipe Fittings, Schedule 80*.
3. Joints in PVC plastic piping shall be solvent cemented in accordance with ASTM D 2672, *Joints in IPS PVC Pipe Using Solvent Cement*.

5.3.8.2.4 CPVC plastic piping shall be iron pipe size (IPS) or copper tube size (CTS) in accordance with the following:

1. CPVC IPS plastic pipe shall be Schedule 40 or Schedule 80, complying with ASTM F 441, *Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80*.
2. CPVC IPS plastic fittings shall be Schedule 40 or Schedule 80 to match the pipe, complying with ASTM F 438, *Socket-Type Chlorinated Poly (Vinyl Chlorinated) (CPVC) Plastic pipe Fittings, Schedule 40*, or ASTM F 439, *Chlorinated Poly (Vinyl Chlorinated) (CPVC) Plastic Pipe Fittings, Schedule 80*. 
(3) CPVC CTS plastic pipe and fittings 1/2” through 2” size shall be SDR 11 and comply with ASTM D 2846, Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Hot and Cold Water Distribution Systems.

(4) Solvent cement for joints in CPVC plastic piping shall be comply with ASTM F 493 Solvent Cements for CPVC Pipe and Fittings.

5.3.8.3 Installation of Vacuum and Scavenging Piping.

5.3.8.3.1 Pipe Sizing. Piping systems shall be designed and sized to draw the required flow rates at the utilization vacuums.

5.3.8.3.2 Protection of Piping. Piping shall be protected in accordance with 5.3.6.11.4.

5.3.8.3.3 Copper Pipe Support. Pipe support for copper piping shall be in accordance with 5.3.6.12.

5.3.8.3.4 Plastic Pipe Support. The maximum support spacing for plastic pipe shall be in accordance with Table 5.3.8.3.4.

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Hanger Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mm</td>
</tr>
<tr>
<td>DN15 (NPS 1/2) (7/8 in. O.D.)</td>
<td>1220</td>
</tr>
<tr>
<td>DN20 (NPS 3/4) (7/8 in. O.D.)</td>
<td>1220</td>
</tr>
<tr>
<td>DN25 (NPS 1) (1 1/8 in. O.D.)</td>
<td>1320</td>
</tr>
<tr>
<td>DN32 (NPS 1 1/4) (1 5/8 in. O.D.)</td>
<td>1320</td>
</tr>
<tr>
<td>DN40 (NPS 1 1/2) (1 7/8 in. O.D.)</td>
<td>1420</td>
</tr>
<tr>
<td>DN50 (NPS 2) (2 3/8 in. O.D.)</td>
<td>1420</td>
</tr>
<tr>
<td>DN65 (NPS 2 1/2) (2 7/8 in. O.D.) and larger</td>
<td>1520</td>
</tr>
<tr>
<td>Vertical risers, all sizes</td>
<td></td>
</tr>
<tr>
<td>Every floor, but not to exceed</td>
<td>3040</td>
</tr>
</tbody>
</table>

5.3.8.3.5 Underground Piping Outside of Buildings. Buried piping outside of buildings shall be in accordance with 5.3.6.13.

5.3.8.3.6 Underground Piping Within Buildings. Underground piping within buildings shall be in accordance with 5.3.6.14.

5.3.8.3.7 Piping Within Floor Slabs.

5.3.8.3.7.1 Copper Category 3 vacuum and scavenging piping that is installed within floor slabs shall be enclosed in a conduit, flexible plastic tubing, or other means to prevent contact between the copper tubing and concrete.

5.3.8.3.7.2 Plastic Category 3 vacuum and scavenging piping shall be permitted to contact concrete.

5.3.8.3.7.3 During construction, access shall be provided at all joints for visual inspection and leak testing.

5.3.8.3.7.4 Care shall be taken to protect plastic piping from damage from vibrators while wet concrete is being consolidated.

5.3.8.3.8 Valves in Vacuum and Scavenging Systems. Shutoff valves shall be permitted to be installed.
5.3.8.3.9* Category 3 Vacuum and Scavenging Source Equipment.

5.3.8.3.9.1 Category 3 vacuum sources shall include the following:

1. A vacuum pump or pumps suited for wet or dry service as intended in the system design.
2. If intended for wet service, a properly vented liquid/air separator.

5.3.8.3.9.2 Category 3 vacuum and scavenging source equipment shall be obtained from and be installed under the supervision of the manufacturer(s) or supplier(s) who are familiar with its installation, operation, and use.

5.3.8.3.10 Drainage from Vacuum Equipment. None of the following requirements for drainage in Category 3 vacuum systems shall supersede provisions of the local plumbing code.

5.3.8.3.10.1 Liquids drained from a Category 3 vacuum source shall discharge indirectly to a sanitary drainage system through an approved air gap to a trapped and vented drain.

5.3.8.3.10.2 The clear air gap between a vacuum drain outlet or indirect drain pipe and the flood category rim of an indirect waste receptor or other point of disposal shall be not less than twice the diameter of the effective opening of the drain served, but not less than 25.4 mm (1 in.) unless the local plumbing code requires a larger air gap.

5.3.8.3.10.3 Where the drainage is from a waste holding tank on the suction side of the vacuum source, the following requirements shall be met:

1. A check valve shall be installed in the drain line from the holding tank between the tank and any vent lines.
2. The trap in the building drainage system shall be the deep-seal type that is conventionally vented within the plumbing system.
3. An additional vent shall be installed between the holding tank drain check valve and the drain trap, on the inlet side of the trap, to close and seal the check valve while the holding tank is operating under vacuum and collecting waste.
4. The additional vent described in 5.3.8.3.10.3(3) shall be permitted to be connected to the plumbing system vents unless a drain pump system with a positive-pressure discharge is installed, in which case 5.3.8.3.10.4 shall apply.
5. Both of the vents in 5.3.8.3.10.3(3) and 5.3.8.3.10.3(4) shall extend vertically to not less than 152 mm (6 in.) above the top of the holding tank before turning horizontal.
6. Outdoor vents shall be protected against the entry of insects, vermin, debris, and precipitation.
7. The trap and drain branch shall be not less than two pipe sizes larger than the waste pipe from the separator but not less than DN50 (NPS 2).
8. The trap seal shall be not less than 100 mm (4 in.) deep.
9. The vent for the vacuum check valve shall be not less than the size of the check valve.
10. The vent for the trap shall be not less than one-half the size of the trap and drain branch.

5.3.8.3.10.4* Where the drainage is from a waste holding tank on the suction side of the vacuum source and a positive discharge pump drain system is in place, the following requirements shall be met:

1. The pump shall drain indirectly to the plumbing system through an air gap of the diameter of the discharge pipe but not less than 25.4 mm (1 in.) above the rim.
2. A check valve shall be installed in the drain line from the holding tank to the drain.
3. The trap in the building drainage system shall be the deep-seal type that is conventionally vented within the plumbing system.
4. The trap and drain branch shall be not less than two pipe sizes larger than the waste pipe from the separator but not less than DN40 (NPS 1½).
(5) The trap seal shall be at least two times the exhaust back pressure in the separator but not less than 100 mm (4 in.) deep.

5.3.8.3.10.5 Where the drainage is at a positive pressure from an air/waste separator on the discharge side of the vacuum source, the following requirements shall be met:

1. Where there is a positive-pressure discharge from a vacuum pump, it is required to drain through an air/waste separator.

2. Discharge shall be either of the following:
   a. Direct into a trap in the building drainage system that is the deep-seal type and is conventionally vented within the plumbing system
   b. Indirect to the plumbing system through an air gap of the diameter of the discharge pipe but not less than 25.4 mm (1 in.) above the rim

3. The trap vent shall extend vertically to not less than 152 mm (6 in.) above the top of the separator before turning horizontal.

4. Outdoor vents shall be protected against the entry of insects, vermin, debris, and precipitation.

5. The trap and drain branch shall be not less than two pipe sizes larger than the waste pipe from the separator but not less than DN40 (NPS 1½).

6. The air/waste separator vent shall be the full size of the separator vent connection.

7. The separator vent shall be separate from the building vent piping.

5.3.8.3.10.6 The indirect drainage from vacuum equipment shall discharge to the sanitary drainage system through an approved air gap without causing overflow or splatter on building surfaces.

5.3.8.3.11 Vacuum Exhaust. The exhaust from Category 3 vacuum and scavenging sources shall comply with the following:

1. The exhaust shall be piped to the outside through a separate vent system.

2. The exhaust point shall be chosen to minimize the hazards of noise.

3. The exhaust point shall be remote from any door, window, or other opening into the building.

4. The exhaust point shall be located at a different elevation than air intakes.

5. The exhaust point shall not be located where affected by prevailing winds, adjacent buildings, topography, or other obstacles to the rapid dispersion of the exhaust gases.

6. The exhaust point shall be protected against the entry of insects, vermin, debris, and precipitation.

7. The exhaust piping shall be sized to prevent back pressure greater than the pump manufacturer's recommendations.

8. Where multiple pumps exhaust through a common pipe, each pump shall be fitted with a check valve, a manual isolation valve, or shall be arranged to permit capping the individual pump exhausting when a pump is removed for service.

9. Where multiple pumps exhaust through a common pipe, piping shall be arranged following the pump manufacturer's recommendations.

5.3.9.1 General.
5.3.9.1.1 Inspection and testing shall be performed on all new piped Category 3 gas-powered device supply systems (i.e., compressed air and nitrogen), Category 3 systems vacuum, and Category 3 systems scavenging, additions, renovations, temporary installations, or repaired systems to assure the facility, by a documented procedure, that all applicable provisions of this document have been adhered to and system integrity has been achieved or maintained.
5.3.9.1.2 The inspection and testing reports shall be submitted directly to the party that contracted for the testing, who shall submit the report through channels to the responsible authority and any others that are required.
5.3.9.1.3 Reports shall contain detailed listings of all findings and results.
5.3.9.1.4 The responsible facility authority shall review these inspection and test records prior to the use of any systems to assure that all findings and results of the inspections and tests have been successfully completed.
5.3.9.1.5 All documentation pertaining to inspections and testing shall be maintained on-site within the facility.
5.3.9.1.6 Before piping systems are initially put into use, the Category 3 health care facility authority shall be responsible for ascertaining that the gas/vacuum delivered at each outlet/inlet is that shown on the outlet/inlet label and that the proper connecting fittings are installed for the specific gas or vacuum.

5.3.9.2 Initial Testing of Category 3 Gas-Powered Device Supply Systems, Category 3 Vacuum Systems, and Category 3 Scavenging Systems.

5.3.9.2.1 General.
5.3.9.2.1.1 The initial tests required by 5.3.9.2 shall be performed prior to the final tests required by 5.3.9.3.
5.3.9.2.1.2 Initial tests shall be conducted by one or more of the following who shall be experienced in the installation, operation, and testing of Category 3 gas-powered device supply systems, vacuum systems, and scavenging systems:
   (1) The installer
   (2) A representative of the system supplier
   (3) A representative of the system manufacturer
   (4) A medical gas system's verifier qualified under 5.3.6.23.3.1(A)
5.3.9.2.1.3 The test gas for Category 3 gas-powered device supply systems shall be oil-free, dry nitrogen NF or the system gas.
5.3.9.2.1.4 Where manufactured assemblies are to be installed, the initial tests required under 5.3.9.2 shall be performed as follows:
   (1) After completion of the distribution piping
   (2) Prior to installation or connection of manufactured assemblies having internal tubing or hoses.
   (3) At all outlets and inlets on manufactured assemblies having internal copper tubing
5.3.9.2.2 Blow Down. Piping in Category 3 gas-powered device supply systems shall be blown clear using oil-free, dry nitrogen NF as follows:
   (1) After installation of the distribution piping
   (2) After installation of outlet shutoff valves
   (3) Before connection to the use points
   (4) Before installation of system components (e.g., pressure indicators, pressure relief valves, manifolds, source equipment)
5.3.9.2.3 Initial Pressure Test for Copper Piping Systems.
5.3.9.2.3.1 Each section of the piping in Category 3 gas-powered device supply systems, copper vacuum, and copper scavenging systems shall be pressure tested using oil-free, dry nitrogen NF or the system gas.
5.3.9.2.3.2 Initial pressure tests shall be conducted as follows:
   (1) After blow down of the distribution piping
   (2) After installation of outlet and inlet shutoff valves
   (3) Prior to the installation of components of the distribution piping system that would be damaged by the test pressure (e.g., pressure/vacuum indicators, line pressure relief valves)
5.3.9.2.3.3 The source shutoff valves for the piping systems shall remain closed during these tests unless being used for the pressure test gas.
5.3.9.2.3.4 The test pressure shall be 1.5 times the system working pressure but not less than a gauge pressure of 1035 kPa (150 psi).
5.3.9.2.3.5 The test pressure shall be maintained until each joint has been examined for leakage by means of an electronic leak detector or a leak detectant that is safe for use with oxygen and does not contain ammonia.
5.3.9.2.3.6 Leaks, if any, shall be located, repaired (if permitted) or replaced (if required) by the installer, and retested.

5.3.9.2.4 Initial Leak Test for Category 3 Plastic Vacuum and Scavenging Piping Systems.
5.3.9.2.4.1 Each section of the piping in Category 3 vacuum and scavenging systems with plastic piping shall be leak tested using a test vacuum or the vacuum source equipment.
5.3.9.2.4.2 If installed, the vacuum source shutoff valves for the piping systems shall remain closed during these tests unless being used for the leak test vacuum source.
5.3.9.2.4.3 The leak test vacuum shall be a minimum of 300 mm (12 in.) HgV.
5.3.9.2.4.4 The test vacuum shall be maintained until each joint has been examined for leakage by means of an electronic leak detector or a leak detectant that is safe for use with oxygen and does not contain ammonia.
5.3.9.2.4.5 Leaks, if any, shall be located, repaired or replaced (if required) by the installer, and retested.

5.3.9.2.5 Initial Cross-Connection Test for Copper Piping Systems.
5.3.9.2.5.1 Tests shall be conducted to determine that no cross-connections exist between the Category 3 gas-powered device supply piping systems (i.e., compressed air and nitrogen), copper Category 3 vacuum piping systems, and copper Category 3 scavenging piping systems.
5.3.9.2.5.2 The piping systems shall be at atmospheric pressure.
5.3.9.2.5.3 The test gas shall be oil-free, dry nitrogen NF or compressed air.
5.3.9.2.5.4 The source of test gas shall be connected only to the piping system being tested.
5.3.9.2.5.5 The piping system being tested shall be pressurized to a gauge pressure of 345 kPa (50 psi).
5.3.9.2.5.6 The individual system gas outlet and vacuum inlet in each installed gas-powered device and copper vacuum/scavenging piping system shall be checked to determine that the test gas pressure is present only at the piping system being tested.
5.3.9.2.5.7 The cross-connection test shall be repeated for each installed Category 3 piping system for gas-powered devices, and for vacuum and scavenging with copper piping.
5.3.9.2.5.8 The proper labeling and identification of system outlets/inlets shall be confirmed during these tests.

5.3.9.2.6 Initial Cross-Connection Test for Category 3 Plastic Vacuum and Scavenging Piping Systems.
5.3.9.2.6.1 Tests shall be conducted to determine that no cross-connections exist between any plastic Category 3 vacuum piping systems or plastic Category 3 scavenging piping systems, and any Category 3 gas-powered device supply systems.
5.3.9.2.6.2 The vacuum source shutoff valves for the vacuum piping systems shall remain closed during these tests unless they are being used for the cross-connection test vacuum source.
5.3.9.2.6.3 The cross-connection test vacuum shall be a minimum of 300 mm (12 in.) HgV.
5.3.9.2.6.4 The source of test vacuum shall be connected only to the vacuum piping system being tested.
5.3.9.2.6.5 The individual gas-powered device system gas outlets and vacuum/scavenging system inlets shall be checked to determine that the test vacuum is only present at the vacuum/scavenging piping system being tested.
5.3.9.2.6.6 The cross-connection tests shall be repeated for each installed vacuum and scavenging system with plastic piping.
5.3.9.2.6.7 The proper labeling and identification of system outlets/inlets shall be confirmed during these tests.

5.3.9.2.7 Initial Piping Purge Test for Gas-Powered Device Systems.
5.3.9.2.7.1 The outlets in each Category 3 gas-powered device supply piping system shall be purged to remove any particulate matter from the distribution piping.
5.3.9.2.7.2 The test gas shall be oil-free, dry nitrogen NF or the system gas.
5.3.9.2.7.3 Each outlet shall be purged with an intermittent high-volume flow of test gas until the purge produces no discoloration in a clean white cloth.
5.3.9.2.7.4 The purging shall be started at the furthest outlet in the system and proceed towards the source equipment.

5.3.9.2.8 Initial Standing Pressure Test for Gas-Powered Device Systems Piping. After successful completion of the initial pressure tests under 5.3.9.2.3, Category 3 gas-powered device distribution piping shall be subjected to a standing pressure test.
5.3.9.2.8.1 Tests shall be conducted after the installation of outlet valves and other distribution system components (e.g., pressure indicators and line pressure relief valves).
5.3.9.2.8.2 The source valve shall be closed unless the source gas is being used for the test.
5.3.9.2.8.3 The piping systems shall be subjected to a 24-hour standing pressure test using oil-free, dry nitrogen NF or the system gas.
5.3.9.2.8.4 Test pressures shall be 20 percent above the normal system operating line pressure.
5.3.9.2.8.5 At the conclusion of the tests, there shall be no change in the test pressure greater than a gauge pressure of 35 kPa (5 psi).
5.3.9.2.8.6 Leaks, if any, shall be located, repaired (unless prohibited) or replaced (if required) by the installer, and retested.

5.3.9.3.1 General.
5.3.9.3.1.1 Final testing of gas-powered device systems, vacuum systems, and scavenging systems shall be performed only after all initial tests required by 5.3.9.2 have been performed.
5.3.9.3.1.2 The final tests required by 5.3.9.3.2 through 5.3.9.3.6 shall be performed by one or
more of the following who shall be experienced with the installation, operation, and testing of Category 3 gas-powered device supply systems, vacuum systems, and scavenging systems:

1. The installer
2. A representative of the system supplier
3. A representative of the system manufacturer
4. A medical gas systems verifier qualified under 5.3.6.23.3.1(A)

5.3.9.3.1.3 The test gas shall be oil-free, dry nitrogen NF or the system gas or vacuum.

5.3.9.3.2 Final Standing Pressure Test (Category 3 Gas-Powered Devices). Each gas-powered device piping system shall be subjected to a 10-minute standing pressure test at operating line pressure using the following procedures:

1. After the system is filled with oil-free, dry nitrogen NF or the system gas, the source valve shall be closed.
2. The piping system downstream of the valve shall show no decrease in pressure after 10 minutes.
3. Any leaks found shall be located, repaired (unless prohibited) or replaced (if required) by the installer, and retested.

5.3.9.3.3 Final Standing Vacuum Test (Category 3 Vacuum and Scavenging Systems). Each Category 3 vacuum and scavenging piping system shall be subjected to a 10-minute standing vacuum test at operating line vacuum using the following procedures:

1. After the system has stabilized at the operating line vacuum, the source valve and any zone valves shall be closed.
2. The piping system upstream of the valves shall show no decrease in vacuum after 10 minutes.
3. Leaks, if any, shall be located, repaired (unless prohibited) or replaced (if required) by the installer, and retested.

5.3.9.3.4 Final Cross-Connection Test (Category 3 Gas-Powered Devices and Vacuum and Scavenging Systems). After closing of walls and completion of the requirements of 5.3.9.2, it shall be determined that no cross-connections exist between the piping systems for Category 3 gas-powered devices and vacuum and scavenging systems using the following method:

1. Test each piping system independently, starting with the vacuum and scavenging systems first, and check that the test vacuum is present only at inlets of the system being tested.
2. Reduce all piping systems to atmospheric pressure.
3. Operate the Category 3 vacuum or scavenging system being tested at the normal system vacuum, using the source equipment.
4. Each Category 3 gas-powered device gas outlet and vacuum or scavenging inlet shall be tested with appropriate adapters to verify that vacuum is present only at the vacuum inlets in the system being tested and not at any gas-powered device gas outlets or inlets of other vacuum or scavenging systems.
5. Shut down the vacuum source equipment and slowly break the vacuum in the vacuum piping system, increasing its pressure to atmospheric.
6. Test each Category 3 vacuum and scavenging system until all are determined to be free of cross-connections.
7. Using oil-free, dry nitrogen NF or the system gas, pressurize the gas-powered device piping system to a gauge pressure of 345 kPa (50 psi).
8. Test each gas-powered device gas outlet using appropriate adapters to verify that the
test gas pressure is present only at the outlets in the gas-powered device system being tested.

(9) After it has been determined that a gas-powered device piping system is free of cross-connections, disconnect the source of test gas and reduce the piping to atmospheric pressure.

(10) Proceed to test each gas-powered device piping system until all are determined to be free of cross-connections.

5.3.9.3.5 Final Piping Purge Test (Category 3 Gas-Powered Devices). In order to remove any traces of particulate matter deposited in the pipelines as a result of construction, a heavy, intermittent purging of each gas-powered device pipeline shall be done.

5.3.9.3.5.1 The appropriate adapter shall be obtained from the facility or manufacturer, and high purge rates shall be put on each outlet.

5.3.9.3.5.2 After the purge is started, it shall be rapidly interrupted several times until the purge produces no discoloration in a white cloth loosely held over the adapter during the purge.

5.3.9.3.5.3 In order to avoid possible damage to the outlet and its components, this test shall not be conducted using any implement other than the correct adapter.

5.3.9.3.6 Final Tie-In Test (Category 3 Gas-Powered Devices and Vacuum and Scavenging Systems).

5.3.9.3.6.1 Prior to the connection of any new piping in extensions or additions to an existing piping system, the final tests in 5.3.9.3 shall be successfully performed on the new work.

5.3.9.3.6.2 Each joint in the final connection between the new work and the existing system shall be leak-tested with the gas of system designation or vacuum at the normal operating pressure or vacuum by means of an electronic leak detector or a leak detectant that is safe for use with oxygen and does not contain ammonia.

5.3.9.3.6.3 The method of leak testing shall not contain ammonia, which is known to cause stress cracking in copper and copper’s alloys.

5.3.9.3.6.4 For gas-powered device piping, immediately after a final connection is made and leak-tested, the specific altered zone and components in the immediate zone or area that is downstream from the point or area of intrusion shall be purged per 5.3.9.3.5.

5.3.9.3.7 Source Equipment Testing (Category 3 Gas-Powered Devices and Vacuum and Scavenging Systems).

5.3.9.3.7.1 General. Source equipment checks for Category 3 gas-powered devices and vacuum and scavenging systems shall be performed following the installation of the interconnecting pipelines, accessories, and source equipment.

5.3.9.3.7.2 Use of Source Equipment for Distribution Piping Tests. Where the source equipment and system gas or vacuum is used for testing of the distribution piping, the source equipment shall be checked out and placed in operation prior to testing the distribution piping.

5.3.9.3.7.3 Compliance with Manufacturer's Instructions. The source equipment for Category 3 gas-powered device system(s), vacuum systems, and scavenging systems shall be checked out and placed in operation according to the manufacturer's instructions.

5.3.10 Compressed Gas Cylinders and Containers.

5.3.10.1 Only cylinders and containers constructed, tested, and maintained in accordance with U.S. Department of Transportation specifications and regulations shall be permitted to be used.
5.3.10.2 Cylinder contents shall be identified by attached labels or stencils naming the contents in accordance with CGA C-7, *Guide to the Preparation of Precautionary Labeling and Marking of Compressed Gas Containers*.

5.3.10.3 The contents of cylinders and containers shall be verified prior to use.

5.3.10.4 Labels shall not be defaced, altered, or removed, and connecting fittings shall not be modified.

5.3.11 Labeling and Identification.

5.3.11.1 Pipe Labeling.

5.3.11.1.1 Piping, both exposed and concealed, shall be labeled by stenciling or adhesive markers that identify the system.

5.3.11.1.2 Pipe labels shall show the name of the gas/vacuum system or its chemical symbol.

5.3.11.1.3 Where positive-pressure gas piping systems operate at nonstandard pressures, the pipe labels shall also include the nonstandard operating pressure in addition to the name or symbol of the gas.

5.3.11.1.4 Pipe labels shall be located as follows:

1. At intervals of not more than 6.1 m (20 ft)
2. At least once in or above every room
3. On both sides of walls or partitions penetrated by the piping
4. At least once in every story height on risers

5.3.11.2 Identification of Shutoff Valves. Shutoff valves shall be identified with the following information:

1. Name or chemical symbol for the specific system
2. Name of the room(s) or area(s) served
3. Caution to not close (or open) the valve except in an emergency

5.3.11.3 Identification of Outlets and Inlets. Outlets and inlets shall be identified as to the name or chemical symbol for the specific gas, vacuum, or scavenging provided.

5.3.12* System Use and Instructions.

5.3.12.1 Prohibited System Interconnections.

5.3.12.1.1 Two or more systems for Category 3 medical gas, gas-powered device gas, or vacuum and scavenging shall not be interconnected for testing or any other reason.

5.3.12.1.2 Leak testing shall be accomplished by separately charging and testing each individual piping system.

5.3.12.2 Changes in System Use.

5.3.12.2.1 Where a Category 3 positive-pressure gas piping distribution system originally used or constructed for use at one pressure or for one gas is converted for operation at another pressure or for another gas, all provisions and requirements of Section 5.3 shall apply.

5.3.12.2.2 Piping for Category 3 gas-powered devices or Category 3 vacuum shall not be permitted to be converted for use as a Category 3 medical gas piping system for oxygen or nitrous oxide.

5.3.12.3 System and Equipment Manufacturer's Instructions.

5.3.12.3.1 The installation of individual components shall be made in accordance with the system or equipment manufacturer's instructions.

5.3.12.3.2 Such instructions shall include directions and information deemed necessary by the manufacturer for attaining proper operation, testing, and maintenance of the system.

5.3.12.3.3 Copies of the manufacturer's instructions shall be left with the system owner.

5.3.13 Operation and Management of Category 3 Systems.
5.3.13.1 Precautions for handling cylinders shall be in accordance with Chapter 11.

5.3.13.2 Special Precautions for the Use of Category 3 Gas and Vacuum Piping Systems.
5.3.13.2.1 Category 3 gas piping systems shall not be used for the distribution of flammable anesthetic gases.
5.3.13.2.2 Piping systems for Category 3 gases shall not be used as grounding electrodes.
5.3.13.2.3 Category 3 vacuum piping shall not be used for vacuum steam condensate return or other nonmedical vacuum applications.
5.3.13.2.4 Every Category 3 facility shall establish a procedure for manually turning off the gas supply at the cylinder valves at the end of each work day.
5.3.13.2.5 Emergency shutoff valves or remote actuators shall not be used to turn off the gas supply at the end of the work day.

5.3.13.3 Gas/Vacuum Systems Identification and Warning Signs.

The labeling and identification of Category 3 gas and vacuum systems shall comply with the requirements of 5.3.11.

5.3.13.4 Gas/Vacuum Systems Maintenance and Record Keeping.
5.3.13.4.1 Permanent records of all tests required by 5.3 shall be maintained on-site in the organization's files.
5.3.13.4.2 A periodic testing procedure for Category 3 gas and vacuum systems and related alarm systems shall be implemented.
5.3.13.4.3 Whenever modifications are made that breach the pipeline, any necessary installer and verification test specified in 5.3.9 shall be conducted on the downstream portions of the medical gas piping system.
5.3.13.4.4 A maintenance program shall be established for the following:
   (1) Relief valves in accordance with applicable codes or manufacturer's recommendation
   (2) Drive gas supply system in accordance with the manufacturer's recommendations
   (3) Vacuum source equipment and accessories in accordance with the manufacturer’s recommendations
   (4) Vacuum piping system and the secondary equipment attached to vacuum station inlets to ensure the continued good performance of the entire vacuum system
   (5) Scavenging systems to assure performance
5.3.13.4.5 Audible and visual alarm indicator(s) shall meet the following requirements:
   (1) Be periodically tested to determine that they are functioning properly
   (2) Have the records of the test maintained until the next test is performed

A.5.3 A Category 3 vacuum system is not intended for Category 1 medical–surgical vacuum applications. A Category 3 wet piping system is designed to accommodate liquid, air–gas, and solids through the service inlet. A Category 3 dry piping system is designed to accommodate air–gas only through the service inlet, with liquids and solids being trapped before entering the system.
A.5.3.1 Section 5.1 covers requirements for Category 1 piped gas and vacuum systems, Section 5.2 covers Category 2 piped gas and vacuum systems, and Section 5.3 covers Category 3 piped gas and vacuum systems. Laboratory systems are no longer covered by Chapter 5 (2002 edition).

A.5.3.1.1.1 See Figure A.5.3.1.1.1 for an illustration of single treatment locations.

***Insert FIGURE A.5.3.1.1.1 Examples of Single Treatment Locations here***.

A.5.3.6.8 The intent is to provide an oxygen-free atmosphere within the tubing and to prevent the formation of copper oxide scale during brazing. This is accomplished by filling the piping with a low-volume flow of low-pressure inert gas.

A.5.3.6.11.2 One of the major concerns is the cross-connection of piping systems of different gases. The reason for different sizes is to prevent cross-connections, not for capacity concerns.

A.5.3.6.17 Service outlets can be recessed or otherwise protected from damage.

A.5.3.6.17.1 This configuration will ensure that the required pressure and flow meet the secondary equipment manufacturer's requirements.

A.5.3.6.19.1 See Figure A.5.3.6.19.1 for an illustration of single treatment locations.

****INSERT FIGURE HERE****

FIGURE A.5.3.6.19.1 Examples of Single Treatment Locations.

A.5.3.6.23.2.3(E) Ammonia is known to cause stress cracking in copper and its alloys.

A.5.3.6.23.3.9 The detector used for total hydrocarbons is calibrated with a gas that has a known quantity of methane. When a sample is run with this calibrated detector, the result will be total hydrocarbons as methane. Since methane is the one hydrocarbon that does not interact with the body and is present in all air and most oxygen, the actual amount of methane in the sample is subtracted from the total hydrocarbon result to give total non-methane hydrocarbons.

A.5.3.6.23.3.11 The committee recognizes that current clinical practice is to use analyzers that might not be able to analyze oxygen to current USP requirements of 99 percent and that these analyzers frequently have an error of up to 3 percent.

A.5.3.7 Category 3 drive gas systems are supplied by one or more of the following:

1. Compressed air from compressors
2. Compressed air from cylinders
3. Nitrogen from cylinders

These systems are used primarily to drive gas-powered power devices. See Figure A.5.3.7 for an illustration of this type of system. Similar applications are in podiatry and plastic surgery. Examples of these are air used to drive turbine-powered drills and air used to dry teeth and gums. Some dental hand pieces have an internal self-contained air return system, while other hand pieces discharge air into the atmosphere. Some discharge a mixture of air and water. Nitrogen is often piped as an alternate or reserve supply to the compressor system.
Examples of Single Treatment Facilities

Use points

Use points

Use points

Balcony but access is totally within treatment facility.

Examples of Two Treatment Facilities

Use points location 1

Use points location 2

Hall

Example of adjacent operation but access is from outside hallway.

Example of across-the-hall

Use point 1

Use point 2

Use points

ENT

Use points

ENT

Stairwell

Example of two-level operation – access is from outside stairs.

Figure A.5.3.1.1.1 and Figure A.5.3.6.19.1
Examples of Single Treatment Locations
The application of dental compressed air is not used for life support purposes such as respirators, IPPB machines, analgesia, anesthesia, and so forth. Air discharged into the oral cavity is incidental and not a primary source of air to sustain life.

A dental compressed air system should not be used to provide power for an air-powered evacuation system without specific attention paid to the discharge of the evacuated gases and liquids. An open discharge of evacuated gases into the general environment of an operatory could compromise the quality of breathing air in the treatment facility. Air discharge should be vented to the outside of the building through a dedicated vent.

An air-powered evacuation system might require significant quantities of air to operate. Manufacturer’s recommendations should be followed regarding proper sizing of the air compressor. Inadequate sizing can result in overheating, premature compressor failures, and inadequate operating pressures and flows.

A.5.3.7.1.3 Drive gas quality can be compromised and expected life of system components can be shortened if an undersized system is installed. Manufacturer’s recommendations should be followed regarding proper sizing of the air compressor(s).

A.5.3.7.6.3 A color dew point monitor downstream of the receiver indicating the quality of air coming into the receiver is desirable.

A color dew point monitor in the main treatment facility is appropriate to help the staff promptly identify when the system is being degraded with air of a dew point higher than is acceptable. The design of the color monitor should be such that the normal tolerance of variations will limit the maximum moisture at 3.9°C (39°F) at a gauge pressure of 100 psi (3.9°C at 690 kPa) at activation.

A.5.3.7.6.5 The environmental air source for the compressor inlet should take into consideration possible contamination by particulates, concentrations of biological waste contaminants, ozone from nearby brush-type electric motors, and exhaust fumes from engines.

Air taken from an outside atmosphere could cause harmful condensation problems in the compressor. Long runs of inlet tube should also be avoided as it will degrade compressor performance. The compressor manufacturer's recommendations should be followed regarding appropriate pipe size to prevent possible degradation of system performance.

A dental air compressor and dental vacuum system can be in the same equipment room as long as the inlet for the dental air compressor does not draw air from a room or space containing an open discharge for the dental vacuum system.

Atmospheric air from an operatory can have traces of mercury vapor, nitrous oxide, and other contaminants. A compressor inlet location that would draw its supply directly from an operatory should be avoided.

A.5.3.7.8 If nitrogen is used as a backup supply to a compressed gas system, the nitrogen operating pressure should be regulated so as not to exceed the operating pressure of the Category 3 compressed air system.

A.5.3.8.3.9 A Category 3 vacuum system is not intended for Category 1 vacuum applications. A wet piping system is designed to accommodate liquid, air–gas, and solids through the service inlet. A dry piping system is designed to accommodate air–gas only through the service inlet.
Notes: 1. Dotted lines indicate optional items.
2. Either the nitrogen system or the air compressor system is primary and the other is optional.

- M Moisture indicator
- F Filter(s)
- $\downarrow$ Check valve
- $\square$ Gas outlet station
- $\square$ Automatic drain
- $\text{O}^{\text{O}}$ Drain plug
- UC Utility center
- G Oil monitor, system test location
- S Service outlet
- $\times$ Shutoff valve

NFPA 99 Log 195 Figure A.5.3.7
Category 3 Drive Gas Supply System
[Liquid(s) and solid(s) are trapped before entering the service inlet.] See Figure A.5.3.8.3.9(a) through Figure A.5.3.8.3.9(d).

****INSERT FIGURE HERE****

FIGURE A.5.3.8.3.9(a) Typical Category 3 Wet or Dry Piping System with Single Vacuum Pump Source.

****INSERT FIGURE HERE****

FIGURE A.5.3.8.3.9(b) Typical Category 3 Wet or Dry Piping System with Duplex Vacuum Source with Air/Liquid Separator.

****INSERT FIGURE HERE****

FIGURE A.5.3.8.3.9(c) Typical Category 3 Wet or Dry Piping System with Single Vacuum Source.

****INSERT FIGURE HERE****

FIGURE A.5.3.8.3.9(d) Typical Category 3 Wet or Dry Piping System with Duplex Vacuum Source with Waste Holding Tank.

A.5.3.8.3.10.4 Improper design permits gas pressure to build up in the ventilation system and might blow the trap on liquid seals. See Figure A.5.3.8.3.10.4(a) and Figure A.5.3.8.3.10.4(b).

****INSERT FIGURE HERE****

FIGURE A.5.3.8.3.10.4(a) Drainage from Gravity Drained Liquid Collector Tank.

****INSERT FIGURE HERE****

FIGURE A.5.3.8.3.10.4(b) Drainage from Positive Discharge Vacuum Pump Through Air/Liquid Separator.

A.5.3.8.3.11(8) Care should be taken to ensure the dual exhaust systems do not develop excessive back pressure when using a common exhaust line.

A.5.3.12 When the storage/supply enclosure is remote from the single treatment facility, it should be locked for security reasons to prevent tampering. Access should be only via authorized staff or fire department. When the enclosure is within the single treatment facility, it is left to the discretion of the single treatment facility management as to whether greater benefit is achieved by immediate access or by security. An enclosure with direct access from a public hallway should be locked. If the door to the enclosure opens onto an exit access corridor, see Figure A.5.3.12.

****INSERT FIGURE HERE****

FIGURE A.5.3.12 Examples of Storage/Supply Enclosures.
Note: Dotted lines indicate optional items.
*Does not have to be below floor.

NFPA 99 Log 195 Figure A.5.3.8.3.9(a)
Typical Category 3 Wet or Dry Piping System with Single Vacuum Pump Source
NFPA 99 Log 195 Figure A.5.3.8.3.9(b)
Typical Category 3 Wet or Dry Piping System
with Duplex Vacuum Source with Air/Liquid Separator
NFPA 99 Log 195 Figure A.5.3.8.3.9(c)
Typical Category 3 Wet or Dry Piping System with Single Vacuum Source

Note: Dotted lines indicate optional items.
*Does not have to be below floor.
NFPA 99 Log 195 Figure A.5.3.8.3.9(d)
Typical Category 3 Wet or Dry Piping System
with Duplex Vacuum Source with Waste Holding Tank
NFPA 99 Log 195 Figure A.5.3.8.3.10.4(a)
Drainage from a Gravity Drained Liquid Collector Tank
NFPA 99 Log 195 Figure A.5.3.8.3.10.4(b)
Drainage from a Positive Discharge Vacuum Pump through an Air/Liquid Separator
Use points

Storage

Hall

Example of storage not remote; locking not required

Use points

Storage

Hall

Example of remote storage adjacent to use points but access to storage is from hall; locking required

Use points

Storage

Example of remote storage; storage on different level; locking required

NFPA 99 Log 195 Figure A.5.3.12
Examples of Storage/Supply Enclosures
needed in Category 3 piping systems.

5.3.6.9.1: To match 5.1.10.4.6.1 in Category 1 for use of the "dimpler" to reduce solder socket depths for brazing.

5.3.6.13.5: When reducing ground cover from 36" to 18", preventing physical damage implies that something needs to be done to justify the reduction. Potential damage would be from surface loads or possible digging, such as being under driveways or planters for shrubbery.

5.3.6.13.7: The concern in backfill is rocks and other solids.

Existing 5.3.6.19.4 removed: Emergency shutoff valves must be located within each of two treatment facilities served by one medical gas supply source. They must not shutoff the gas supply to the other facility. What is the purpose of a remotely activated shutoff valve at the manifold? Shutoff valves at the medical gas supply source are to be closed at the end of the day in 5.3.13.5.3. Does it make sense to energize a valve to close?

5.3.6.20.6: Adds temperature requirements for cylinders as the basis for heating and cooling.

5.3.6.23.3.9: To describe what has to be tested before describing the test. Include the test of the system gas if it is used as the source.

5.3.8.2: To delete "Category 3" in the title of a sub-section. It is in 5.3.8, the main section title. To add CPVC plastic pipe for vacuum and scavenging systems.

5.3.8.3.10.6: Adds the requirement for no overflow or splatter from indirect drainage.

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99-353 Log #379 HEA-PIP

99-354 Log #253 HEA-PIP

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Submitter: David D. Eastman, Metro Detroit Plumbing Industry Training Center

Revise text to read as follows:

5.3.1.2 Wherever the term medical gas occurs in Level 3, the term shall apply only to piped systems of nitrous oxide and medical oxygen only.

Substantiation: It came to my attention that "more than a few" Level 3 dental facilities were operating in conjunction with laboratories of one type or another, and that some of them were sharing oxygen systems. Changing the wording in 5.3.1.2 will take the "lab oxygen" away from the medical oxygen and hopefully eliminate another potential source of cross-connection. Who knows what happens in those labs?

This is not original material; its reference/source is as follows:

5.3.1.2

Committee Meeting Action: Accept in Principle

Committee Statement: See Committee Action on Proposal 99-352 (Log #195).

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Submitter: Keith Ferrari, Praxair

Revise text to read as follows:

5.3.3.3.4 Outdoor Locations.

5.3.3.3.4.1 Storage facilities shall be sited per NFPA 55; that are adjacent to a building wall shall be located such that the distance to any window of the adjacent building is greater than 7.62 m (25 ft).

Substantiation: 5.3.3.3.4.1 requirement (windows must be at least 25 ft from the MLX system) are in direct contradiction to NFPA 55 site requirements --wall opening must be at least 10 ft from the MLX system.

This is not original material; its reference/source is as follows:

NFPA 55, 2005

Committee Meeting Action: Accept in Principle

Committee Statement: See Committee Action on Proposal 99-352 (Log #195).
5.3.3.4.4 Supply systems supplying only a single treatment facility shall contain the following: a minimum of two banks of cylinders of oxygen and a minimum of two banks of cylinders of nitrous oxide (if used), each containing the greater of either at least an average day's supply or one of the following:

1. When storage is not remote, one cylinder of oxygen and one cylinder of nitrous oxide (if used)
2. When storage is remote, two cylinders of oxygen, minimum, and two cylinders of nitrous oxide (if used) minimum.

Substantiation: Many smaller Level 3 facilities use so little oxygen and nitrous oxide that a single cylinder will last almost a week. As written, the standard currently requires the smaller facilities to maintain almost a month's supply of oxygen in connection, while a larger facility is only required to maintain a day's supply. Lessening the amount a Level 3 facility must have on hand does not endanger the patient in any way, especially if the change is only applied to systems where the storage is not remote.

This is not original material; its reference/source is as follows:

Committee Meeting Action: Accept in Principle
Committee Statement: See Committee Action on Proposal 99-352 (Log #195).

99-356 Log #89 HEA-PIP
(5.3.10.1.1 and 5.3.12.4.7)

Submitter: John F. Youhouse, Youhouse Plumbing
Recommendation: The use of station outlets / inlets is wrong. It should be service outlets / inlets.
Substantiation: Level 3 inlets and outlets are service not station unless the inlet /outlet is critical - continuous duty. This misapplication of terminology exists throughout - between 5.3.10.1.1 and 5.3.12.4.7.
Committee Meeting Action: Reject
Committee Statement: The proposer's substantiation is not true in all cases. Some manufacturers do provide station outlets.

99-357 Log #381 HEA-PIP
(5.3.10.2.1(3))

Submitter: David D. Eastman, Metro Detroit Plumbing Industry Training Center
Recommendation: Delete text as follows:

5.3.10.2.1(3) ASTM B 280, Standard Specification for Seamless Copper Tubing for Air Conditioning and Refrigeration Field Service. ACR tube (OD size) except that tube installed underground or within floor slabs shall be permitted to be soft annealed temper.
Substantiation: Taken only in the context of 5.3.10.2.1, item (3) indicates that only soft annealed ACR tube can be used underground for Level 3 Vacuum System. The next paragraph (5.3.10.2.2) states the more appropriate idea, that any grade of acceptable material available as soft annealed tubing is acceptable.
This is not original material; its reference/source is as follows:

Committee Meeting Action: Accept in Principle
Committee Statement: See Committee Action on Proposal 99-352 (Log #195).
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<td>Log #90</td>
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<tr>
<td><strong>Submitter:</strong> John F. Youhouse, Youhouse Plumbing</td>
<td><strong>Recommendation:</strong> Revise text to read as follows:</td>
<td><strong>Substantiation:</strong> Delete the one hour requirement as in level one 5.1.10.5.3.13. Although Level 3 systems are sometimes installed in crawl spaces, they are no more dirty than new construction. The installer can make the call if less than 8 hours is required by conditions.</td>
<td><strong>Committee Meeting Action:</strong> Accept in Principle</td>
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<td><strong>Committee Statement:</strong> See Committee Action on Proposal 99-352 (Log #195).</td>
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<td><strong>Submitter:</strong> Craig B. Williams, Life Medical Networks</td>
<td><strong>Recommendation:</strong> Revise text to read as follows:</td>
<td><strong>Substantiation:</strong> Deletion of this paragraph provides uniform consistency of this requirement within this standard whether Level 1, 2 or 3.</td>
<td><strong>Committee Meeting Action:</strong> Accept</td>
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<td><strong>Submitter:</strong> David D. Eastman, Metro Detroit Plumbing Industry Training Center</td>
<td><strong>Recommendation:</strong> Revise text to read as follows:</td>
<td><strong>Substantiation:</strong> This change would bring the requirement for brazing Level 3 medical gas piping into line with the requirements for Level 1 medical gas piping.</td>
<td><strong>Committee Meeting Action:</strong> Accept in Principle</td>
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<td><strong>Committee Statement:</strong> See Committee Action on Proposal 99-359 (Log #173).</td>
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<td>99-361</td>
<td>Log #91</td>
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<td>(5.3.10.7.4.4)</td>
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<td><strong>Submitter:</strong> John F. Youhouse, Youhouse Plumbing</td>
<td><strong>Recommendation:</strong> Delete - stainless steel.</td>
<td><strong>Substantiation:</strong> Most flux containers have stiff brushes in their caps. Level one paragraph 5.1.10 5.4.4 has already removed the stainless steel brush requirement.</td>
<td><strong>Committee Meeting Action:</strong> Accept in Principle</td>
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<td><strong>Committee Statement:</strong> See Committee Action on Proposal 99-352 (Log #195).</td>
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</table>
5.3.10.10.3.1 Mains, branches, and drops to individual service outlets in Level 3 nitrous oxide and inlets in the following piping systems other than oxygen shall be not less than DN8 (NPS 1/4 in.) (3/8 in. OD) size.

Since there are no other piping system "following," this section as currently written mandates a minimum size for nitrous oxide, but gives no minimum size requirements for any other piping systems. Changing the wording will eliminate this situation.

This is not original material; its reference/source is as follows:
5.3.10.10.3.1

Committee Meeting Action: Reject
Committee Statement: See Committee Action on Proposal 99-352 (Log #195).

99-363 Log #49 HEA-PIP
Final Action: Reject
(5.3.10.5.3 (New))

Submitter: Lynn Nielsen, City of Henderson Building and Fire Safety Dept.
Recommendation: Add new text to read:
5.3.10.10.5.3 Piping for Level 3 gas-powered devices within floor slabs and underground within buildings shall be in accordance with 5.3.10.10.7.

Substantiation: A cross reference is needed between these two sections.
Committee Meeting Action: Reject
Committee Statement: See Committee Action/Statement on Committee Proposal 99-352 (Log #195).

99-364 Log #96 HEA-PIP
Final Action: Accept
(5.3.10.6.3)

Submitter: J. Richard Wagner, Poole & Kent Corporation
Recommendation: Hangers and supports for copper tube shall be sized for copper tube and have a copper finish.

Substantiation: The copper finish on hangers and supports for copper tube is not for corrosion protection. It simply indicates that the device is sized for copper tube. This change is supported by Formal Interpretation FI No. 99.05.1.
Committee Meeting Action: Accept

99-365 Log #97 HEA-PIP
Final Action: Accept
(5.3.10.6.4)

Submitter: J. Richard Wagner, Poole & Kent Corporation
Recommendation: Revise text to read as follows:
In potentially damp locations, copper tube hangers and supports that are in contact with the tubes shall be plastic-coated or otherwise be electrically insulated from the tube by a material that will not absorb moisture.

Substantiation: Insulating materials such as felt should not be used in damp locations.
Committee Meeting Action: Accept
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<td>99-366</td>
<td>Log #102 HEA-PIP</td>
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**Submitter:** Corky Bishop P.E., Medical Gas Management, LLC  
**Recommendation:** Change the title to:  
**Piping within floor slabs and underground within buildings for level 3 gas-powered devices and vacuum.**  
**Substantiation:** This paragraph applies to soft copper piping which is only allowed to be used for level 3 gas-powered devices and vacuum per section 5.3.10. This section prohibits soft soldered joints underground. Medical gas piping is allowed to have brazed joints underground. Underground piping within buildings for medical gases is covered in paragraph 5.3.10.10.4.2.  
**Committee Meeting Action:** Accept in Principle  
**Committee Statement:** See Committee Action on Proposal 99-352 (Log #195).

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<td>99-367</td>
<td>Log #50 HEA-PIP</td>
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**Submitter:** Lynn Nielson, City of Henderson Building and Fire Safety Dept.  
**Recommendation:** Revise text to read:  
5.3.10.10.7.1 The tube(s) shall be installed in one (or more) continuous conduits that are of sufficient size to permit subsequent installation, removal, and replacement of the gas and/or vacuum gas-powered device lines.  
**Substantiation:** Field installation of under floor sleeved vacuum lines is impractical. Application to air (gas)-powered devices should be included for protection too.  
**Committee Meeting Action:** Reject  
**Committee Statement:** See Committee Action on Proposal 99-352 (Log #195).

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<td>99-368</td>
<td>Log #384 HEA-PIP</td>
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**Submitter:** David D. Eastman, Metro Detroit Plumbing Industry Training Center  
**Recommendation:** Revise text to read as follows:  
5.3.10.10.9 Runouts from horizontal piping for medical gas (i.e. oxygen and nitrous oxide) and gas powered devices shall be taken off above the centerline of the main or branch pipe and rise vertically at an angle of not more than 45 degrees from vertical.  
**Substantiation:** The original intention of this proposal is to prevent water from accumulating in the piping and finding its way to the patient. The way that the level 1 systems are described automatically applies this provision to the medical air and instrument air systems; however, the wording of the level 3 section applies this provision only to oxygen and nitrous oxide. Adding the above wording brings the gas driven devices systems under the same provision. This is particularly important, since compressed air systems are far more likely to bring water into the piping.  
**This is not original material; its reference/source is as follows:**  
5.3.10.10.9  
**Committee Meeting Action:** Reject  
**Committee Statement:** See Committee Action on Proposal 99-291 (Log #78) for level 1. The committee will be deleting the main or branch line takeoff angle requirements.
5.3.12.3.9.2 Medical gas outlets (i.e., Oxygen and nitrous oxide) shall deliver 70 LPM (2.45 SCFM) with a pressure drop of no more than 35 kPa (5 psi) and static pressure of 345 kPa to 380 kPa (50 psi to 55 psi).

NFPA Standards are expected to be based on currently available products that provide safe and effective performance. Data on products that have been in use in Level 3 facilities and accepted as safe and effective by users show that the installation of these products would result in non-compliance with the current test requirements in NFPA 99 2005 edition.

The proposed revision for the Verifier Operational Pressure Test uses a flow rate of 70 SLPM which is more than 10 times the flow rate used in delivering medical gas (i.e., oxygen and nitrous oxide) in a usage setting. The proposed test requirement is based on test data obtained from tests of products currently used in Level 3 oxygen/nitrous oxide systems.

Test results:
The flow rate testing was performed on a Porter system with a Vanguard A Manifold, Zone Valve, and Triple Outlet. The total flow rate on the oxygen side of the system was measured and was found to be 172 SLPM (liters) with a 12 PSIG drop.
When the flow rate was dropped to 100 liters (3.5 cfm) the pressure drop was 4 psig.
Using the same system the flow rate for the nitrous oxide side was less. The maximum flow rate with the same system was 83 SLPM with a 10 PSIG pressure drop. This may be due to the nitrous oxide regulator. The maximum flow rate on the nitrous oxide regulator was 278 SLPM.
The average flow rate for oxygen at the use point is between 4-6 liters per minute.
The average flow rate for nitrous oxide at the use point is between 3-4 liters per minute.

Note: Supporting material is available for review at NFPA Headquarters.

5.3.12.3.10 Medical gas outlets (i.e., Oxygen and nitrous oxide) shall deliver 50 LPM (1.8 SCFM) with a pressure drop of no more than 35 kPa (5 psi) and static pressure of 345 kPa to 380 kPa (50 psi to 55 psi).

Field experience has shown that 50 LPM is an adequate flow rate.

Using NPS 3/8 piping for oxygen and NPS 1/4 for nitrous oxide, the flow rates specified in paragraph 5.3.12.3.10.2 will never be obtained.

Committee Meeting Action: Reject
Committee Statement: The flow rates were reduced in Proposal 99-369 (Log #81).
Medical gas outlets (e.g., oxygen and nitrous oxide) shall deliver 50 Nl/min (1.8 SCFM) with a pressure drop of no more than 35 kPa (5 psi) and static pressure of 345–380 kPa (50–55 psi).

This requirement was added in the 2002 cycle and is the same flow requirement for level 1 systems, Hospitals. The typical level 3, Dental manifold is not manufactured to the same degree as a level 1 manifold. NFPA standards for a level 3 manifold are less rigorous than a level 1 and correctly so. The NFPA standard allows for smaller pipe size in level 3, Mains, branches, and drops to individual service outlets in Level 3 oxygen piping systems shall be not less than DN10 (NPS 3/8) (1/2 in. O.D.) size. Mains, branches, and drops to individual service outlets and inlets in the following piping systems shall be not less than DN8 (NPS 1/4) (3/8 in. O.D.) size, for Level 1, Mains and branches in medical gas piping systems shall be not less than DN15 (NPS 1/2) (5/8 in. O.D.) size. For an average dental office of five to seven chairs, one to two chairs using gas at a time with flow rates of two to three LPM per gas, requiring 100 LPM is an excessive requirement considering this and normal equipment and installation.

This is not original material; its reference/source is as follows:
NFPA 99C/2005

Committee Meeting Action: Accept in Principle
Committee Statement: See Committee Action on Proposal 99-369 (Log #81).
Submittal: Mindy Wang, Ampco Safety Tools

Recommendation: Add new text to read:

5.3.13.2.1 Wrenches and tools used to connect equipment shall be manufactured of materials of adequate strength and of nonsparking type.

Substantiation:

- Gas and Vacuum System hazards are documented in NFPA 99, Annex B Nature of Hazards:
  - In an oxygen-enriched atmosphere, materials that are flammable and combustible in air ignite more easily and burn more vigorously
  - The occurrence of a fire requires the presence of combustible or flammable materials, an atmosphere of oxygen or other oxidizing agents, and a source of ignition. Combustible materials can be unavoidably present when oxygen is being administered, but ...ignition sources are avoidable.
  - Oxygen-enriched atmospheres can exist in the immediate vicinity of all oxygen administration equipment
  - An oxygen-enriched atmosphere documents a flammability hazard. Therefore, NFPA 99, 5.3.13.1.3, (8) requires sparks and flame be kept away from cylinders.
  - NFPA 30, Flammable and Combustible Liquids, Chapter 6, section 6.5.1 lists frictional heat or sparks as sources of ignition of flammable vapors and precaution shall be taken to control ignition sources.
  - Recognizing the potential for steel tools to be an ignition source in flammable environment, the Occupational Safety & Health Administration (OSHA) provides guidance in booklet 3080 Hand and Power Tools, 2002 revised, “iron and steel hand tools may produce sparks that can be an ignition source around flammable substances. Where this hazard exists, spark-resistant tools should be used.”
  - NFPA 99, Annex B Nature of Hazards cautions that improper maintenance, handling, or assembly of equipment can result in personal injury, property damage, or fire.
  - NFPA 99 can better mitigate the flammability hazards by specifying the use of nonsparking tools. Without this specification, steel tools are likely to be used which can be an ignition source. The risk of ignition introduced by steel tools can be avoided through the specific reference for the use of nonsparking tools.

This is not original material; its reference/source is as follows:


Committee Meeting Action: Reject

Committee Statement: Non-sparking tools are not needed when dealing with non-flammable medical gases.

Submittal: Kenneth Urbanek, IGN Medical

Recommendation: Add new text to read as follows:

5.3.13.7.2(1) Annual Leak Test of Zone Valves.
5.3.13.7.2(2) Annual area alarm panel sensor activation by applied load for hi-low alarms
5.3.13.7.2(3) Annual master alarm panel point activation by applied load

Substantiation: There is no uniform test periodicity. There is not a consistent practice among sites. A standard would assist in allocation of resources by areas based on usage, wear and tear.

Committee Meeting Action: Accept in Principle

Committee Statement: See Committee Action on Proposal 99-352 (Log #195).
5.3.13.7.2(4) Annual out/inlet testing to cover all terminals over three (3) year period for GPL and annual for special care locations and anesthetizing locations. There is no uniform test periodicity. There is not a consistent practice among sites. A standard would assist in allocation of resources by areas based on usage, wear and tear.

Committee Meeting Action: Accept in Principle
Committee Statement: See Committee Action on Proposal 99-352 (Log #195).

5.3.13.7.5(3) Audible and Visual Alarm Indicator(s) be tested annually. Test method for disconnected devices include removal from line and application of pressure/vacuum. There is no periodicity requirement in the language so the devices are tested at installation or replacement. Once the alarm sensor is on line it is too difficult to pressurize to test for the high alarm at 60 psi.

Committee Meeting Action: Accept in Principle
Committee Statement: See Committee Action on Proposal 99-352 (Log #195).

Patients served by the system(s) are not dependent on mechanical ventilation or assisted mechanical ventilation at any time, including during administration of anesthesia. Was the purpose of this requirement to elevate all facilities with an anesthesia machine to a Level 1 facility? The best example of a Level 2 system is an outpatient surgery center. The current wording would force any facility with anesthesia machines in use to be elevated to Level 1 requirements. This also applies to Chapters 14, 17, and 18.

Committee Meeting Action: Reject
Committee Statement: The occupancy chapters will be deleted in the revised NFPA 99.
(2) Medical gas and vacuum systems shall be permitted to be Level 2 systems only where both of the following conditions exist:

(a) Paragraphs 14.3.5.1(1)(a) and 14.3.5.1(1)(b) apply.
(b) Patients served by the system(s) are not dependent on mechanical ventilation or assisted mechanical ventilation at any time, including during administration of anesthesia.

*Substantiation:* The best example of a Level 2 system is an outpatient surgery center. The current wording would force any facility with anesthesia machines in use to be elevated to Level 1 requirements. Some examples of Level 2 occupancies in the annex would be helpful. This also applies to Chapters 17 and 18.

*Committee Meeting Action: Reject*

*Committee Statement:* Removing this wording still does not change the fact that you can not be a level 2 if the patient is dependent on mechanical ventilation or assisted mechanical ventilation.

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14.3.5.2 Where nitrous oxide or halogenated agents are intended to be administered to a patient a WAGD shall be installed and conform to Level 1 WAGD system in Chapter 5.

*Substantiation:* The proposal clarifies that only when halogenated agents are used along with nitrous oxide, oxygen or other medical gases for administration to a patient the facility shall require Level 1 WAGD. It also clarifies that a facility that administers only nitrous oxide could be a Level 3 facility as described in Chapter 5. This was addressed during NFPA Technical Committee 99 Piping Systems meetings in 2001 but was incorrectly added to Chapter 14 in the 2002 edition of NFPA 99. The proposed paragraphs have been the practice in used. The requirement as stated in 14.5.3.2 is not in accord with Section 5.3 for Level 3 facilities, thus causing confusion among regulatory agencies, installers and users of Level 3 facilities. Some the users of NFPA 99 only cites 14.3.5.2 and not use the more detailed description of Level 3 systems in Section 5.3 of NFPA 99 thus requiring facilities that administers only nitrous oxide to install Level 1 WAGD. Level 3 clearly indicates the need for "scavenging" not "WAGD". This was intended by the committee to clarify that there is a difference between a nitrous oxide scavenging system and disposal of waste anesthetic gas.

Paragraph 5.3.3.6 I explains why all manufacturers are supplying vacuum equipment for the removal of air-gas as in the past. Paragraph 5.3.3.6.4.1 supports the use of the Level 3 vacuum system. 5.3.9.2 confirms the Vacuum Alarm is not required by code.

*Committee Meeting Action: Accept*

*Revise text to read as follows:*

14.3.5.2 Where nitrous oxide or halogenated agents are intended to be administered to a patient a WAGD shall be installed and conform to Level 1 WAGD system in Chapter 5.

*Committee Statement:* Editorial correction.
A.5.1.3.4.13.9

The local signal arose from the simple need of a maintenance person to know what is going on with any given piece of source equipment. Note that it is not an alarm in the sense of a local or master alarm. It is simply an indicator, which might be a gauge, a flag, a light, or some other possible manifestation that allows a maintenance person to stand at the equipment and know what conditions are present (e.g., which header of cylinders is in service). The elements to be displayed are typically those that will also be monitored at the master alarm, but the local signal is visible at the equipment rather than remotely.

Substantiation: The local signal has caused a great deal of confusion & misconception as to the purpose & meaning of the requirement. The word “actuate” misleads the reader to interpret the standard on local signals to require, as a minimum, a local alarm or other electronic device when a gauge or flag appropriately indicating the conditions of the source is sufficient to meet the requirement. The 2002 NFPA 99 explained the intent of the local signal as "The local signal was a new requirement in the 2002 edition and arose from the simple need of a maintenance person to know what is going on with any given piece of source equipment. Note that it is not an alarm in the sense of a local or master alarm. It is simply an indicator, which might be a gauge, a flag, a light, or some other possible manifestation that allows a maintenance person to stand at the equipment and know what conditions are present (e.g., which header of cylinders is in service). The elements to be displayed are typically those that will also be monitored at the master alarm, but the local signal is visible at the equipment rather than remotely" (Health Care Facilities Handbook - 2002, page 133).

This is not original material; its reference/source is as follows:
NFPA 99, 2006 and NFPA 99, 2002

Committee Meeting Action: Accept
99-519     Log #252  HEA-PIP
(A.5.1.9.2.3 (New )

Submitter: Keith Ferrari, Praxair
Recommendation:   Add new text as follows:
A.5.1.9.2.3
  1) It is acceptable to run one pair of wires per switch from the bulk supply system to a junction box that splits the signal
to each master panel without using relays.
  2) Certain alarms may permit a single signal wire and a common ground, however this is not permitted because it
would allow a failure of a single wire to alarm multiple signals on the panel.
  3) It is acceptable to splice or connect lengths of signal wire following standard industry methods, such as a junction
box.
Substantiation: There is a wide variety of interpretation to how to wire alarms (junction box or not). The concern is
magnified when working with Bulk oxygen sites where the run of lines may exceed 1000 feet of wiring from the bulk site
to the individual alarms panels.

The NFPA 99 handbook information may explain the requirement to an extent, but some of the handbook explanation
is not included in future editions of NFPA and the intent can be lost. By adding an annex explanation, the intent can be
explained in future editions of NFPA 99.
This is not original material; its reference/source is as follows:
NFPA 99, 2005 Handbook explanation and interpretation of the handbook explanation
Committee Meeting Action: Accept in Principle

Revise 5.1.9.2.3 as follows:
5.1.9.2.3 The two master alarm panels required in 5.1.9.2.1 shall connect to
the alarm initiating devices that they monitor in accordance with the following:
5.1.9.2.3.1 Each of the two mandatory alarms shall be wired independently to
the initiating device(s) for each signal.
5.1.9.2.3.2 The wiring between each mandatory alarms and the initiating
device(s) shall not utilize common conductors which if interrupted would
disable more than one signal.
5.1.9.2.3.3 Each set of wires (in whatever number as required by the alarm)
shall run to the initiating device(s) without interruption other than in-line
splices necessary to complete the necessary length of wire.
5.1.9.2.3.4 A single initiating device shall be permitted to actuate multiple
master alarms.
5.1.9.2.3.5 The mandatory master alarm panels shall not be arranged such
that failure of either panel would disable any signal on the other panel.
5.1.9.2.3.6 Where initiating devices are remote from the building and the
wiring is to run underground in compliance with NFPA 70, the following
exceptions shall be permitted to be used:
  (1) wiring from the initiating device and through the underground section
shall be permitted to be run to a junction box located where the wiring first
enters the building.
  (2) a single set of wires complying with 5.1.9.2.3.2 and 5.1.9.2.3.3 for each
signal shall be permitted to connect the initiating device and the junction box.
  (3) between the junction box and the two mandatory alarm panels, wiring
shall comply with 5.1.9.2.3.1 through 5.1.9.2.3.5 in all respects.
5.1.9.2.3.7 Where a relay is required to ensure correct operation of an
initiating device, the control power for the relay shall not be such that disabling
any master alarm panel would disable the relay.
Committee Statement: Changes clarify the intent of the proposed Annex material.
Keith Ferrari, Praxair

**Recommendation:** Section C5.1 is outdated. The information was in need of a review and update. Please refer to the attached documents for current errors found.

***Insert Table C.5.1 Here***

**Substantiation:** The proposed document is based on current chapter 5 initial testing standards. I believe that the user of the code book will find the material easier to follow and more helpful during initial inspections and initial testing.

*This is not original material; its reference/source is as follows:*

NFPA 99, 2005 Handbook

**Committee Meeting Action:** Accept in Principle

Remove existing C.5.1 in its entirety and replace with the table in the recommendation.

**Committee Statement:** The first table was deleted as it just corrected references. The second table will replace the entire C.5.1 and make the corrections.

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Keith Ferrari, Praxair

**Recommendation:** Section C5.2 is outdated and inconsistent. The information was in need of a review and update. Please refer to the attached documents for current errors found.

***Insert Table C.5.2 Here***

**Substantiation:** The proposed document is based on current chapter 5 and chapter 9 retesting and maintenance standards. I believe that the user of the code book will find the material easier to follow and more helpful during retesting and maintenance. The attached documents sections of retesting and maintenance were purposely expanded to allow the technical committee to view frequency options for the final inclusion into C.5.2, if accepted.

*This is not original material; its reference/source is as follows:*

NFPA 99, 2005 Handbook; CSA Z305.1; ISO 7396; CGA E-10; and various major medical gas equipment venders OEM suggested testing and maintenance guides.

**Committee Meeting Action:** Accept in Principle

Accept in Principle.

**Committee Statement:** See Committee Action on Proposal 99-341 (CP#251).
### C.5.1 Initial Testing of Nonflammable Medical Piped Gas Systems Level 1

<table>
<thead>
<tr>
<th>Components</th>
<th>Initial Testing</th>
<th>NFPA 99 Ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relief Valve</td>
<td>Pressure valve set at 50% above normal line pressure, should be tested to assure proper function prior to use</td>
<td>C.5.1 [5.1.3.4.6.1] (should be 5.1.3.4.6.3)</td>
</tr>
<tr>
<td>Medical Air Supply Source</td>
<td>Proper function of the safety valve, automatic drain, pressure gauge, and high-water-level sensor should be verified prior to use</td>
<td>C.5.1.2 [5.1.3.5.2] (should be 5.1.3.5.11)</td>
</tr>
<tr>
<td>Manifold for Gas Cylinders w/o reserve supply</td>
<td>Changeover Warning Signal (Step by step instructions)</td>
<td>C.5.1.3 [5.1.3.4.10]</td>
</tr>
<tr>
<td>Manifold for Gas Cylinders w/o reserve supply</td>
<td>Reserve-In-Use Warning Signal (Step by step instructions)</td>
<td>C.5.1.3 [5.1.3.4.10]</td>
</tr>
<tr>
<td>Manifolds for Cryogenic Liquid Containers</td>
<td>Changeover Warning Signal (Step by step instructions)</td>
<td>C.5.1.3 [5.1.3.4.12]</td>
</tr>
<tr>
<td>Manifolds for Cryogenic Liquid Containers</td>
<td>Reserve-In-Use Warning Signal (Step by step instructions)</td>
<td>C.5.1.4 [5.1.3.4.12]</td>
</tr>
<tr>
<td>Manifolds for Cryogenic Liquid Containers</td>
<td>Reserve Supply Low (Step by step instructions)</td>
<td>C.5.1.5 [5.1.3.4.12]</td>
</tr>
<tr>
<td>Bulk Cryogenic Liquid Systems</td>
<td>Changeover Warning Signal (Step by step instructions)</td>
<td>C.5.1.3 [5.1.3.4.13]</td>
</tr>
<tr>
<td>Bulk Cryogenic Liquid Systems</td>
<td>Reserve-In-Use Warning Signal (Step by step instructions)</td>
<td>C.5.1.4 [5.1.3.4.13]</td>
</tr>
<tr>
<td>Bulk Cryogenic Liquid Systems</td>
<td>Reserve Supply Low (Step by step instructions)</td>
<td>C.5.1.5 [5.1.3.4.13]</td>
</tr>
<tr>
<td>Instrument Air Standby Headers</td>
<td>Reserve Supply Low (Step by step instructions)</td>
<td>C.5.1.5 [5.1.3.8.2.3] (should be 5.1.3.8 or 5.1.3.8.5)</td>
</tr>
<tr>
<td>Master Alarms</td>
<td>Changeover Warning Signal (Step by step instructions)</td>
<td>C.5.1.3 [5.1.9.2.4]</td>
</tr>
<tr>
<td>Master Alarms</td>
<td>Reserve-In-Use Warning Signal (Step by step instructions)</td>
<td>C.5.1.4 [5.1.9.2.4]</td>
</tr>
<tr>
<td>Master Alarms</td>
<td>Reserve Supply Low (Step by step instructions)</td>
<td>C.5.1.5 [5.1.9.2.4]</td>
</tr>
<tr>
<td>Master Alarms</td>
<td>High or Low Pressure in Piping System (Step by step instructions)</td>
<td>C.5.1.6 [5.1.9.2.4]</td>
</tr>
<tr>
<td>Area Alarms</td>
<td>This signal should be initially tested at the time the tests of C.5.1.6 are performed</td>
<td>C.5.1.7 [5.1.9.3]</td>
</tr>
</tbody>
</table>

(5.1.3.4.11 is not mentioned above – manifolds for gas cylinders with reserve?)

Too specific and limited. Confusing to the average reader.
C.5.1 Performance Criteria and Testing – Level 1 (Gases, Medical-Surgical Vacuum, and WAGD)

This section sets out a minimum recommended guide for testing. Testing requirements are listed in 5.1.12. Tests specified in 5.1.12 shall be carried out by an experienced person or persons designated by the administration of health care facility. Such a person shall certify the results of tests to the administration. The designated person or persons shall be experienced in Medical Gas testing and verification of piping systems with cross connection testing, a member of the health care facility shall be present to verify the testing.

<table>
<thead>
<tr>
<th>Responsibility</th>
<th>Test Reference</th>
<th>Test (as applicable)</th>
<th>Purpose of test:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installer</td>
<td>5.1.12.2.1</td>
<td>General</td>
<td></td>
</tr>
<tr>
<td>Installer</td>
<td>5.1.12.2.2</td>
<td>Initial Blow Down</td>
<td>Distribution Piping is blown down to remove particulates</td>
</tr>
<tr>
<td>Installer</td>
<td>5.1.12.2.3</td>
<td>Initial Pressure Test</td>
<td>Distribution Piping is free from pressure loss</td>
</tr>
<tr>
<td>Installer</td>
<td>5.1.12.2.4</td>
<td>Cross-Connection Test</td>
<td>Distribution Piping is free from cross-connections</td>
</tr>
<tr>
<td>Installer</td>
<td>5.1.12.2.5</td>
<td>Piping Purge Test</td>
<td>Distribution Piping is Purged to remove particulates</td>
</tr>
<tr>
<td>Installer</td>
<td>5.1.12.2.6</td>
<td>Standing Pressure Test for Positive Pressure Medical Gas Piping</td>
<td>Distribution Piping is free from excessive pressure loss</td>
</tr>
<tr>
<td>Installer</td>
<td>5.1.12.2.7</td>
<td>Standing Vacuum Test for Vacuum System</td>
<td>Distribution Piping is free from excessive vacuum loss</td>
</tr>
<tr>
<td>System Verification</td>
<td>5.1.12.3.1</td>
<td>General</td>
<td></td>
</tr>
<tr>
<td>System Verification</td>
<td>5.1.12.3.2</td>
<td>Standing Pressure Test</td>
<td>Distribution Piping is free from leaks</td>
</tr>
<tr>
<td>System Verification</td>
<td>5.1.12.3.3</td>
<td>Cross-Connection Test</td>
<td>Distribution Piping is free from cross-connections</td>
</tr>
<tr>
<td>System Verification</td>
<td>5.1.12.3.3.1</td>
<td>Individual Pressurization</td>
<td></td>
</tr>
<tr>
<td>System Verification</td>
<td>5.1.12.3.3.2</td>
<td>Pressure Differential</td>
<td></td>
</tr>
<tr>
<td>System Verification</td>
<td>5.1.12.3.4</td>
<td>Valve Test</td>
<td>Shutoff valves are functioning &amp; labeled properly</td>
</tr>
<tr>
<td>System Verification</td>
<td>5.1.12.3.5</td>
<td>Alarm Test</td>
<td>Alarms are functioning &amp; labeled properly</td>
</tr>
<tr>
<td>System Verification</td>
<td>5.1.12.3.5.1</td>
<td>General</td>
<td></td>
</tr>
<tr>
<td>System Verification</td>
<td>5.1.12.3.5.2</td>
<td>Master Alarm</td>
<td></td>
</tr>
<tr>
<td>System Verification</td>
<td>5.1.12.3.5.3</td>
<td>Area Alarm</td>
<td></td>
</tr>
<tr>
<td>System Verification</td>
<td>5.1.12.3.6</td>
<td>Piping Purge Test</td>
<td>Distribution Piping is Purged to remove particulates</td>
</tr>
<tr>
<td>System Verification</td>
<td>5.1.12.3.7</td>
<td>Piping Particulate Test</td>
<td>Distribution Piping is free from particulates</td>
</tr>
<tr>
<td>System Verification</td>
<td>5.1.12.3.8</td>
<td>Piping Purity Test</td>
<td>Distribution Piping is free from excessive water vapor, total hydrocarbons, and halogenated hydrocarbons</td>
</tr>
<tr>
<td>System Verification</td>
<td>5.1.12.3.9</td>
<td>Final Tie-In Test</td>
<td>The new and existing Distribution system is free from leaks at the point of connection and no additional contamination was added to the existing system</td>
</tr>
<tr>
<td>System Verification</td>
<td>5.1.12.3.10</td>
<td>Operational Pressure Test</td>
<td>Distribution Piping is free from excessive pressure/vacuum loss</td>
</tr>
<tr>
<td>System Verification</td>
<td>5.1.12.3.11</td>
<td>Medical Gas Concentration Test</td>
<td>Proper concentration of system gas is present at each outlet</td>
</tr>
<tr>
<td>System Verification</td>
<td>5.1.12.3.12</td>
<td>Medical Air Purity Test [Compressor System]</td>
<td>Proper quality of medical air is present</td>
</tr>
<tr>
<td>System Verification</td>
<td>5.1.12.3.13</td>
<td>Labeling</td>
<td>Distribution Piping, Outlets/Inlets, Shut-off Valves, Alarms, Source Equipment, are labeled correctly</td>
</tr>
<tr>
<td>System Verification</td>
<td>5.1.12.3.14</td>
<td>Source Equipment Verification</td>
<td>Source equipment properly functions</td>
</tr>
<tr>
<td>System Verification</td>
<td>5.1.12.3.14.1</td>
<td>General</td>
<td></td>
</tr>
<tr>
<td>5.1.12.3.14.2</td>
<td>Gas Supply Sources</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------</td>
<td>-------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.1.12.3.14.3</td>
<td>Medical Air Compressor Systems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.1.12.3.14.4</td>
<td>Medical-Surgical Vacuum Systems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test Frequency</td>
<td>Components</td>
<td>Description</td>
<td>Preventive Maintenance</td>
</tr>
<tr>
<td>---------------</td>
<td>------------</td>
<td>-------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>Daily</td>
<td>Central Supply Systems</td>
<td>Manifolds for Gas Cylinders w/o Reserve Supply</td>
<td>Check proper pressure maintained and changeover signal has not malfunctioned</td>
</tr>
<tr>
<td>Daily</td>
<td>Central Supply Systems</td>
<td>Manifolds for Cryogenic Liquid Containers</td>
<td>Check proper pressure maintained and changeover signal has not malfunctioned</td>
</tr>
<tr>
<td>Daily</td>
<td>Central Supply Systems</td>
<td>Bulk Cryogenic Liquid Systems</td>
<td>Check supply system to ensure medical gas is ordered when the contents gauge drops to the reorder level</td>
</tr>
<tr>
<td>Daily</td>
<td>Pressure and Vacuum Indicators</td>
<td>Pressure and Vacuum Indicators</td>
<td>Check main-line pressure gauge to ensure the continued presence of desired pressure</td>
</tr>
<tr>
<td>Daily</td>
<td>Central Supply Systems</td>
<td>Medical Air System - Operating Alarms and Local Alarms - Receiver Drain</td>
<td>Check receiver drain to determine if an excessive quantity of condensed water has accumulated in the receiver</td>
</tr>
<tr>
<td>Daily</td>
<td>Pressure and Vacuum Indicators</td>
<td>Pressure Gauges</td>
<td>Check proper piping system pressure</td>
</tr>
<tr>
<td>Monthly</td>
<td>Warning Systems</td>
<td>Signal alarm panels</td>
<td>Perform activation of the audible and visual signals, when tests buttons are provided with signal panels</td>
</tr>
<tr>
<td>Monthly</td>
<td>Warning Systems</td>
<td>Master Alarms - Reserve-In-Use Warning Signal</td>
<td>Test audible and visual signals</td>
</tr>
<tr>
<td>Monthly</td>
<td>Warning Systems</td>
<td>Master Alarms - Reserve Supply Low High-Pressure Cylinder or Liquid Reserve</td>
<td>Test audible and visual signals, if test buttons are provided</td>
</tr>
<tr>
<td>Monthly</td>
<td>Warning Systems</td>
<td>Warning System</td>
<td>Test audible and visual signals, if test buttons are provided</td>
</tr>
<tr>
<td>Quarterly</td>
<td>Central Supply Systems</td>
<td>Medical Air System - Medical Air Quality Monitoring</td>
<td>Check location of the air intake to ensure that it continues to be a satisfactory source for medical air</td>
</tr>
<tr>
<td>Annual</td>
<td>Warning Systems</td>
<td>Warning System</td>
<td>Test all components of warning systems, if it can be done without changing system pressure</td>
</tr>
<tr>
<td>Annually</td>
<td>Central Supply Systems</td>
<td>Manifolds for Cryogenic Liquid Containers</td>
<td>Perform operation test of reserve and activation of reserve-in-use signal</td>
</tr>
<tr>
<td>Annually</td>
<td>Central Supply Systems</td>
<td>Manifolds for Cryogenic Liquid Containers</td>
<td>Perform a test of the actuating switch and signal of the contents of the reserve</td>
</tr>
<tr>
<td>Annually</td>
<td>Central Supply Systems</td>
<td>Medical Air System - Operating Alarms and Local Alarms - Pressure Gauge</td>
<td>Check proper functioning of the pressure gauge</td>
</tr>
<tr>
<td>Annually</td>
<td>Central Supply Systems</td>
<td>Medical Air System - Operating Alarms and Local Alarms - Water Level Sensor</td>
<td>Check proper functioning of the high-water-level sensor</td>
</tr>
<tr>
<td>Annually</td>
<td>Central Supply Systems</td>
<td>Medical Air System - Dew Point sensor</td>
<td>Check proper functioning</td>
</tr>
<tr>
<td>Annually</td>
<td>Warning Systems</td>
<td>Master Alarms - Reserve-In-Use Warning Signal</td>
<td>Test all components of this warning signal</td>
</tr>
<tr>
<td>Annually</td>
<td>Warning Systems</td>
<td>Master Alarms - Reserve Supply Low High-Pressure Cylinder or Liquid Reserve</td>
<td>Test all components of this warning signal</td>
</tr>
<tr>
<td>Annually</td>
<td>Warning Systems</td>
<td>Master Alarms - Medical Air System Alarms</td>
<td>Check alarms</td>
</tr>
<tr>
<td>Periodic</td>
<td>Central Supply Systems</td>
<td>Bulk Cryogenic Liquid Systems</td>
<td>Test Master Signal Panel System</td>
</tr>
<tr>
<td>Periodic</td>
<td>Valves</td>
<td>Shut off Valves</td>
<td>Check for external leakage</td>
</tr>
<tr>
<td>Periodic</td>
<td>Station Outlets/Inlets</td>
<td>Station Outlets</td>
<td>Check for leakage and flow - follow manufacturers instructions</td>
</tr>
<tr>
<td>Manufacturer Rec</td>
<td>Central Supply Systems</td>
<td>Bulk Cryogenic Liquid Systems</td>
<td>Maintenance and testing of bulk system</td>
</tr>
<tr>
<td>Manufacturer Rec</td>
<td>Central Supply Systems</td>
<td>Medical Air System - Air compressor (reciprocating)</td>
<td>Maintain per Manufacturers Recommendations</td>
</tr>
<tr>
<td>Manufacturer Rec</td>
<td>Central Supply Systems</td>
<td>Medical Air System - Absorber beds</td>
<td>Maintain per Manufacturers Recommendations</td>
</tr>
<tr>
<td>As needed</td>
<td>Warning Systems</td>
<td>Master Alarms - Changeover Warning Signals</td>
<td>If signals fail, (repair) test activation</td>
</tr>
<tr>
<td>Frequency</td>
<td>Category</td>
<td>System Details</td>
<td>Notes</td>
</tr>
<tr>
<td>-----------</td>
<td>---------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>Regularly</td>
<td>Central Supply Systems</td>
<td>Bulk Cryogenic Liquid Systems</td>
<td>Check piping system gauges, gradual variation either increase or decrease from normal should be reported to supplier</td>
</tr>
<tr>
<td>Routinely</td>
<td>Central Supply Systems</td>
<td>Medical Air System - Instrumentation/Analytical equipment</td>
<td>Calibrated and maintained in operating order</td>
</tr>
</tbody>
</table>

(5.1.3.5 is not specific to any area of med air section, 5.1.3.5.7, 5.1.3.5.10,...) (5.1.3.4.11 is not mentioned above - manifolds for gas cylinders with reserve ?)