AGENDA

NFPA Technical Committee on Piping Systems (HEA-PIP)
NFPA 99 First Draft Meeting (A2026)

August 6 – August 8, 2024
8 a.m. (CT)

Embassy Suites by Hilton Kansas City Plaza
Kansas City, Missouri

To join the meeting, please contact nduggan@nfpa.org

1. **Call to order.** Michael Crowley.
2. **Introductions.** See committee roster attached.
3. **Chair report.** Michael Crowley.
4. **Staff liaison report.** Gregory Harrington.
   a. **First Draft meeting process**.
   b. **Reference publication/extract updates**.
   c. **Copyright/extracts from external publications**.
5. **Previous meeting minutes.** August 15-17, 2022, NFPA 99 remote Second Draft meeting. See attached.
6. **NFPA 99 First Draft.**
   a. Public Inputs. See attached.
   b. Task group reports.
      i. Ch. 5 review. See PI-251 (Chapter 5) - Jonathan Willard.
      ii. Ch. 15 review. See PI-342 (Chapter 15) - David Braidich.
      iii. Laboratory gases. Jonathan Willard.
   c. Staff-identified items. See attached.
      i. Table 5.1.11/5.1.11.2.2 inconsistency.
      ii. Conversion in 5.1.3.6.1(5).
      iii. Vacuum exhaust piping materials in 5.1.3.7.7 – permitted or limited?
7. **Other business.**
8. **Future meetings.**
9. **Adjournment.**

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MINUTES

NFPA Health Care Facilities Technical Committee on Piping Systems (HEA-PIP)
NFPA 99 Second Draft Meeting (A2023)

August 15-17, 2022

Microsoft Teams Meeting

1. **Call to order.** The meeting was called to order by Chair Michael Crowley at 11:00 a.m. (EDT) on August 15, 2022.
2. **Introductions.** Staff Liaison Gregory Harrington called the roll of committee members. See attached for attendance.
3. **Chair report.** The chair welcomed and thanked the committee for attending and indicated the primary purpose of the meeting was to prepare the second drafts of the 2024 edition of NFPA 99.
4. **Staff liaison report.** Staff added his welcome and delivered a presentation on the NFPA second draft meeting process.
5. **Previous meeting minutes.** The minutes of the August 3-6, 2021 Microsoft Teams meeting were approved as submitted.
6. **Review Correlating Committee on Health Care Facilities previous meeting minutes**. The committee reviewed the correlating committee meeting minutes. Re. item 8 on NFPA 55/99 nonvoting TC representatives, it was noted that J. Willard is also a member of the TC on Industrial and Medical Gases, which is responsible for NFPA 55.
7. **Task group reports.**
   a. Laboratory gases task group – J. Willard. No report – the task group has been retained on the agenda. Task group members: J. Willard (chair), M. Allen, M. Carlson, K. Ferrari, J. McBride, and K. Scarlett.
   b. Cryogenic N_2 systems task group – J. Lucas. The task group presented recommended revisions to Sec. 5.4 of NFPA 99. See the second draft report for the committee actions. The task group was discharged with thanks.
   c. Ch. 15/Ch. 4 category relationship task group – M. Allen. The task group presented recommendations for a complete rewrite of Ch. 15 to be independent of Ch. 5. Second revisions were developed accordingly. See the second draft report for the committee actions. The task group was discharged with thanks.
   d. Anesthetizing location task group – D. Lyons. The task group presented recommended revisions via public comments. See the second draft report for the committee actions. The task group was discharged with thanks.

e. Auxiliary source connection task group – M. Allen. The task group presented recommended revisions via public comments. See the second draft report for the committee actions. The task group was discharged with thanks.

f. Pandemic task group – K. Ferrari. The task group presented recommended revisions via public comments. See the second draft report for the committee actions. The task group recommends the proposed content be incorporated in the NFPA 99 Handbook as commentary. Staff will relay the material to the handbook development team. The task group was discharged with thanks.

8. NFPA 99 Second Draft.

a. **Referenced publications.** The committee reviewed the draft reference publication updates. No action.

b. **Extracts.** The committee reviewed the draft extract updates and created second revisions where applicable. See the second draft report for the committee actions.

c. **Public Comments.** The committee reviewed the assigned public comments and created second revisions where applicable. See the second draft report for the committee actions. J. Lathrop indicated that he would abstain from voting on items related to NFPA 55.

d. **Committee Inputs.** The committee reviewed the committee inputs and created second revisions where applicable. See the second draft report for the committee actions.

9. Other business. A task group was appointed to further study the subject of public inputs PI-268 and PI-269 as they relate to leakage testing and develop recommendations for any needed revisions for the next edition of NFPA 99. Task group members: S. Parikh (chair), M. Carlson, M. Franklin, A. Lowe, and J. Lucas.

10. Future meetings. The Correlating Committee on Health Care Facilities will meet later this year to prepare its second draft reports on NFPA 99 and NFPA 99B. Dates and location are to be determined. This committee will next meet in 2024 to prepare the first drafts of the 2027 edition of NFPA 99.

11. Adjournment. The meeting adjourned at 4:52 p.m. (EDT) on August 17, 2022.

X	**Crowley, Michael**	Chair	Coffman Engineers, Inc.
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X	**Anderson, Grant**	Principal	Bard, Rao & Athanas Consulting
X	**Beebe, Chad**	Principal	American Society for Healthcare
X	**Braidich, David**	Principal	US Army Corps of Engineers
X	**Carter, Mark**	Principal	National Institutes Of Health
X	**Colombo, Dana**	Principal	PIPE/National ITC Corporation
X	**Dodson, Marc**	Principal	C-Scan Technologies, Inc.
X	**Ferrari, Keith**	Principal	Compressed Gas Association

X	**Franklin, Mark**	Principal	Sherman Engineering Company
	Fuchs, Andrew	Principal	Local 137
X	**Gagné, Neil**	Principal	Wm. G. Frank Medical Gas Testing &
X	**Golla, Ed**	Principal	TRI/Air Testing
X	**Gregory, John**	Principal	WSP USA
X	**Hamilton, Scott**	Principal	International Association of Plumbing &
	Kelly, Daniel	Principal	Bon Secours Charity Health System
X	**Lathrop, James**	Principal	Koffel Associates, Inc.
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X	**Lowe, Anthony**	Principal	Allied Hospital Systems
X	**Lucas, James**	Principal	Tri-Tech Medical Inc.
X	**Lyons, David**	Principal	American Society of Anesthesiologists
X	**Martin, Bret**	Principal	CNA Insurance
X	**McBride, Jeffery**	Principal	Red Lion Medgas Consultants, Inc.
	Miller, Douglas	Principal	Local 190
X	**Scarlett, Kevin**	Principal	Washington State Department of Health
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X	**Smidt, Ronald**	Principal	NFPA Health Care Section
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X	**Rizzo, Vincent**	Alternate	US Department of Veterans Affairs

X	**Rumbos, Paul**	Alternate	Major Medical Hospital Services, Inc.
	Stanford, Sharon	Alternate	American Dental Association
X	**Sullivan, Daniel**	Alternate	BeaconMedaes
	Williams, John	Alternate	Washington State Department of Health
X	**Harrington, Gregory**	Staff Liaison	National Fire Protection Association

Guests:

John Mullen	IAPMO
Richard Anderson	ICC
Sig Hernandez	Air Products and Chemicals rep. Compressed Gas Association
Dr. Hana Alberti	Center for Dental Practice Policy, ADA Practice Institute
Brianne Hall	Fishbeck
Jason McDonald	Grumman/Butkus Associates
Travis Webb	Modular Services Company

Public Input No. 30-NFPA 99-2024 [Global Input]

Delete the word "strict" throughout and reword the requirements accordingly.

See the action taken on FR 971 from the previous revision cycle which is provided in the substantiation.

See:

5.1.3.2.2

5.1.3.1.9.1

5.1.3.1.8.1

15.4.2.3.2

15.1.5

9.1.3

8.1.3

11.3.12.4.1

11.3.12.3.1

11.3.12.2.1

Additional Proposed Changes

File Name	Description	Approved
FR_971_2024.docx		

Statement of Problem and Substantiation for Public Input

FR 971 from the previous revision cycle is attached, which removes the word "strict" from 1.3.2.3. This PI proposes to correlate with this action as the term adds no value to the requirements. Installations either comply or don't comply with Code requirements.

Submitter Information Verification

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State:
Zip:
Submittal Date: Mon Jan 15 11:14:22 EST 2024
Committee: HEA-PIP

First Revision No. 971-NFPA 99-2021 [Section No. 1.3.2.3]

1.3.2.3

An existing system that is ~~not in strict compliance~~noncompliant with the ~~provisions~~requirements of this code shall be permitted to be continued in use, unless the authority having jurisdiction has determined that such use constitutes a distinct hazard to life.

Submitter Information Verification

Committee: HEA-FUN

Submittal Date: Thu Jul 15 12:44:01 EDT 2021

Committee Statement

Committee Statement: The term 'distinct' in regard to hazard to life is commonly used in NFPA codes and standards.

Response Message: FR-971-NFPA 99-2021

Public Input No. 20-NFPA 99-2020 [Section No. 1.3.2.3]

Ballot Results

This item has passed ballot

x

26 Eligible Voters

8 Not Returned

16 Affirmative All

2 Affirmative with Comments

0 Negative with Comments

0 Abstention

X

Not Returned

Brooks, Bruce D.

Dahozy, Roger N.

Day, Richard L.

Lyman, Dale L.

Peterkin, James S.

Reno, Pamela

Van Overmeiren, Frank L.

Vann, Joshua

X

Affirmative All

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Beebe, Chad E.
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Grogan, Shaine M
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Martin, Bret M.
Puchovsky, Milosh T.
Scarlett, Kevin A.
Schmitt, Dennis L.
Scibetta, Joe
Sontag, Robert
Stone, Michael C.
X

Affirmative with Comment

Abell, Bruce L.

Make the same change to the contents of Section 16.1.2. Presently, the contents of Section 1.3.2.3 and Section 16.1.2 are identical.

Mucia, Michele

Agree there needs to be a change but feel it should read: An existing system that is non compliant with the requirements of this code shall be permitted for continued use, unless the Authority Having Jurisdiction has determined that continued use of the existing system poses a distinct hazard to life.

Public Input No. 301-NFPA 99-2024 [Global Input]

I would propose banning any new installation of bulk, or central, piped nitrous systems. This will involve approximately 80 locations where it would need to struck from the text of NFPA 99. But it would also require a revision or deletion to the definition of Bulk Nitrous Oxide Systems. Further, I would propose a timeline for existing central nitrous to be sunset (perhaps 2030?). The alternative language would state, "Where required for use, nitrous oxide shall be provided via portable E-cylinders (or equivalent) in lieu of utilizing permanent outlets piped from central cylinders or containers."

Statement of Problem and Substantiation for Public Input

Several hospitals in the northwest have studied the clinical use of nitrous oxide in comparison to the purchase and found significant (~90%!) waste from the central supply system (liquid or compressed gas) to what is actually delivered to the patient. The result is unnecessary cost, but more importantly, unnecessary greenhouse gas emissions. This would have no impact on clinical use; nitrous oxide remains a useful anesthetic. And in many, if not most, cases, the anesthesia carts already have E-cylinders attached, and clinical use of nitrous is such that cylinders are replaced at reasonable levels for facility staff.

The following webinar from Practice Greenhealth is required viewing to fully understand the proposal and the ease in which this transition can occur: Collaborating to prevent Nitrous Oxide waste in medical gas systems. https://practicegreenhealth.org/tools-and-resources/webinar-collaborating-prevent-nitrous-oxide-waste-medical-gas-systems

The following is further background on nitrous oxide, quoting from CSA Standards on Medical Gas Pipeline Systems (Z7396.1:22):

P.2 Nitrous oxide
P.2.1
Nitrous oxide is regarded as the predominant greenhouse gas for the 21st century. Nitrous oxide has a global warming potential (GWP) 300 times that of CO2 and persists in the atmosphere for 114 years. Once common use for anesthesia, the demand for N2O has waned considerably with the advent of new anesthetics and changes in practice. Some facilities continue to use N2O for self-administered conscious sedation during childbirth or for pain control in emergency departments.
P.2.2
N20 is known to permeate non-metallic materials including the plastic hoses connected to medical gas pipelines including hoses in articulating arms, and connected to anesthesia machines. Because these hoses are connected to the medical gas pipeline under pressure, they give off N20 24 hours a day, 7 days a week and can constitute the majority or all of the consumption of N20 in a healthcare facility.

And finally, the avoidance of a centrally manifolded, central nitrous oxide supply system with the associated costly distribution piping would be a significant first cost savings to any newly constructed hospital (or renovation requiring nitrous oxide). Once in operations, with the avoidance of significant wasted nitrous oxide, there is a nominal financial savings as less nitrous oxide would need to be purchased, although nitrous oxide is not particularly expensive. Further, as described in the webinar, usage of nitrous oxide from portable cylinders should not generate an operational challenge, as most locations do not require frequent cylinder exchanges to accommodate clinical needs. Limiting the installation of new central nitrous oxide supply systems with piped distribution would reduce first cost, have a minor impact on operation cost and workload, but most importantly, minimize GHG emissions.

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Committee: HEA-PIP

Public Input No. 424-NFPA 99-2024 [Section No. 3.3.39]

3.3.39 Dental Office.

A building or part thereof in which the following occur: (1) examinations and minor treatments/ procedures performed under the continuous supervision of a dental professional; (2) use of limited to minimal and moderate sedation and treatment or procedures that do not render the patient incapable of self-preservation under emergency conditions; and (3) no overnight stays for patients or 24-hour operations. (PIP)

Statement of Problem and Substantiation for Public Input

The majority of dental offices performing sedation are certified to perform minimal to moderate sedation. Moderate sedation = awake, responsive, breathing on your own. The risk level to the patient and staff is minor if there is a system failure. NFPA is opening a can of worms that will cause unneeded chaos regarding Moderate Sedation.

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Public Input No. 425-NFPA 99-2024 [Section No. 3.3.41]

3.3.41 Dental ~~Surgical~~ Vacuum.

A method that provides drainage, aspiration, and suction to remove body fluids from patients during dental treatment. (PIP)

Statement of Problem and Substantiation for Public Input

Using the word Surgical is adding a layer of confusion. Dental Vacuum and Dental Suction are commonly used in nearly every dental office. The word surgery and surgical are not common in standard dental offices.

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Public Input No. 75-NFPA 99-2024 [New Section after 3.3.168]

Responsible Facility Authority - Definition

New code

This is a proposed definition. To be added after 3.3.168

An individual that is designated by the healthcare facility to be responsible for conducting risk assessments, defining compliance requirements, maintaining medical gas management programs and policies, instilling emergency management programs, and developing and enforcing a permit to work system.

Substantiation

The term responsible facility authority is utilized in the code, but is not defined in chapter 3.

Statement of Problem and Substantiation for Public Input

There is currently no definition for the term used in the NFPA 99

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Public Input No. 426-NFPA 99-2024 [Section No. 3.3.193]

3.3.193 Waste Anesthetic Gas Disposal (WAGD).

The process of capturing and carrying away gases vented from the patient breathing circuit during the normal operation of gas anesthesia or analgesia equipment. Scavenging (3.3.170) is a form of WAGD under conditions of minimal to moderate sedation. (PIP)

Statement of Problem and Substantiation for Public Input

See additional proposed edits to WAGD codes in Chapter 5. Within Chapter 5 - NFPA 99 does not consider the use of nitrous oxide and oxygen for minimal sedation / pain management. There are many areas of the hospital that this is now very common (and rapidly growing). The term Scavenging is not used in Chapter 5 - and it should be. It should be allowable to Scavenge in a patient room through a Vacuum inlet. Requiring a WAGD inlet in a patient room is not providing any additional safety benefit as it ties into the same Vacuum Line 5ft downstream. These nitrous oxide and oxygen systems are being used for minimal sedation and pain management - for relatively short procedures.

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Committee: HEA-PIP

Public Input No. 251-NFPA 99-2024 [Chapter 5]

Chapter 5 Gas and Vacuum Systems

5.1 Category 1 Piped Gas and Vacuum Systems.

5.1.1* Applicability.

5.1.1.1*

These requirements shall apply to health care facilities that require Category 1 systems as referenced in Chapter 4.

5.1.1.2*

Where the terms *medical gas* or *medical support gas* occur, the provisions shall apply to all piped systems for oxygen, nitrous oxide, medical air, carbon dioxide, helium, nitrogen, instrument air, and mixtures thereof. Wherever the name of a specific gas service occurs, the provision shall apply only to that gas.

5.1.1.3*

An existing system that is not in strict compliance with the provisions of this code shall be permitted to be continued in use, unless the authority having jurisdiction has determined that such use constitutes a distinct hazard to life.

5.1.1.4

This chapter shall apply to new health care facilities as specified by Section 1.3 unless otherwise specified by 5.1.1.5.

5.1.1.5

The following sections of this chapter shall apply to the operation, management, and maintenance of Category 1 medical gas and vacuum systems in both new and existing facilities:

(1) 5.1.2

(2) 5.1.3.1

(3) 5.1.3.2

(4) 5.1.3.3.4

(5) 5.1.3.6.2

(6) 5.1.3.6.3.10(A)(2)

(7) 5.1.3.7.6(A)(2)

(8) 5.1.3.8.4.1(2)

(9) 5.1.14

5.1.1.6

Category 1 systems shall be permitted to serve spaces identified as Category 1, Category 2, or Category 3.

5.1.2 Nature of Hazards of Gas and Vacuum Systems.

Potential fire and explosion hazards associated with positive pressure gas central piping systems and medical–surgical vacuum systems shall be considered in the design, installation, testing, operation, and maintenance of these systems.

5.1.3* Category 1 Sources.

pp. 9 - 124 INTENTIONALLY OMITTED

5.4.6.9.1.2

Valves and other control apparatus shall be suitable for cryogenic service.

5.4.6.9.1.3*

Special purpose devices shall meet the following requirements:

(1) They shall be constructed of materials compatible with cryogenic service.

(2) They shall be placed such that they are visible for inspection, testing, and service.

(3) They shall be placed or guarded to prevent the development of any hazards when they operate.

5.4.6.9.1.4

Electrical devices and wiring placed in proximity to cryogenic fluid or potentially exposed to ice or condensate shall be protected for wet locations.

5.4.6.9.2 Installation.

Piping for field-installed cryogenic liquid withdrawal systems shall be installed in accordance with the manufacturer's recommendations.

5.4.6.9.3 Insulation or Protection.

All piping for field-installed cryogenic liquid withdrawal systems shall be insulated or protected to prevent inadvertent contact, icing, and condensation.

5.4.6.10 Testing.

Piping for field-installed cryogenic liquid withdrawal systems shall be tested in accordance with the manufacturer's recommendations and include the following:

(1) Evaluation of relief valve locations and cracking pressures

(2) Leak tests at the higher of 1.5 times the expected normal operating pressure or the highest relief valve cracking pressure in the piping

(3) Insulation integrity

(4)* Other criteria as determined by the application

Additional Proposed Changes

File Name	Description	Approved
Reorg_2027_C.docx	Work of the Revisions Task Group	

Statement of Problem and Substantiation for Public Input

The attached file is the work of the Reorganization Task Group.

What has been done:
In brief, the sections from the start of the chapter through to valves (5.1.4) have been reorganized with the objectives:
1. more logical flow
2. elimination of redundancies
3. more coherent placement of sections.
4. 5.1.13 has been revised to be in line with the other central supply systems in 5.1.7

Text has been minimally changed for readability/good syntax or organization (new headings) only - no technical changes were intended.
5.1.4 through 5.1.12 inclusive from the current document are not affected and are not included in the submission. They are not changed by this proposal except for an unavoidable renumbering. Note that cross referencing has been checked and validated for all numbered references in BLUE. It is understood that the necessary renumbering will affect other references. These have been noted in

RED with the 2024 reference noted.

Significant changes to note:
• Operational sections in the front of the chapter (e.g. 5.1.1.5, 5.1.3.1, 5.1.3.2) were moved back to Operations (5.1.14)
• Design considerations were gathered into 5.1.3 as they are logically first in any work on a new system
• The common “building blocks “ of a central supply system were grouped into 5.1.4
• All central supply systems are now grouped under 5.1.7, and refer back to 5.1.3 and 5.1.4 as appropriate. This eliminated a great deal of redundancy in the document and we believe will improve usability.
• In Medical Air, the various requirements for aftercoolers and dryers were reorganized so they are together instead of spread across the section.
• sections which are redundant (e.g. 5.1.3.3.1.6 - 5.1.3.3.1.10 see 5.1.3.10.2.6 - 5.1.3.10.2.11, electrical requirements for motor driven sources, etc.) are included only once.
• 5.1.13 references the sections of 5.1.3, 5.1.4 and 5.1.7 appropriate to the technology, and redundancies in that section are removed.
• 5.1.14 is reorganized to accept the sections which have been moved there from 5.1.1 and 5.1.3.

5.1.14 now is organized:

5.1.14* Category 1 Operation and Management.
5.1.14.1 Existing Facilities
5.1.14.2 Responsible Facility Authority.
5.1.14.2.1 Responsibilities.
5.1.14.2.1.3 Qualifications.
5.1.14.3 Permit-to-Work System.
5.1.14.4 Special Precautions — Patient Gas, Vacuum, WAGD, and Medical Support Gas Systems.
5.1.14.4.1 Cylinder and Container Identification and Labeling.
5.1.14.4.3 Decommissioned spaces
5.1.14.4.4 Access in Emergency
5.1.14.5 Central Supply System Operations.
5.1.14.5.13 Medical Gas and Vacuum Systems Information and Warning Signs.
5.1.14.6 Medical Gas and Vacuum Systems Maintenance
5.1.14.6.2 Qualifications.
5.1.14.6.3. Required Aspects of a Maintenance Program
5.1.14.6.4 Maintenance Operations
5.1.14.6.4.1 Central Supply Systems
5.1.14.6.4.2 Alarms Maintenance
5.1.14.6.4.3 Manufactured Assemblies Employing Flexible Connection(s) Between the User Terminal and the Piping System.
5.1.14.6.4.5 Breaches to the pipeline
5.1.14.6.4.6 Vacuum Inlets
5.1.14.6.4.7 Access to valves and alarms
5.1.14.7 Record Keeping

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Chapter 5 Gas and Vacuum Systems

5.1 Category 1 Piped Gas and Vacuum Systems.

5.1.1* Applicability.

5.1.1.1*

These requirements shall apply to health care facilities that require Category 1 systems as referenced in Chapter 4.

5.1.1.2*

Where the terms *medical gas* or *medical support gas* occur, the provisions shall apply to all piped systems for oxygen, nitrous oxide, medical air, carbon dioxide, helium, nitrogen, instrument air, and mixtures thereof. Wherever the name of a specific gas service occurs, the provision shall apply only to that gas.

5.1.1.3*

An existing system that is not in strict compliance with the provisions of this code shall be permitted to be continued in use, unless the authority having jurisdiction has determined that such use constitutes a distinct hazard to life.

5.1.1.4

This chapter shall apply to new health care facilities as specified by ~~Section~~ Section 1.3 unless otherwise specified by 5.1.~~1~~14.~~6~~1.
~~5.1.1.5~~

~~The following sections of this chapter shall apply to the operation, management, and maintenance of Category 1 medical gas and vacuum systems in both new and existing facilities:~~
~~(1) 5.1.2~~
~~(2) 5.1.3.1~~
~~(3) 5.1.3.2~~
~~(4) 5.1.3.3.4~~
~~(5) 5.1.3.6.2~~
~~(6) 5.1.3.6.3.10(A)(2)~~
~~(7) 5.1.3.7.6(A)(2)~~
~~(8) 5.1.3.8.4.1(2)~~
~~(9) 5.1.14~~

5.1.1.~~6~~ 5

Category 1 systems shall be permitted to serve spaces identified as Category 1, Category 2, or Category 3.

5.1.2 Nature of Hazards of Gas and Vacuum Systems.
Potential fire and explosion hazards associated with positive pressure gas central piping systems and medical–surgical vacuum systems shall be considered in the design, installation, testing, operation, and maintenance of these systems.

5.1.3 Design Requirements

5.1.3.~~3.2.~~1. Qualification of Designers~~–~~
Medical gas and vacuum systems shall be designed by one of the following:

(1) A party technically competent and experienced in the field of medical gas and vacuum system design and meeting the requirements of ASSE/IAPMO/ANSI 6060, *Professional Qualifications Standard for Medical Gas System Designers*

(2) A party deemed technically competent through other qualification(s) deemed sufficient by the health care facility's governing body

5.1.3.~~5.2~~2 Permitted Locations for ~~Medical Gases~~Patient Gas and Support Gas Station Outlets.
~~Central supply systems~~Patient gas station outlets shall only be placed in areas~~for oxygen, medical air, nitrous oxide, carbon dioxide, and all other patient medical gases shall be piped only to medical gas outlets complying with 5.1.5, into areas~~ where the gases will be used under the direction of licensed medical professionals for purposes congruent with the following:

(1) Direct respiration by patients

(2) Clinical application of the gas to a patient, such as the use of an insufflator to inject carbon dioxide into patient body cavities during laparoscopic surgery and carbon dioxide used to purge heart-lung machine blood flow ways

(3) Medical device applications directly related to respiration

(4) Power for medical devices used directly on patients

(5) Calibration of medical devices intended for 5.1.3.~~5.~~2(1) through 5.1.3.~~5.~~2(4)

(6) Simulation centers for the education, training, and assessment of health care professionals

5.1.3.~~.5.~~3 Permitted Uses for medical gas and support gas central supply systems

(1) Central supply systems for patient medical gases shall be piped only to medical gas outlets complying with XXX {{ED note former 5.1.5.}}

(2) ~~Medical Support Gases.~~

Central supply systems for medical support gases shall not be piped to, or used for, any purpose except medical support application.

5.1.3.4 Colocation of Central Supply Systems

~~5.1.3.3.1 General.~~
~~Central supply systems shall be located to meet the criteria in 5.1.3.3.1 through 5.1.3.3.1.10.~~
5.1.3.~~3~~4.1.~~1~~
Any of the following central supply systems shall be permitted to be located together in the same outdoor enclosure:

(1) Manifolds for gas cylinders *(see 5.1.~~3.5.10~~7.2)*

(2) Manifolds for cryogenic liquid containers *(see 5.1.~~3.5~~7.~~11~~.3)*

(3) Cryogenic fluid central supply *(see ~~5.1.3.10~~5.1.7.9)*

(4) *Individual components on the oxygen side of concentrator sources *(see ~~5.1.3.9~~5.1.7.8)*

5.1.3.~~3~~4.~~1.~~2
Any of the following systems shall be permitted to be located together in the same indoor enclosure:

(1) Manifolds for gas cylinders *(see 5.1.~~3~~7.2~~.5.10~~)*

(2) Manifolds for cryogenic liquid containers *(see 5.1.7.3~~5.1.3.5.11~~)*

(3) In-building emergency reserves *(see ~~5.1.3.5.13~~5.1.7)*

(4) Instrument air standby headers *(see {{ED note former 5.1.13.3.7.6})*

(5) *Individual components on the oxygen side of concentrator sources *(see ~~5.1.3.9~~5.1.7.8)*

5.1.3.~~3~~4.~~1.~~3 –
Any of the following central supply systems shall be permitted to be located together in the same room:

(1) Medical air central supply compressor supply sources *(see ~~5.1.3.6.3~~5.1.7.2)*

(2) Medical–surgical vacuum central supply sources *(see ~~5.1.3.7~~5.1.7.7)*

(3) Waste anesthetic gas disposal (WAGD) central supply sources *(see ~~5.1.3~~5.1.7.7~~.8~~)*

(4) Instrument air compressor central supply sources *(see* {{ED note former *5.1.13.3.7*} *)*

(5) Any other compressor, vacuum pump, or electrically powered machinery

(6) *Compressors, dryers, and air receivers used to supply oxygen concentrators (*see ~~*5.1.3.9*~~*5.1.7.8*)

(7) Concentrator units with air and oxygen sides in an integral unit (*see ~~*5.1.3.9*~~*5.1.7.8*)

5.1.3.~~3~~4.~~1.~~4
Any central supply system listed under 5.1.3.~~3~~4.1~~.3~~ shall not be located in the same room with any central supply system listed under ~~5.1.3.3.1.1 or~~ 5.1.3.~~3.1.2~~4.3, except instrument air reserve headers complying with ~~5.1.3.2.11~~5.1.4.5.7 and {{ED note former 5.1.13.3.7.6} shall be permitted to be in the same room as an instrument air compressor.

~~5.1.4* Category 1 Sources, Requirements for all types of Supply Sources and Central Supply Systems~~

~~Central supply systems shall be permitted to consist of the following:~~
~~(1) Cylinder manifolds for gas cylinders in accordance with 5.1.3.5.10~~
~~(2) Manifolds for cryogenic liquid containers in accordance with 5.1.3.5.11~~
~~(3) Cryogenic fluid central supply systems in accordance with 5.1.3.10~~
~~(4) Medical air compressor systems in accordance with 5.1.3.6~~
~~(5) Medical–surgical vacuum producers in accordance with 5.1.3.7~~
~~(6) WAGD producers in accordance with 5.1.3.8~~
~~(7) Instrument air compressor systems in accordance with 5.1.13.3.7~~
~~(8) Proportioning systems for medical air USP in accordance with 5.1.3.6.3.14~~
~~(9) Oxygen central supply systems using concentrators in accordance with 5.1.3.9~~

5.1.~~4~~3.~~1~~5 Design and Construction of locations enclosing Cylinders, Containers, and Central Supply Systems

5.1.3.5~~5.1.4.1~~.1* General
(1) Full or empty medical gas cylinders and portable containers shall be stored in locations complying with 5.1.3.5.1 (4) and shall be permitted to be in the same rooms or enclosures as their respective central supply systems. Approved existing installations shall be permitted to be continued in service.

(2)* Cylinders and portable containers, whether full or empty, shall not be stored in enclosures containing motor-driven machinery, with the exception of cylinders intended for instrument air reserve headers complying with {{ED note former 5.1.13.3.7.6} , which shall be permitted to be placed in the same location containing an instrument air compressor when it is the only motor-driven machinery located within the room. Only cylinders intended for instrument air reserve headers complying with {{ED note former 5.1.13.3.7.6} shall be permitted to be stored in enclosures containing instrument air compressors.

(3) Storage of portable patient care gas equipment shall comply with Chapter 11.

(4) All locations shall:

(A) be provided with lockable doors or gates or otherwise able to be secured.

(B) have interior finishes of noncombustible or limited-combustible materials.

(C)* comply with NFPA 70 for ordinary locations.

(D)* not also contain fuel fired equipment.

(E)* be supplied with electrical power compliant with the requirements for essential electrical systems as described in Chapter 6.

(F) have racks, shelves, and supports, where provided, constructed of noncombustible materials or limited-combustible materials.

(G) if the location requires heat, the maximum allowable temperature of the in-room heating element shall be 130°C (266°F).

(H) ensure electrical devices are protected from physical damage.

5.1.~~4.1~~3.5.2 Indoor locations for central supply systems using containers or cylinders, and storage locations for portable containers and cylinders, except portable patient care gas equipment, shall comply with 5.1.3.5.1 (4) and shall also:

(1) be constructed with access to move cylinders, equipment, and so forth in and out of the location on hand trucks complying with the requirements of 11.4.3.1.1.

(2)* The location shall allow access by delivery vehicles and management of cylinders and containers.

(3) be provided with racks, chains, or other fastenings to secure all cylinders from falling, whether connected, unconnected, full, or empty.

(4)* if containing oxygen, nitrous oxide, or other oxidizers, shall be separated from the rest of the building by walls and floors having a 1-hour fire resistance rating with doors and other opening protectives having a ¾-hour fire protection rating.

(5) if containing oxygen, nitrous oxide, and mixtures of these gases, shall not communicate with the following:

(A) Areas involved in critical patient care
(B) Anesthetizing locations
(C) Locations storing flammables
(D) Rooms containing open electrical contacts or transformers
(E) Storage tanks for flammable or combustible liquids
(F) Engines
(G) Kitchens
(H) Areas with open flames

(6) be designed to meet the operational requirements of 5.1.14.4.1.11 and 5.1.14.4.1.12 ~~5.1.3.2~~ regarding room temperature.

5.1.~~4.1~~3.5.3 Outdoor locations for central supply systems using containers or cylinders, and storage locations for portable containers and cylinders shall comply with 5.1.3.5.1 (4) and shall also:

(1) be constructed with access to move cylinders, equipment, and so forth in and out of the location on hand trucks complying with the requirements of 11.4.3.1.1.

(2) be provided with racks, chains, or other fastenings to secure all cylinders from falling, whether connected, unconnected, full, or empty.

(3) be well drained and provided with an enclosure (e.g., wall or fencing) constructed of noncombustible materials.

(4) protect cylinders and containers from prolonged contact with soil.

5.1.~~4.1~~3.5.4 Locations for central supply systems using stationary containers shall comply with 5.1.3.5.1 (4) and shall also:

(1)* allow access by delivery vehicles and management of cylinders if cylinders are used.

(2) comply with ~~5.1.3.10~~5.1.7.9.

5.1.~~4.1~~3.5.5 Locations for motor-driven central supply systems shall comply with 5.1.3.5.1 (4) and shall also:

(1) be constructed with access to move equipment and so forth in and out of the location as necessary.

(2) control the maximum allowable temperature of the room to be in accordance with the central supply system(s) manufacturer's recommendations.

~~5.1.3.3.1.5~~

5.1.43.6~~3~~~~Indoor locations for oxygen, nitrous oxide, and mixtures of these gases shall not communicate with the following:~~

***** Maximum Allowable Quantities of Gas in a Location

The total quantity of medical gases connected to or in storage for central supply systems shall comply with Table 5.1.3.6 for each enclosure or room.

Table 5.1.43.6 Storage Quantities for Medical Gas and Cryogenic Fluid Central Supply Systems in Health Care Facilities

Gas	Maximum Allowable Quantity, Connected and in Storage		
	Outdoor Enclosures[a]	Indoor Nonsprinklered[b]	Indoor Sprinklered[c]
Oxygen and nitrous oxide[d]	No limit	283 m^3 (10,000 ft^3)	566 m^3 (20,000 ft^3)
Carbon dioxide, helium, medical air, and nitrogen	No limit		

[a]Outdoor enclosure constructed and ventilated in accordance with this code and NFPA 55.
[b]Indoor structure constructed in accordance with 5.1.~~3.3.~~3.5.1 (4)~~2~~ and ventilated in accordance with 9.3.6.
[c]Indoor structure constructed in accordance with ~~5.1.3.3.2~~5.1.3.5.1 (4), ventilated in accordance with 9.3.6, and provided with an approved, automatic sprinkler system in accordance with NFPA 13.
[d]Sum of all oxidizing gases within a room.

5.1.~~4.3~~3.6.1*
The limits for the maximum allowable quantities listed in Table 5.1.3.6 shall be permitted to be exceeded where documented by an approved risk assessment by the health care facility's governing body.

5.1.~~4.4~~3.7 Ventilation

5.1.~~4.4~~3.7.1 Ventilation for Indoor Locations.
Central supply system locations, medical gas storage rooms, and transfilling room ventilation shall comply with 9.3.6.

5.1.~~4.4~~3.7.2 Ventilation for Outdoor Locations.

(1) Outdoor locations surrounded by impermeable walls, except fire barrier walls, shall have protected ventilation openings located at the base of each wall to allow free circulation of air within the enclosure.

(2) Walls that are shared with other enclosures or with buildings shall be permitted to not have openings.

(3) The fire barrier wall shall not have openings or penetrations, except conduit or piping shall be permitted, provided that the penetration is protected with a firestop system in accordance with the building code.

5.1.~~4.4~~3.7.3 Ventilation for Motor-Driven Equipment.

(A) Locations containing motor driven supply sources and central supply systems shall be ventilated to prevent accumulation of heat.~~(1) Areas involved in critical patient care~~

(B) For air-cooled equipment, the room shall be designed to maintain the ambient temperature range as recommended by the manufacturer

5.1.4.~~5~~ Common Elements for Sources of Supply and Central Supply Systems

5.1.4.1 General.
Central supply systems shall be obtained from a supplier or manufacturer familiar with their proper construction and use and installed in accordance with the manufacturer's instructions.

5.1.4.2* 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 3000 kPa (435 psi), interconnecting hose shall contain no polymeric materials.

(2) In those portions of systems intended to handle oxygen or nitrous oxide at gauge pressures of less than 3000 kPa (435 psi), construction shall be compatible with oxygen under the temperatures and pressures to which the components can be exposed in the containment and use of oxygen, nitrous oxide, mixtures of these gases, or mixtures containing more than 23.5 percent oxygen.

(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 in accordance with the manufacturer's requirements.

5.1.4.3 Controls for Line Pressure.

All positive-pressure supply systems shall be provided with means to control the final line pressure at the source with all the following characteristics:

(1) Able to maintain stable pressures within the *limits* of {{ED note former Table 5.1.11}

(2) Each control mechanism able to flow 100 percent of the peak calculated demand

(3) Redundant, such that each component of the control mechanism can be isolated for service or replacement while maintaining normal operation

(4) Protected against overpressure *(see 5.1.4.4)*

(5) Be constructed of materials deemed suitable by the manufacturer

5.1.4.3.1
Line pressure regulators, where used to fulfill 5.1.4.3 in cryogenic fluid central supply systems, shall be of a balanced design.

5.1.4.3.2 Multiple pressures from a single Central Supply System.

Where a single central supply system supplies separate piped distribution networks operating at different pressures, each piped distribution network shall comply with 5.1.4.3 for pressure controls, 5.1.4.4 for relief valves, *{ed note: former 5.1.4.2}* for the source valve, and *{ed note: former* 5.1.9.2.4(7)} for the master alarm.

5.1.4.3.3 Control Equipment located remote from the Central Supply System
Pressure control equipment, as specified in 5.1.4.3 that is physically remote from the central supply system, shall be installed within a secure enclosure to prevent unauthorized access in accordance with 5.1.3.5.1 (4) (A).

5.1.4.3.3.1
The enclosure shall provide enough space to perform maintenance and repair.

5.1.4.3.3.2
The location of the enclosure for control equipment other than for medical air shall not communicate with combustible or flammable materials.

5.1.4.4 Relief Valves.

5.1.4.4.1
Central supply systems for positive-pressure gases shall include one or more relief valves, all meeting the following requirements:

(1) They shall be located between each final line regulator and the source valve.

(2) They shall have a relief setting that is 50 percent above the normal system operating pressure.

5.1.4.4.2
All pressure relief valves shall meet the following requirements:

(1) They shall be of brass, bronze, or stainless steel construction.

(2) They shall be designed for the specific gas service.

(3) They shall have a relief pressure setting not higher than the maximum allowable working pressure (MAWP) of the component with the lowest working pressure rating in the portion of the system being protected.

(4) They shall be designed in accordance with ASME B31.3, *Process Piping.*

(5) Relief valves, if indoors, shall be vented to outside in accordance with the following:

(a) They shall be vented to the outside of the building, except that relief valves for compressed air systems having less than 84,950 L (3000 ft3) at STP shall be permitted to be diffused locally by means that will not restrict the flow.
(b) They shall have a vent discharge line that is not smaller than the size of the relief valve outlet or 20 mm (NPS 3/4), whichever is larger.
(c) Where two or more relief valves discharge into a common vent line, the internal cross-sectional area of the common line shall be not less than the aggregate cross-sectional area of all relief valve vent discharge lines served.
(d) They shall discharge to open air such that escaping gas does not impinge on personnel, equipment, or adjacent structures or enter into enclosed spaces.
(e) They shall have the discharge terminal turned down and screened to prevent the entry of rain, snow, or vermin.
(f) Materials and construction for relief valve discharge lines shall be the same as required for positive-pressure gas distribution. *(See {ed note: former 5.1.10.1.})*
(g) Relief valve vent lines shall be labeled in accordance with *{ed note: former 5.1.11.1}* ~~5.1.11.1~~ in any manner that will distinguish them from the medical gas pipeline.

5.1.4.4.3
Pressure relief valves for cryogenic fluid central supply systems shall be in accordance with ~~5.1.3.10~~5.1.7.9.10.

5.1.4.5* Electrical Power and Control for motor driven supply sources

(A) Source systems driven by electric motors shall be controlled to ensure continuous supply at pressures consistent with Table *{ed note: former 5.1.11}* under all conditions of system use as follows:

(1) Automatic activation of producer(s) as necessary to supply the demand.
(2) Managing the operation to equalize wear on all producers. Where this equalization is achieved manually, the facility staff shall arrange a schedule for manual alternation.

(B) Controls shall provide the following functions:

(1) Where source systems having two or more producers employ any electrical circuit device that upon failure could prevent supply, the controls shall be provided with an automatically activated alternative method for ensuring supply (e.g., redundant component(s), an alternate electrical supply path, or other equivalent method).
(2) Control circuits shall be arranged in such a manner that isolation of one producer or component from the system (e.g., for maintenance or repair) does not interrupt the operation of other producer(s) or component(s).
(3) Automatic restart function shall be included, such that the supply will resume normally after power interruption without manual intervention.

(C) Each producer motor shall be provided with electrical components including, but not limited to, the following:

(1) Dedicated disconnect switch installed in the electrical circuit ahead of each motor starter
(2) Motor starting device
(3) Overload protection

(D) Electrical controls for source systems driven by electric motors shall be provided with electrical protections including, at a minimum:

(1) Built-in disconnect means shall be included to allow appropriate operation of multiple producer systems and protect service personnel from exposure to live voltages.
(2) Control circuits shall be arranged so that failure of any component of the control circuit, or shutdown of one producer (e.g., for service), does not interrupt automatic operation of the standby producer(s).
(3) An automatic restart function shall be included, such that the producer(s) will restart after power interruption without manual intervention.
(4) Where components are common to more than one control circuit (e.g. autodrains) each common device shall be provided with electrical protection to prevent loss of the control circuits(s) in the event of short circuit in the device.

(E) Electrical installation and wiring shall conform to the requirements of *NFPA 70*.

(F) Emergency electrical service for the compressors shall conform to the requirements of the essential electrical system as described in Chapter 6.

5.1.4.6 Local Signals.

5.1.4.6.1
The following central supply systems shall have local signals located at the source equipment:

(1) Manifolds for gas cylinders without reserve supply *(see 5.1.~~3.5.10~~7.2)*

(2) Manifolds for gas cylinders with reserve supply

(3) Manifolds for cryogenic liquid containers *(see ~~5.1.3.5.11~~5.1.7.3)*

(4) Cryogenic fluid central supply systems *(see 5.1.7.9~~5.1.3.10~~)*

(5) In-building emergency reserves *(see ~~5.1.3.5.13~~5.1.7)*

(6) Instrument air headers *(see* {ed note: former *5.~~5.~~1.13.3.7.6~~)~~*}

5.1.4.6.2 The local signals shall meet the following requirements:

(1) Provision of visual indication only.

(2) Labeling for the service and condition being monitored.

(3) If intended for outdoor installation, be installed per manufacturer's requirements.

5.1.4.7* Headers.
In central supply systems using cylinders or containers, headers shall include the following:

(1) *Connections for cylinders or containers in the number required for the header's application

(2) Lead for each cylinder or container constructed of materials complying with 5.1.4.2 and provided with end fittings permanently attached to the cylinder lead complying with the mandatory requirements of CGA V-1, *Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections* (ANSI B57.1)

(3) Filter of a material complying with 5.1.4.2 to prevent the intrusion of debris into the manifold controls

(4) Header shutoff valve downstream of the nearest cylinder or container connection, but upstream of the point at which the header connects to the central supply system

(5) Pressure indicator indicating the pressure of header contents

(6) Check valve to prevent backflow into the header and to allow service to the header

(7) If intended for cylinder service, a check valve at each connection for the cylinder lead in 5.1.4.7(1) to prevent loss of gas in the event of damage to the cylinder lead or operation of an individual cylinder relief valve

(8) If intended for gas cylinder service, a pressure regulator to reduce the cylinder pressure to an intermediate pressure to allow the proper operation of the primary and secondary headers

(9) If intended for service with cryogenic liquid containers, a pressure relief valve

(10) Vent valves, if fitted on a header, vented outside of the building per 5.1.~~4.5.4.~~4.4.2~~1~~ (5)

5.1.4.8* Auxiliary Connections.
All medical gas and vacuum systems shall be provided with a point of access for connection of a temporary or supplemental source of supply compliant with the following:

(A) located in the main line, on the patient side of the source valve, as determined by the responsible facility authority.

(B) if installed for a cryogenic fluid central supply system, at the same size as the main line.

(C) if installed for other central supply systems, at the same size as the main line or DN50 (NPS 2 in.), whichever is less.

(D) consisting of a tee, valve, and removable plugged or capped connection point.

(E) labeled in accordance with {ed note: former 5.1.11 } at the valve and at the connection point.

5.1.4.8.1 The auxiliary connection valve shall be normally closed and secured in accordance with {{ED. note - former 5.1.4.1.2}}

{{ED. note - delete former 5.1.4.10}}

5.1.5* Emergency Oxygen Supply Connection (EOSC).
Emergency oxygen supply connections (EOSCs) shall be installed to allow connection of a temporary auxiliary source of supply for emergency or maintenance situations where either of the following conditions exist:

(1) The bulk liquid system or cryogenic fluid central supply system is outside of and remote from the building that the oxygen supply serves, and there is no connected in-building oxygen reserve sufficient for one average day's supply. *(See 5.1.6 for requirements for such reserves.)*

(2) Multiple freestanding buildings are served from a single oxygen source such that damage to the interconnecting oxygen line could result in one or more buildings losing oxygen supply, in which case each building is required to be provided with a separate emergency connection.

5.1.5.1
EOSCs shall be located as follows:

(1) Located 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

5.1.5.2
EOSCs shall consist of the following:

(1) Physical protection to prevent unauthorized tampering

(2) Female DN (NPS) inlet for connection of the emergency oxygen source that is sized for 100 percent of the system demand at the emergency source gas pressure

(3) Manual shutoff valve to isolate the EOSC when not in use

(4) Two check valves, one downstream of the EOSC and one downstream of the main line shutoff valve, with both upstream from the tee connection for the two pipelines

(5) Relief valve sized to protect the downstream piping system and related equipment from exposure to pressures in excess of 50 percent higher than normal line pressure

(6) Any valves necessary to allow connection of an emergency supply of oxygen and isolation of the piping to the normal source of supply

(7) Minimum of 1 m (3 ft) of clearance around the EOSC for connection of temporary auxiliary source

(8) *Four alarm connection points installed to both master alarm panels to allow the temporary supply to be monitored while in use

5.1.6 In-Building Emergency Reserves (IBERs).

5.1.6.1
IBERs shall not be used as substitutes for the bulk gas reserve system that is required in 5.1.7.9.3.2.

5.1.6.2
When an IBER is provided inside the building as a substitute for the EOSC or for other purposes, it shall be located in accordance with 5.1.3.5.2.

5.1.6.3

IBERs shall consist of either of the following:

(1) Gas cylinder header per 5.1.4.7 with sufficient cylinder connections to provide for at least one average day's supply with the appropriate number of connections being determined after consideration of the delivery schedule, the proximity of the facility to alternate supplies, and the facility's emergency plan

(2) Manifold for gas cylinders complying with 5.1.7.2

5.1.6.4
IBERs shall include a check valve in the main line placed on the distribution system side of the ordinary source's main line valve to prevent flow of gas from the emergency reserve to the ordinary source.

5.1.6.5
IBERs shall have a local signal that visibly indicates the operating status of the equipment and an alarm at all master alarms when or just before the reserve begins to serve the system.

~~**(2) Anesthetizing locations**~~
~~**(3) Locations storing flammables**~~
~~**(4) Rooms containing open electrical contacts or transformers**~~
~~**(5) Storage tanks for flammable or combustible liquids**~~
~~**(6) Engines**~~
~~**(7) Kitchens**~~
~~**(8) Areas with open flames**~~
5.1.~~3~~7* Category 1 Central Supply Systems~~Sources~~.

Central supply systems shall be permitted to consist of any of the following:

(1) Cylinder manifolds for gas cylinders in accordance with 5.1.7.2

(2) Manifolds for cryogenic liquid containers in accordance with 5.1.7.3

(3) Cryogenic fluid central supply systems in accordance with 5.1.7.9

(4) Medical air compressor systems in accordance with 5.1.7.4

(5) Medical–surgical vacuum producers in accordance with 5.1.7.7

(6) WAGD producers in accordance with 5.1.7.7

(7) Instrument air compressor systems in accordance with {{ED note former 5.1.13.3.7}}

(8) Proportioning systems for medical air USP in accordance with 5.1.7.6

(9) Oxygen central supply systems using concentrators in accordance with 5.1.7.8

5.1.7.1 Common requirements for Manifolds

Table 5.1.7.1 Minimum Separation Distance Between Manifolds and Exposures

Exposure	Minimum Distance ft	Minimum Distance m
(1) Building exits	10	3.1
(2) Wall openings	1	0.3
(3) Air intakes	10	3.1
(4) Property lines	5	1.5
(5) Room or area exits	3	0.9
(6) Combustible materials, (e.g., paper, leaves, weeds, dry grass, debris)	15	4.5
(7) Incompatible hazardous materials	20	6.1

[**55:**Table 8.6.3]

~~5.1.3.1 Central Supply System Identification and Labeling.~~
~~5.1.3.1.1*~~

Cylinders, containers, and tanks shall be designed, fabricated, tested, and marked (i.e., stamped) in accordance with Department of Transportation (DOT) regulations, Transport Canada's (TC) *Transportation of Dangerous Goods Regulations*, or the ASME *Boiler and Pressure Vessel Code*. [55:7.1.5.1]

5.1.3.1.2* –

Cylinder contents shall be identified by attached labels or stencils naming the contents in accordance with the mandatory requirements of CGA C-7, *Guide to Classification and Labeling of Compressed Gases*.

5.1.3.1.3 –

Liquid containers shall have additional product identification visible from all directions with a minimum of 51 mm (2 in.) high letters such as a 360-degree wraparound tape for medical liquid containers.

5.1.3.1.4 –

Cryogenic liquid containers shall be provided with gas-specific outlet connections in accordance with the mandatory requirements of CGA V-5, *Standard for Diameter Index Safety System (Noninterchangeable Low Pressure Connections for Medical Gas Applications)*, or CGA V-1, *Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections*.

5.1.3.1.5 –

Cylinder and cryogenic liquid container outlet connections shall be affixed in such a manner as to be integral to the valve(s), unremovable with ordinary tools, or so designed as to render the attachment point unusable when removed.

5.1.3.1.6 –

The contents of cylinders and cryogenic liquid containers shall be verified prior to use.

5.1.3.1.7 –

Labels shall not be defaced, altered, or removed, and connecting fittings shall not be modified.

5.1.3.1.8 –

Source locations containing positive-pressure gases other than oxygen and medical air shall be provided with signage located on or immediately adjacent to the door that is visible upon entering the space as follows:

-Positive Pressure Gases

-

NO Smoking or Open Flame

-

Room May Have Insufficient Oxygen

-

Open Door and Allow Room to Ventilate Before Entering

5.1.3.1.8.1 –

Existing signage that is not in strict compliance with the requirements of this code shall be permitted to be continued in use unless the authority having jurisdiction has determined that such use constitutes a distinct hazard to life.

5.1.3.1.9 –

Source locations containing only oxygen or medical air shall be provided with signage located on or immediately adjacent to the door that is visible upon entering the space as follows:

-Medical Gases

-

NO Smoking or Open Flame

5.1.3.1.9.1 –

Existing signage that is not in strict compliance with the requirements of this code shall be permitted to be continued in use unless the authority having jurisdiction has determined that such use constitutes a distinct hazard to life.

5.1.3.1.10 –

In health care facilities where smoking is prohibited, signs required by 5.1.3.1.8 and 5.1.3.1.9 shall be permitted to omit the reference to smoking.

5.1.3.2 Central Supply System Operations.

5.1.3.2.1 –

The use of adapters or conversion fittings to adapt one gas-specific fitting to another shall be prohibited.

5.1.3.2.2 –

Cylinders and containers shall be handled in strict accordance with 11.6.2.

5.1.3.2.3 –

Only gas cylinders, reusable shipping containers, and their accessories shall be permitted to be stored in rooms containing central supply systems or gas cylinders.

5.1.3.2.4 –

No flammable materials, cylinders containing flammable gases, or containers containing flammable liquids shall be stored in rooms with gas cylinders.

5.1.3.2.5* –

If cylinders are wrapped when received, the wrappers shall be removed prior to storage.

5.1.3.2.6 –

Cylinders without correct markings or whose markings and gas-specific fittings do not match shall not be used.

5.1.3.2.7 –

~~Cryogenic liquid storage units intended to supply gas to the facility shall not be used to transfill other liquid storage vessels.~~

~~5.1.3.2.8~~

~~Care shall be exercised when handling cylinders that have been exposed to freezing temperatures or containers that contain cryogenic liquids to prevent injury to the skin.~~

~~5.1.3.2.9~~

~~Cylinders containing compressed gases and containers for volatile liquids shall be kept away from radiators, steam piping, and like sources of heat.~~

~~5.1.3.2.10~~

~~When cylinder valve protection caps are supplied, they shall be secured tightly in place unless the cylinder is connected for use.~~

~~5.1.3.2.11~~

~~Cylinders in use and in storage shall be prevented from reaching temperatures in excess of 52ºC (125ºF).~~

~~5.1.3.2.12~~

~~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 –7ºC (20ºF) or greater than 52ºC (125ºF).~~

~~5.1.3.3* Central Supply System Locations.~~

~~5.1.3.3.1 General.~~

~~Central supply systems shall be located to meet the criteria in 5.1.3.3.1 through 5.1.3.3.1.10.~~

~~5.1.3.3.1.1~~

~~Any of the following central supply systems shall be permitted to be located together in the same outdoor enclosure:~~

~~(1) Manifolds for gas cylinders *(see 5.1.3.5.10)*~~

~~(2) Manifolds for cryogenic liquid containers *(see 5.1.3.5.11)*~~

~~(3) Cryogenic fluid central supply *(see 5.1.3.10)*~~

~~(4) *Individual components on the oxygen side of concentrator sources *(see 5.1.3.9)*~~

~~5.1.3.3.1.2~~

~~Any of the following systems shall be permitted to be located together in the same indoor enclosure:~~

~~(1) Manifolds for gas cylinders *(see 5.1.3.5.10)*~~

~~(2) Manifolds for cryogenic liquid containers *(see 5.1.3.5.11)*~~

~~(3) In-building emergency reserves *(see 5.1.3.5.13)*~~

~~(4) Instrument air standby headers *(see 5.1.13.3.7.6)*~~

~~(5) *Individual components on the oxygen side of concentrator sources *(see 5.1.3.9)*~~

~~5.1.3.3.1.3~~

~~Any of the following central supply systems shall be permitted to be located together in the same room:~~

~~(1) Medical air central supply compressor supply sources *(see 5.1.3.6.3)*~~

~~(2) Medical-surgical vacuum central supply sources *(see 5.1.3.7)*~~

~~(3) Waste anesthetic gas disposal (WAGD) central supply sources *(see 5.1.3.8)*~~

~~(4) Instrument air compressor central supply sources *(see 5.1.13.3.7)*~~

~~(5) Any other compressor, vacuum pump, or electrically powered machinery~~

~~(6) *Compressors, dryers, and air receivers used to supply oxygen concentrators *(see 5.1.3.9)*~~

~~(7) Concentrator units with air and oxygen sides in an integral unit *(see 5.1.3.9)*~~

~~5.1.3.3.1.4~~

~~Any central supply system listed under 5.1.3.3.1.3 shall not be located in the same room with any central supply system listed under 5.1.3.3.1.1 or 5.1.3.3.1.2, except instrument air reserve headers complying with 5.1.3.2.11 and 5.1.13.3.7.6 shall be permitted to be in the same room as an instrument air compressor.~~

~~5.1.3.3.1.5~~

~~Indoor locations for oxygen, nitrous oxide, and mixtures of these gases shall not communicate with the following:~~

~~(1) Areas involved in critical patient care~~

~~(2) Anesthetizing locations~~

~~(3) Locations storing flammables~~

~~(4) Rooms containing open electrical contacts or transformers~~

~~(5) Storage tanks for flammable or combustible liquids~~

~~(6) Engines~~

~~(7) Kitchens~~

~~(8) Areas with open flames~~

~~5.1.3.3.1.6*~~

~~Cryogenic fluid central supply systems for oxygen shall comply with NFPA 55.~~

~~5.1.3.3.1.7~~

~~Bulk nitrous oxide central supply systems shall comply with NFPA 55 and with the mandatory requirements of CGA G-8.1, *Standard for Nitrous Oxide Systems at Customer Sites*.~~

~~5.1.3.3.1.8~~

~~Central supply systems for carbon dioxide using permanently installed containers with product capacities greater than 454 kg (1000 lb) shall comply with NFPA 55 and with the mandatory requirements of CGA G-6.1, *Standard for Insulated Liquid Carbon Dioxide Systems at Consumer Sites*.~~

5.1.3.3.1.9

Central supply systems for carbon dioxide using permanently installed containers with product capacities of 454 kg (1000 lb) or less shall comply with NFPA 55 and with the mandatory requirements of CGA G-6.5, *Standard for Small Stationary Insulated Carbon Dioxide Supply Systems*.

5.1.3.3.1.10*

Cryogenic fluid central supply systems for inert gases shall comply with NFPA 55 and with the mandatory requirements of CGA P-18, *Standard for Bulk Inert Gas Systems*.

5.1.3.3.2* Design and Construction.

5.1.3.3.2.1

Medical gas and vacuum systems shall be designed by one of the following:

(1) A party technically competent and experienced in the field of medical gas and vacuum system design and meeting the requirements of ASSE/IAPMO/ANSI 6060, *Professional Qualifications Standard for Medical Gas System Designers*

(2) A party deemed technically competent through other qualification(s) deemed sufficient by the health care facility's governing body

5.1.3.3.2.2

Locations for central supply systems other than cryogenic fluid central supply systems and motor-driven equipment and locations for the storage of positive-pressure gases shall meet the following requirements:

(1) The location shall be constructed with access to move cylinders, equipment, and so forth in and out of the location on hand trucks complying with the requirements of 11.4.3.1.1.

(2) The location shall be provided with lockable doors or gates or otherwise able to be secured.

(3) If outdoors, the location shall be well drained and provided with an enclosure (e.g., wall or fencing) constructed of noncombustible materials.

(4) If outdoors, cylinders and containers shall be protected from prolonged contact with soil.

(5) If indoors, the location shall have interior finishes of noncombustible or limited-combustible materials.

(6) *If indoors, rooms containing oxygen, nitrous oxide, or other oxidizers shall be separated from the rest of the building by walls and floors having a 1-hour fire resistance rating with doors and other opening protectives having a 3/4-hour fire protection rating.

(7) *The location shall comply with *NFPA 70* for ordinary locations.

(8) *Fuel-fired equipment shall not be located in the room.

(9) If the location requires heat, the maximum allowable temperature of the in-room heating element shall be 130°C (266°F).

(10) The location shall be provided with racks, chains, or other fastenings to secure all cylinders from falling, whether connected, unconnected, full, or empty.

(11) *The location shall be supplied with electrical power compliant with the requirements for essential electrical systems as described in Chapter 6.

(12) The location shall have racks, shelves, and supports, where provided, constructed of noncombustible materials or limited-combustible materials.

(13) The location shall protect electrical devices from physical damage.

(14) *The location shall allow access by delivery vehicles and management of cylinders.

(15) The location shall be designed to meet the operational requirements of 5.1.3.2 regarding room temperature.

5.1.3.3.2.3

Locations for motor-driven central supply systems shall meet the following requirements:

(1) They shall be constructed with access to move equipment and so forth in and out of the location as necessary.

(2) They shall be provided with lockable doors or gates or otherwise able to be secured.

(3) They shall comply with *NFPA 70* for ordinary locations.

(4) The maximum allowable temperature of the room shall be in accordance with the manufacturer's recommendations.

(5) They shall be supplied with electrical power compliant with the requirements for essential electrical systems as described in Chapter 6.

5.1.3.3.2.4

Design and construction of locations for cryogenic fluid central supply systems shall comply with 5.1.3.10.

5.1.3.3.2.5*

The total quantity of medical gases connected to or in storage for central supply systems shall comply with Table 5.1.3.3.2.5 for each enclosure or room.

Table 5.1.3.3.2.5 Storage Quantities for Medical Gas and Cryogenic Fluid Central Supply Systems in Health Care Facilities

-	Maximum Allowable Quantity, Connected and in Storage		
Gas	Outdoor Enclosures[a]	Indoor Nonsprinklered[b]	Indoor Sprinklered[c]
Oxygen and nitrous oxide[d]	No limit	283 m^3 (10,000 ft^3)	566 m^3 (20,000 ft^3)

-	Maximum Allowable Quantity, Connected and in Storage		
Gas	Outdoor Enclosures[a]	Indoor Nonsprinklered[b]	Indoor Sprinklered[c]
Carbon dioxide, helium, medical air, and nitrogen	No limit		

[a]Outdoor enclosure constructed and ventilated in accordance with this code and NFPA 55.
[b]Indoor structure constructed in accordance with 5.1.3.3.2 and ventilated in accordance with 9.3.6.
[c]Indoor structure constructed in accordance with 5.1.3.3.2, ventilated in accordance with 9.3.6, and provided with an approved, automatic sprinkler system in accordance with NFPA 13.
[d]Sum of all oxidizing gases within a room.

5.1.3.3.2.6

Storage of portable patient care gas equipment shall comply with Chapter 11.

5.1.3.3.2.7*

The limits for the maximum allowable quantities listed in Table 5.1.3.3.2.5 shall be permitted to be exceeded where documented by an approved risk assessment by the health care facility's governing body.

5.1.3.3.3 Ventilation.

5.1.3.3.3.1 Ventilation for Indoor Locations.

Central supply system locations, medical gas storage rooms, and transfilling room ventilation shall comply with 9.3.6.

5.1.3.3.3.2 Venting of Relief Valves.

Indoor supply systems shall have all relief valves vented per 5.1.3.5.6.1(4) through 5.1.3.5.6.1(9).

5.1.3.3.3.3 Ventilation for Motor-Driven Equipment.

The following source locations shall be ventilated to prevent accumulation of heat:

(1) Medical air central supply systems sources *(see 5.1.3.6)*
(2) Medical-surgical vacuum central supply systems sources *(see 5.1.3.7)*
(3) Waste anesthetic gas disposal (WAGD) central supply systems sources *(see 5.1.3.8.1)*
(4) Instrument air central supply systems sources *(see 5.1.13.3.7)*

5.1.3.3.3.4 Ventilation for Outdoor Locations.

(1) Outdoor locations surrounded by impermeable walls, except fire barrier walls, shall have protected ventilation openings located at the base of each wall to allow free circulation of air within the enclosure.
(2) Walls that are shared with other enclosures or with buildings shall be permitted to not have openings.
(3) The fire barrier wall shall not have openings or penetrations, except conduit or piping shall be permitted, provided that the penetration is protected with a firestop system in accordance with the building code.

5.1.3.3.4 Storage.

5.1.3.3.4.1

Full or empty medical gas cylinders, when not connected, shall be stored in locations complying with 5.1.3.3.2 through 5.1.3.3.3 and shall be permitted to be in the same rooms or enclosures as their respective central supply systems. Approved existing installations shall be permitted to be continued in service.

5.1.3.3.4.2*

Cylinders, whether full or empty, shall not be stored in enclosures containing motor-driven machinery, with the exception of cylinders intended for instrument air reserve headers complying with 5.1.13.3.7.6, which shall be permitted to be placed in the same location containing an instrument air compressor when it is the only motor-driven machinery located within the room. Only cylinders intended for instrument air reserve headers complying with 5.1.13.3.7.6 shall be permitted to be stored in enclosures containing instrument air compressors.

5.1.3.4 Control Equipment.

For control equipment, as specified in 5.1.3.5.5, 5.1.3.5.6, and 5.1.3.5.7, 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(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.

5.1.3.5* Central Supply Systems.

Central supply systems shall be permitted to consist of the following:

(1) Cylinder manifolds for gas cylinders in accordance with 5.1.3.5.10
(2) Manifolds for cryogenic liquid containers in accordance with 5.1.3.5.11
(3) Cryogenic fluid central supply systems in accordance with 5.1.3.10
(4) Medical air compressor systems in accordance with 5.1.3.6

(5) Medical-surgical vacuum producers in accordance with 5.1.3.7
(6) WAGD producers in accordance with 5.1.3.8
(7) Instrument air compressor systems in accordance with 5.1.13.3.7
(8) Proportioning systems for medical air USP in accordance with 5.1.3.6.3.14
(9) Oxygen central supply systems using concentrators in accordance with 5.1.3.9

5.1.3.5.1 General.

Central supply systems shall be obtained from a supplier or manufacturer familiar with their proper construction and use and installed in accordance with the manufacturer's instructions.

5.1.3.5.2 Permitted Locations for Medical Gases.

Central supply systems for oxygen, medical air, nitrous oxide, carbon dioxide, and all other patient medical gases shall be piped only to medical gas outlets complying with 5.1.5, into areas where the gases will be used under the direction of licensed medical professionals for purposes congruent with the following:

(1) Direct respiration by patients
(2) Clinical application of the gas to a patient, such as the use of an insufflator to inject carbon dioxide into patient body cavities during laparoscopic surgery and carbon dioxide used to purge heart-lung machine blood flow ways
(3) Medical device applications directly related to respiration
(4) Power for medical devices used directly on patients
(5) Calibration of medical devices intended for 5.1.3.5.2(1) through 5.1.3.5.2(4)
(6) Simulation centers for the education, training, and assessment of health care professionals

5.1.3.5.3 Medical Support Gases.

Central supply systems for medical support gases shall not be piped to, or used for, any purpose except medical support application.

5.1.3.5.4* 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 3000 kPa (435 psi), interconnecting hose shall contain no polymeric materials.
(2) In those portions of systems intended to handle oxygen or nitrous oxide at gauge pressures of less than 3000 kPa (435 psi), construction shall be compatible with oxygen under the temperatures and pressures to which the components can be exposed in the containment and use of oxygen, nitrous oxide, mixtures of these gases, or mixtures containing more than 23.5 percent oxygen.
(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 in accordance with the manufacturer's requirements.

5.1.3.5.5 Controls for Line Pressure.

5.1.3.5.5.1*

All positive-pressure supply systems shall be provided with means to control the final line pressure at the source with all the following characteristics:

(1) Able to maintain stable pressures within the limits of Table 5.1.11
(2) Each control mechanism able to flow 100 percent of the peak calculated demand
(3) Redundant, such that each component of the control mechanism can be isolated for service or replacement while maintaining normal operation
(4) Protected against overpressure *(see 5.1.3.5.6)*
(5) Be constructed of materials deemed suitable by the manufacturer

5.1.3.5.5.2

The line pressure regulators required under 5.1.3.5.5.1, where used for cryogenic fluid central supply systems, shall be of a balanced design.

5.1.3.5.6 Relief Valves.

5.1.3.5.6.1

All pressure relief valves shall meet the following requirements:

(1) They shall be of brass, bronze, or stainless steel construction.
(2) They shall be designed for the specific gas service.
(3) They shall have a relief pressure setting not higher than the maximum allowable working pressure (MAWP) of the component with the lowest working pressure rating in the portion of the system being protected.
(4) They shall 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) They shall have a vent discharge line that is not smaller than the size of the relief valve outlet or 20 mm (NPS 3/4), whichever is larger.
(6) Where two or more relief valves discharge into a common vent line, the internal cross-sectional area of the common line shall be not less than the aggregate cross-sectional area of all relief valve vent discharge lines served.

~~(7) They shall discharge to open air such that escaping gas does not impinge on personnel, equipment, or adjacent structures or enter into enclosed spaces.~~
~~(8) They shall have the discharge terminal turned down and screened to prevent the entry of rain, snow, or vermin.~~
~~(9) They shall be designed in accordance with ASME B31.3, *Process Piping*.~~
~~5.1.3.5.6.2~~
~~Pressure relief valves for cryogenic fluid central supply systems shall be in accordance with 5.1.3.10.10.~~
~~5.1.3.5.6.3~~
~~When vented to outdoors, materials and construction for relief valve discharge lines shall be the same as required for positive-pressure gas distribution. *(See 5.1.10.1.)*~~
~~5.1.3.5.6.4~~
~~Central supply systems for positive-pressure gases shall include one or more relief valves, all meeting the following requirements:~~
~~(1) They shall be located between each final line regulator and the source valve.~~
~~(2) They shall have a relief setting that is 50 percent above the normal system operating pressure, as indicated in Table 5.1.11.~~
~~5.1.3.5.6.5~~
~~When vented outside, relief valve vent lines shall be labeled in accordance with 5.1.11.1 in any manner that will distinguish them from the medical gas pipeline.~~
~~5.1.3.5.7 Multiple Pressures.~~
~~Where a single central supply system supplies separate piped distribution networks operating at different pressures, each piped distribution network shall comply with 5.1.3.5.5 for pressure controls, 5.1.3.5.6 for relief valves, 5.1.4.2 for the source valve, and 5.1.9.2.4(7) for the master alarm.~~
~~5.1.3.5.8 Local Signals.~~
~~5.1.3.5.8.1~~
~~The following central supply systems shall have local signals located at the source equipment:~~
~~(1) Manifolds for gas cylinders without reserve supply *(see 5.1.3.5.10)*~~
~~(2) Manifolds for gas cylinders with reserve supply~~
~~(3) Manifolds for cryogenic liquid containers *(see 5.1.3.5.11)*~~
~~(4) Cryogenic fluid central supply systems *(see 5.1.3.10)*~~
~~(5) In-building emergency reserves *(see 5.1.3.5.13)*~~
~~(6) Instrument air headers *(see 5.1.13.3.7.6)*~~
~~5.1.3.5.8.2~~
~~The local signals shall meet the following requirements:~~
~~(1) Provision of visual indication only~~
~~(2) Labeling for the service and condition being monitored~~
~~(3) If intended for outdoor installation, be installed per manufacturer's requirements~~
~~5.1.3.5.9* Headers.~~
~~In central supply systems using cylinders containing either gas or liquid, each header shall include the following:~~
~~(1) *Cylinder connections in the number required for the header's application~~
~~(2) Cylinder lead for each cylinder constructed of materials complying with 5.1.3.5.4 and provided with end fittings permanently attached to the cylinder lead complying with the mandatory requirements of CGA V-1, *Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections* (ANSI B57.1)~~
~~(3) Filter of a material complying with 5.1.3.5.4 to prevent the intrusion of debris into the manifold controls~~
~~(4) Header shutoff valve downstream of the nearest cylinder connection, but upstream of the point at which the header connects to the central supply system~~
~~(5) Pressure indicator indicating the pressure of header contents~~
~~(6) Check valve to prevent backflow into the header and to allow service to the header~~
~~(7) If intended for gas cylinder service, a check valve at each connection for the cylinder lead in 5.1.3.5.9(2) to prevent loss of gas in the event of damage to the cylinder lead or operation of an individual cylinder relief valve~~
~~(8) If intended for gas cylinder service, a pressure regulator to reduce the cylinder pressure to an intermediate pressure to allow the proper operation of the primary and secondary headers~~
~~(9) If intended for service with cryogenic liquid containers, a pressure relief valve~~
~~(10) Vent valves, if fitted on a header, vented outside of the building per 5.1.3.5.6.1(5) through 5.1.3.5.6.1(9) and 5.1.3.5.6.3~~
~~5.1.3.5.10~~5.1.7.2* **Manifolds for Gas Cylinders.**

~~5.1.7.2~~~~5.1.3.5.10~~**.1**~~—~~

The manifolds in this category shall be located in accordance with 5.1.~~3.3~~3 ~~.1 and shall meet the following:~~

~~(1) If located outdoors, they shall be installed in an enclosure used only for this purpose and sited to comply with minimum distance requirements in Table 5.1.3.5.11.1.~~
~~(2) If located~~ ~~indoors, they shall be installed within a room used only for enclosure of such manifolds.~~
~~5.1.3.5.10.2~~
~~The manifold locations for this category shall be constructed in accordance with 5.1.3.3.2.~~

5.1.7.2~~5.1.3.5.10~~.~~3~~ 2
The manifolds in this category shall have their primary and secondary headers located in the same enclosure.

5.1.7.2~~5.1.3.5.10~~.~~4~~ 3
The manifolds in this category shall consist of the following:

(1) Two equal headers in accordance with 5.1.~~3.5.~~4.~~79~~, each with a sufficient number of gas cylinder connections for one average day's supply, but not fewer than two connections, and with the headers connected to the final line pressure regulator assembly in such a manner that either header can supply the system

~~(2) Vent valves, if fitted on a header, vented outside of the building per 5.1.3.5.6.1(5) through 5.1.3.5.6.1(9) and 5.1.3.5.6.3~~

(~~3~~2) Intermediate relief valve(s), piped to the outside in accordance with 5.1.4.4.2 (5)~~5.1.3.5.6.1(5) through 5.1.3.5.6.1(9)~~, that protects the piping between the header pressure regulator and the line pressure regulator assembly, and protects the line pressure regulators from overpressure in the event of a header regulator failure

5.1.7.2~~5.1.3.5.10~~.~~5~~ 4
The manifolds in this category shall include an automatic means of alternating the two headers to accomplish the following in normal operation:

(1) One header is the primary and the other is the secondary, with either being capable of either role.

(2) When the primary header is supplying the system, the secondary header is prevented from supplying the system.

(3) When the primary header is depleted, the secondary header automatically begins to supply the system.

5.1.7.2~~5.1.3.5.10~~.~~6~~ 5
The manifolds in this category shall have a local signal that visibly indicates the operating status of the equipment and shall activate an indicator at all master alarm panels when or at a predetermined set point before the secondary header begins to supply the system, indicating changeover has occurred or is about to occur.

5.1.7.2~~5.1.3.5.10~~.~~7~~ 6
If manifolds are located out of doors, they shall be installed per 5.1.3 and the manufacturer's requirements.

5.1.7.3~~5.1.3.5.11~~* Manifolds for Portable Cryogenic Liquid Containers.

5.1.7.3~~5.1.3.5.11~~.1~~–~~
Manifolds for cryogenic liquid containers shall be located in accordance with 5.1.3~~in accordance with 5.1.3.3.1 and the following:~~
~~(1) If located outdoors, they shall be installed in an enclosure used only for the enclosure of such containers and sited to comply with minimum distance requirements in Table 5.1.3.5.11.1.~~
~~(2) If located indoors, they shall be installed within a room used only for the enclosure of such containers.~~
~~Table 5.1.3.5.11.1 Minimum Separation Distance Between Portable Cryogenic Containers and Exposures~~

~~Exposure~~	~~Minimum Distance~~ ~~ft~~	~~m~~
~~(1) Building exits~~	~~10~~	~~3.1~~
~~(2) Wall openings~~	~~1~~	~~0.3~~
~~(3) Air intakes~~	~~10~~	~~3.1~~
~~(4) Property lines~~	~~5~~	~~1.5~~
~~(5) Room or area exits~~	~~3~~	~~0.9~~
~~(6) Combustible materials, (e.g., paper, leaves, weeds, dry grass, debris)~~	~~15~~	~~4.5~~

- Exposure	Minimum Distance ft	m
(7) Incompatible hazardous materials	20	6.1

[55:Table 8.6.3]

5.1.7.3~~5.1.3.5.11~~.2
The manifolds in this category shall have their primary and secondary headers located in the same enclosure.

5.1.7.3~~5.1.3.5.11~~.3
The reserve header shall be permitted to be located in the same enclosure as the primary and secondary headers or in another enclosure compliant with 5.1.~~3.5.11~~3~~.1~~.

5.1.7.3~~5.1.3.5.11~~.4
The manifolds in this category shall consist of the following:

(1) Two equal headers in accordance with 5.1.4.7~~5.1.3.5.9~~, each having sufficient internal or external vaporization capacity to meet the required peak flow rate and each having sufficient number of liquid container connections for one average day's supply, and with the headers connected to the final line pressure regulator assembly in such a manner that either header can supply the system

(2) Reserve header in accordance with 5.1.4.7 ~~5.1.3.5.9~~ having sufficient number of gas cylinder connections for one average day's supply, but not fewer than three connections, and connected downstream of the primary/secondary headers and upstream of the final line pressure regulators

(3) Pressure relief installed downstream of the connection of the reserve header and upstream of the final line pressure regulating assembly and set at 50 percent above the nominal inlet pressure

(4) If provided with one liquid container header (primary), one gas cylinder header (secondary), and a reserve gas cylinder header (a hybrid arrangement), a secondary gas cylinder supply having equal capacity to meet the required peak flow rate of the primary header, and a reserve gas cylinder header in accordance with 5.1.4.7 ~~5.1.3.5.9~~ having sufficient number of gas cylinder connections for one average day's supply, but not fewer than three connections

5.1.7.3~~5.1.3.5.11~~.5
The manifolds in this category shall include an automatic means of controlling the three headers to accomplish the following during normal operation:

(1) If provided with two liquid container headers, one cryogenic liquid header shall be the primary and the other shall be the secondary, with either being capable of either role.

(2) If provided with one liquid container header and one gas cylinder header (a hybrid arrangement), the liquid container header is the primary and the gas cylinder header is the secondary.

(3) When the primary header is supplying the system, the secondary header is prevented from supplying the system.

(4) When the primary header is depleted, the secondary header automatically begins to supply the system.

5.1.7.3~~5.1.3.5.11~~.6
The manifolds in this category shall be equipped with a means to conserve the gas produced by evaporation of the cryogenic liquid in the secondary header (when so provided). This mechanism shall discharge the conserved gas into the system upstream of the final line regulator assembly.

5.1.7.3~~5.1.3.5.11~~.7
The manifolds in this category shall include a manual or automatic means to place either header into the role of primary header and the other into the role of secondary header, except where a liquid/gas hybrid manifold is employed.

5.1.7.3~~5.1.3.5.11~~.8
The manifolds in this category shall include a means to automatically activate the reserve header if for any reason the primary and secondary headers cannot supply the system.

5.1.7.3~~5.1.3.5.11~~.9
The manifolds in this category shall have a local signal that visibly indicates the operating status of the equipment and activates an indicator at all master alarms under the following conditions:

(1) When or at a predetermined set point before the secondary header begins to supply the system, indicating changeover

(2) Where a hybrid arrangement is employed, when or at a predetermined set point before the secondary (cylinder) header contents fall to one average day's supply, indicating secondary low

(3) When or at a predetermined set point before the reserve header begins to supply the system, indicating reserve is in use

(4) When or at a predetermined set point before the reserve header contents fall to one average day's supply, indicating reserve low

~~5.1.3.5.12* Emergency Oxygen Supply Connection (EOSC).~~
~~Emergency oxygen supply connections (EOSCs) shall be installed to allow connection of a temporary auxiliary source of supply for emergency or maintenance situations where either of the following conditions exist:~~
~~(1) The bulk liquid system or cryogenic fluid central supply system is outside of and remote from the building that the oxygen supply serves, and there is no connected in-building oxygen reserve sufficient for one average day's supply. *(See 5.1.3.5.13 for requirements for such reserves.)*~~
~~(2) Multiple freestanding buildings are served from a single oxygen source such that damage to the interconnecting oxygen line could result in one or more buildings losing oxygen supply, in which case each building is required to be provided with a separate emergency connection.~~
~~5.1.3.5.12.1~~
~~EOSCs shall be located as follows:~~
~~(1) Located 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~~
~~5.1.3.5.12.2~~
~~EOSCs shall consist of the following:~~
~~(1) Physical protection to prevent unauthorized tampering~~
~~(2) Female DN (NPS) inlet for connection of the emergency oxygen source that is sized for 100 percent of the system demand at the emergency source gas pressure~~
~~(3) Manual shutoff valve to isolate the EOSC when not in use~~
~~(4) Two check valves, one downstream of the EOSC and one downstream of the main line shutoff valve, with both upstream from the tee connection for the two pipelines~~
~~(5) Relief valve sized to protect the downstream piping system and related equipment from exposure to pressures in excess of 50 percent higher than normal line pressure~~
~~(6) Any valves necessary to allow connection of an emergency supply of oxygen and isolation of the piping to the normal source of supply~~
~~(7) Minimum of 1 m (3 ft) of clearance around the EOSC for connection of temporary auxiliary source~~
~~(8) *Four alarm connection points installed to both master alarm panels to allow the temporary supply to be monitored while in use~~
~~5.1.3.5.13 In-Building Emergency Reserves (IBERs).~~
~~5.1.3.5.13.1~~
~~IBERs shall not be used as substitutes for the bulk gas reserve system that is required in 5.1.3.10.3.4.~~
~~5.1.3.5.13.2~~
~~When an IBER 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~~
~~5.1.3.5.13.3~~
~~IBERs shall consist of either of the following:~~
~~(1) Gas cylinder header per 5.1.3.5.9 with sufficient cylinder connections to provide for at least one average day's supply with the appropriate number of connections being determined after consideration of the delivery schedule, the proximity of the facility to alternate supplies, and the facility's emergency plan~~
~~(2) Manifold for gas cylinders complying with 5.1.3.5.10~~
~~5.1.3.5.13.4~~
~~IBERs shall include a check valve in the main line placed on the distribution system side of the ordinary source's main line valve to prevent flow of gas from the emergency reserve to the ordinary source.~~
~~5.1.3.5.13.5~~
~~IBERs shall have a local signal that visibly indicates the operating status of the equipment and an alarm at all master alarms when or just before the reserve begins to serve the system.~~
~~5.1.3.5.14* Auxiliary Connections.~~
~~All medical gas and vacuum systems shall be provided with a point of access for connection of a temporary or supplemental source of supply complying with 5.1.3.5.14.1 through 5.1.3.5.14.5.~~
~~5.1.3.5.14.1~~

~~The auxiliary connection shall be located in the main line, on the patient side of the source valve, as determined by the responsible facility authority.~~
~~5.1.3.5.14.2~~
~~The auxiliary connection shall be the same size as the main line but not required to be larger than DN50 (NPS 2 in.).~~
~~5.1.3.5.14.3~~
~~The auxiliary connection shall consist of a tee, valve, and removable plugged or capped connection point.~~
~~5.1.3.5.14.4~~
~~The valve and connection point shall be labeled in accordance with 5.1.11.~~
~~5.1.3.5.14.5~~
~~The valve shall be secured in accordance with 5.1.4.1.2.~~
~~5.1.3.6~~5.1.7.4* **Category 1 Medical Air Central Supply Systems.**

~~5.1.3.6.~~5.1.7.~~1~~4.1* **Quality of Medical Air.**
Medical air shall be required to have the following characteristics:

(1) It shall be supplied from cylinders, bulk containers, or medical air compressor sources, or it shall be reconstituted from oxygen USP and oil-free, dry nitrogen NF.

(2) It shall meet the requirements of medical air USP.

(3) It shall have no detectable liquid hydrocarbons.

(4) It shall have less than 25 ppm gaseous hydrocarbons.

(5) It shall have equal to or less than 1 mg/m^3 (6.85×10^{-7} lb/yd^3) of permanent particulates sized 1 micron or larger in the air at normal atmospheric pressure.

~~5.1.3.6.2* Uses of Medical Air.~~

~~Medical air sources shall be connected to the medical air distribution system only and shall be used only for air in the application of human respiration, in the calibration of medical devices for respiratory application, and in simulation centers for the education, training, and assessment of health care professionals in accordance with 5.1.3.5.2.~~

~~5.1.3.6.~~5.1.7.4.2~~3~~* **Medical Air Compressor Supply Sources.**

5.1.7.4.2.~~5.1.3.6.3.~~1 **Location.**
Medical air compressor systems shall be located per 5.1.~~3~~3~~.3 .as follows:~~
~~(1) Indoors in a dedicated mechanical equipment area, adequately ventilated and with any required utilities (e.g., electricity, drains, lighting)~~
~~(2) In a room ventilated per 5.1.3.3.3.3~~

~~(3) For air-cooled equipment, in a room designed to maintain the ambient temperature range as recommended by the manufacturer~~

5.1.7.4.2.~~5.1.3.6.~~2~~3.2~~ **Required Components and Arrangement.**
Medical air compressor sources and central supply systems shall consist ~~of the following:~~
~~(1)~~ of Ccomponents complying with 5.1.~~3~~.67.4.2.~~3~~3~~.4~~ through 5.1.~~3~~.67.4.~~3~~.82.7, arranged per 5.1.~~3~~.67.4.2~~3~~.~~8~~9
~~(2) Automatic means to prevent backflow from all on-cycle compressors through all off-cycle compressors~~
~~(3) Manual shutoff valve to isolate each compressor from the centrally piped system and from other compressors for maintenance or repair without loss of pressure in the system~~
~~(4) Intake filter–muffler(s) of the dry type~~
~~(5) Pressure relief valve(s) set at 50 percent above line pressure~~
~~(6) Piping and components between the compressor and the source shutoff valve that do not contribute to contaminant levels~~
~~(7) Except as defined in 5.1.3.6.3.2(1) through 5.1.3.6.3.2(6), materials and devices used between the medical air intake and the medical air source valve that are of any design or construction appropriate for the service as determined by the manufacturer~~
~~5.1.3.6.3.3 Air Drying Equipment.~~
~~Medical air compressor systems shall preclude the condensation of water vapor in the piping distribution system by air drying equipment.~~

5.1.7.4.2.~~5.1.3.6.~~3~~.4~~ **–Compressors for Medical Air.**

(A)*–

Compressors for medical air shall be designed to prevent the introduction of contaminants or liquid into the pipeline by any of the following methods:

(1) Elimination of oil anywhere in the compressor (e.g., liquid ring and permanently sealed bearing compressors)

(2) Reciprocating compressors provided with a separation of the oil-containing section from the compression chamber by at least two seals creating an area open to atmosphere that allows the following:
   (a) Direct and unobstructed visual inspection of the interconnecting shaft through vent and inspection openings no smaller than 1.5 shaft diameters in size
   (b) Confirmation by the facility operators of proper seal operation by direct visual inspection through the above-shaft opening, without disassembly of the compressor (e.g., extended head compressors with an atmospheric vent between the compression chamber and the crankcase)

(3) Rotating element compressors provided with a compression chamber free of oil that provide the following:
   (a) Separation of each oil-containing section from the compression chamber by at least one seal having atmospheric vents on each side with the vent closest to the oil-containing section supplied with a gravity drain to atmosphere
   (b) Unobstructed visualization of the atmospheric vent(s), closest to each oil-containing section, that is accessible for inspection without disassembling the compressor
   (c) Entry of the rotating shaft into each compression chamber at a point that is above atmospheric pressure
   (d) Confirmation by the facility operators of proper seal operation by direct visual inspection of the atmospheric vents

(B~~)~~)

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.

(C~~)~~)

Liquid ring compressors shall comply with the following:

(1) Service water and seal water of a quality recommended by the compressor manufacturer shall be used.
(2) Reserve medical air standby headers or a backup compressor shall be installed.
(3) When installed, the header shall comply with 5.1.~~3.5.9~~4.7.
(4) When installed, the number of attached cylinders shall be sufficient for ~~1~~ 1 hour normal operation.

(D)

Compressors shall be constructed of materials deemed suitable by the manufacturer.

(E) Each compressor shall be protected by an intake filter–muffler(s) of the dry type.

(~~E~~F)

Antivibration mountings shall be installed for compressors as required by equipment dynamics or location and in accordance with the manufacturer's recommendations.

(~~F~~G)

Flexible connectors shall connect the air compressors with their intake and outlet piping.

5.1.7.4.3 Compressor Intake.

(A) The medical air compressors shall draw their air from a source of clean air.

(B) 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 can collect vehicular exhausts or other noxious fumes.

(C) The medical air intake shall be located a minimum of 6 m (20 ft) above ground level.

(D) 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.

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

(1) This alternate source of supply air shall be available on a continuous 24-hour-per-day, 7-day-per-week basis.

(2) Ventilating systems having fans with motors or drive belts located in the airstream shall not be used as a source of medical air intake.

(F) Compressor intake piping shall be permitted to be made of materials and use a joining technique as permitted under *{ed note: former* 5.1.10.2} and *{ed note: former* 5.1.10.3.}

(G) Air intakes for separate compressors shall be permitted to be joined together to one common intake where the following conditions are met:

(1) The common intake is sized to minimize back pressure in accordance with the manufacturer's recommendations.

(2) Each compressor can be isolated by manual or check valve, blind flange, or tube cap to prevent open inlet piping when the compressor(s) is removed for service from the consequent backflow of room air into the other compressor(s).

(H) The end of the intake shall be turned down and screened or otherwise be protected against the entry of vermin, debris, or precipitation by screening fabricated or composed of a noncorroding material.

(I) Medical air intake shall be labeled in accordance with *{ed note: former 5.1.11.1 }* with any method that would distinguish it as a medical air intake.

5.1.7.4.4 Air Drying Equipment.

Medical air compressor systems shall preclude the condensation of water vapor in the piping distribution system by engineered application of air drying equipment.

~~**5.1.3.6.3.**~~**5.1.7.4.**~~**5**~~ **4.1 Aftercoolers**~~.~~

Aftercoolers, where required shall meet the following requirements:

(~~**A**~~**1)**

~~Aftercoolers, where required, shall~~ be provided with individual condensate traps. (i.e.

~~**(B)**~~ they do not use the

~~The~~ receiver ~~shall not be used~~ as an aftercooler- trap~~or aftercooler trap~~.)

(~~**C**~~**2)**

~~Aftercoolers shall~~ be constructed of materials deemed suitable by the manufacturer.

(~~**D**~~**3)** include

~~A~~antivibration mountings ~~shall be installed for aftercoolers~~ as required by equipment dynamics or location and in accordance with the manufacturer's recommendations.

~~**5.1.3.6.3.6 Medical Air Receivers.**~~

~~**Receivers for medical air shall meet the following requirements:**~~

~~**(1) They shall be made of corrosion-resistant materials or otherwise be made corrosion resistant.**~~

~~**(2) They shall comply with Section VIII, "Unfired Pressure Vessels," of the ASME *Boiler and Pressure Vessel Code*.**~~

~~(3) They shall be equipped with a pressure relief valve, automatic drain, manual drain, sight glass, and pressure indicator.~~
~~(4) They shall be of a capacity sufficient to prevent the compressors from short-cycling.~~

5.1.7.4.4.~~5.1.3.6.3~~2.~~7~~ Medical Air Dryers.

Medical air dryers, where required, 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 kPa to 380 kPa (50 psi to 55 psi) at any level of demand

(2) Be sized for 100 percent of the system peak calculated demand at design conditions

(3) Be constructed of materials deemed suitable by the manufacturer

(4) Be provided with antivibration mountings installed as required by equipment dynamics or location and in accordance with the manufacturer's recommendations

(5) *Be provided with a sample port downstream of each dryer for maintenance

5.1.7.4.~~5.1.3.6.3.6~~5 Medical Air Receivers.

Receivers for medical air shall meet the following requirements:

(1) they shall not be used as aftercoolers

(1)~~—~~ They shall be made of corrosion-resistant materials or otherwise be made corrosion resistant.

(2)~~—~~ They shall comply with Section VIII, "Unfired Pressure Vessels," of the ASME *Boiler and Pressure Vessel Code.*

(3) ~~—~~They shall be equipped with a pressure relief valve, automatic drain, manual drain, sight glass, and pressure indicator.

(4)~~—~~ They shall be of a capacity sufficient to prevent the compressors from short-cycling.

~~5.1.3.6.3.8~~5.1.7.4.6 Medical Air Filters.

Medical air filters shall meet the following requirements:

(1) Be appropriate for the intake air conditions

(2) Be located upstream (source side) of the final line regulators

(3) Be sized for 100 percent of the system peak calculated demand at design conditions and be rated for a minimum of 98 percent efficiency at 1 micron or greater

(4) Be equipped with a continuous visual indicator showing the status of the filter element life

(5) Be constructed of materials deemed suitable by the manufacturer

5.1.7.4.7 Electrical power and control

Electrical controls for compressor systems employing electrical motors shall comply with 5.1.4.5.

5.1.7.4.~~5.1.3.6.3.8~~9~~—~~ Piping Arrangement and Redundancies.

(A~~)—~~)

Component arrangement in a medical air central supply system shall be as follows:

(1~~)—~~) Components shall be arranged to allow service and a continuous supply of medical air in the event of a single fault failure.

(2~~)—~~) Component arrangement shall be permitted to vary as required by the technology(ies) employed, provided that an equal level of operating redundancy and medical air quality is maintained.

(3) Piping and components between the compressor and the source shutoff valve shall not contribute to contaminant levels. In all other respects, materials and devices used between the medical air intake and the medical air source valve are permitted to be of any design or construction appropriate for the service as determined by the manufacturer

(B)

Medical air compressors shall be sufficient to serve the peak calculated demand with the largest single compressor out of service. In no case shall there be fewer than two compressors.

(C) Compressors shall be provided with automatic means to prevent backflow from all on-cycle compressors through all off-cycle compressors

(D) Manual shutoff valve(s) shall allow the isolation of each compressor from the centrally piped system and from other compressors for maintenance or repair without loss of pressure in the system

(~~C~~E)
When aftercoolers are provided, they shall be arranged to meet either one of the following:

(1~~)~~) Arranged as a duplex or multiplex set, sized to serve the peak calculated demand with the largest single aftercooler out of service, and provided with valves adequate, to isolate any single aftercooler from the system without shutting down supply of medical air

(2~~)~~) Arranged one per compressor, sized to handle the output of that compressor, and valved as appropriate to allow repair or replacement with that compressor out of service but without shutting down supply of medical air

(3) Under normal operation, only one aftercooler shall be open to airflow with the other aftercooler valved off.

(~~D~~F)*
A medical air receiver(s) shall be provided with proper valves to allow the flow of compressed air to enter and exit out of separate receiver ports during normal operation and allow the receiver to be bypassed during service without shutting down the supply of medical air.

(~~E~~G)
Dryers, filters, and regulators shall be at least duplexed, with each component sized to serve the peak calculated demand with the largest of each component out of service and comply with the following:~~.~~
~~(F)~~
~~*~~

(1) Dryers, filters, and regulators shall be provided with manual valves upstream and manual valves or check valves downstream to allow service to the components without shutting down the system in either one of the following ways:

(~~1~~a~~)~~) They shall be installed for each component, upstream and downstream of each component, allowing each to be individually isolated~~.~~ OR

(~~2~~b~~)~~) They shall be installed upstream (source side) and downstream of components in series so as to create redundant parallel branches of components.

~~(G~~(2)~~)~~

A three-way valve (three-port), indexed to flow, full port shall be permitted to be used to isolate one branch or component for the purposes of 5.1.7.4.8 (E) and ~~5.1.3.6.3.9(C)~~5.1.7.4.8 (G)~~, 5.1.3.6.3.9(D), 5.1.3.6.3.9(E), and 5.1.3.6.3.9(F).~~

~~(H)~~

~~Under normal operation, only one aftercooler shall be open to airflow with the other aftercooler valved off.~~

(~~I~~3)

Under normal operation, only one dryer–filter(s)–regulator sequence shall be open to airflow with the other sequence valved off.

(~~J~~H)
If the relief valves required in 5.1.~~3.6.3.2(5) and 5.1.3.6.3.6(3)~~4.4 can be isolated from the system by the valve arrangement used to comply with 5.1.7.4.8 (G), ~~5.1.3.6.3.9(F),~~ then a redundant relief valve(s) shall be installed in the parallel sequence.

(~~K~~I)
A DN8 (NPS 1/4) valved sample port shall be provided downstream of the final line pressure regulators, dew point monitor, and carbon monoxide monitor and upstream of the source shutoff valve to allow for sampling of the medical air.

(~~L~~J)

Medical air source systems shall be provided with a source valve per *{ed note: former* 5.1.4.2.}

(~~M~~K)
Where medical air piping systems at different operating pressures are required, the piping shall separate after the filters but shall be provided with separate line regulators, dew point monitors, relief valves, and source shutoff valves.

~~**5.1.3.6.3.10* Electrical Power and Control.**~~
~~**(A)**~~
~~**Medical air source systems shall be controlled to ensure continuous supply of medical air at pressures consistent with Table 5.1.11 under all conditions of system use as follows:**~~
~~**(1) Automatic activation of compressor(s) as necessary to supply the demand.**~~
~~**(2) Managing the operation to equalize wear on all compressors. Where this equalization is achieved manually, the facility staff shall arrange a schedule for manual alternation.**~~
~~**(B)**~~
~~**Controls shall provide the following functions:**~~
~~**(1) Where medical air source systems having two or more compressors employ any electrical circuit device that upon failure could prevent supply of medical air, the controls shall be provided with an automatically activated alternative method for ensuring supply (e.g., redundant component(s), an alternate electrical supply path, or other equivalent method).**~~
~~**(2) Control circuits shall be arranged in such a manner that isolation of one compressor or component from the system (e.g., for maintenance or repair) does not interrupt the operation of other compressor(s) or component(s).**~~
~~**(3) Automatic restart function shall be included, such that the supply of medical air will resume normally after power interruption without manual intervention.**~~
~~**(C)**~~
~~**Each compressor motor shall be provided with electrical components including, but not limited to, the following:**~~
~~**(1) Dedicated disconnect switch installed in the electrical circuit ahead of each motor starter**~~
~~**(2) Motor starting device**~~
~~**(3) Overload protection**~~
~~**(D)**~~
~~**Medical air compressor system controls shall be provided with electrical systems including, at a minimum:**~~
~~**(1) Built-in disconnect means shall be included to allow appropriate operation of multiple compressor systems and protect service personnel from exposure to live voltages.**~~
~~**(2) Control circuits shall be arranged so that failure of any component of the control circuit, or shutdown of one compressor (e.g., for service), does not interrupt automatic operation of the standby compressor.**~~
~~**(3) An automatic restart function shall be included, such that the compressor(s) will restart after power interruption without manual intervention.**~~
~~**(4) Where components are common to more than one control circuit (e.g., autodrains) the common device shall be provided with electrical protection to prevent loss of the control circuits(s) in the event of short circuit in the device.**~~
~~**(E)**~~
~~**Electrical installation and wiring shall conform to the requirements of *NFPA 70*.**~~
~~**(F)**~~
~~**Emergency electrical service for the compressors shall conform to the requirements of the essential electrical system as described in Chapter 6.**~~
~~**5.1.3.6.3.11 Compressor Intake.**~~
~~**(A)**~~
~~**The medical air compressors shall draw their air from a source of clean air.**~~
~~**(B)**~~
~~**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 can collect vehicular exhausts or other noxious fumes.**~~
~~**(C)**~~
~~**The medical air intake shall be located a minimum of 6 m (20 ft) above ground level.**~~
~~**(D)**~~
~~**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.**~~
~~**(E)**~~
~~**If an air source equal to or better than outside air (e.g., air already filtered for use in operating room ventilating systems) is available, it shall be permitted to be used for the medical air compressors with the following provisions:**~~

~~(1) This alternate source of supply air shall be available on a continuous 24-hour-per-day, 7-day-per-week basis.~~
~~(2) Ventilating systems having fans with motors or drive belts located in the airstream shall not be used as a source of medical air intake.~~
~~(F)~~
~~Compressor intake piping shall be permitted to be made of materials and use a joining technique as permitted under 5.1.10.2 and 5.1.10.3.~~
~~(G)~~
~~Air intakes for separate compressors shall be permitted to be joined together to one common intake where the following conditions are met:~~
~~(1) The common intake is sized to minimize back pressure in accordance with the manufacturer's recommendations.~~
~~(2) Each compressor can be isolated by manual or check valve, blind flange, or tube cap to prevent open inlet piping when the compressor(s) is removed for service from the consequent backflow of room air into the other compressor(s).~~
~~(H)~~
~~The end of the intake shall be turned down and screened or otherwise be protected against the entry of vermin, debris, or precipitation by screening fabricated or composed of a noncorroding material.~~
~~(I)~~
~~Medical air intake shall be labeled in accordance with 5.1.11.1 with any method that would distinguish it as a medical air intake.~~

5.1.7.4.9 ~~5.1.3.6.3.12~~ **Operating Alarms and Local Signals.**

Medical air systems shall be monitored for conditions that can affect air quality during use or in the event of failure, based on the type of compressor(s) used in the system.

(A)
A local alarm complying with *{ed note: former* 5.1.9.5} shall be provided for the medical air compressor source.

(B)
Where liquid ring air compressors, compressors having water-cooled heads, or water-cooled aftercoolers are used, air receivers shall be equipped with a high water level sensor that shuts down the compressor system and activates a local alarm indicator. *[See {ed note: former 5.1.9.5.3(8)}.]*

(C)
Where liquid ring compressors are used, each compressor shall have a liquid level sensor in each air–water separator that, when the liquid level is above the design level, shuts down its compressor and activates a local alarm indicator. *[See {ed note: former 5.1.9.5.3(9)}.]*

(D)
Where nonliquid ring compressors compliant with 5.1.~~3.6.3.4~~5.5.2.3(A)(1) are used, the air temperature at the immediate outlet of each compressor cylinder shall be monitored by a high-temperature sensor that shuts down that compressor and activates a local alarm indicator *[see {ed note: former 5.1.9.5.3(10)}].* The temperature setting shall be as recommended by the compressor manufacturer.

(E)
Where compressors compliant with 5.1.7.4.2.3~~5.1.3.6.3.4~~(A)(2) and 5.1.7.4.2.3~~5.1.3.6.3.4~~(A)(3) are used, the following requirements shall apply:

(1) The air temperature at the immediate outlet of each compressor chamber shall be monitored by a high-temperature sensor that shuts down that compressor and activates a local alarm indicator (see {ed note: former 5.1.9.5.3}), the temperature setting shall be as recommended by the compressor manufacturer.

(2) Coalescing filters with element change indicator shall be provided.

(3) Charcoal absorber shall be provided.

(4) Gaseous hydrocarbons shall be monitored on a quarterly basis.

(F)
When the capacity of the medical air system not in use is less than the equivalent capacity of one compressor, a local alarm shall activate *[see {ed note: former 5.1.9.5.3(1)}]*. This signal shall require manual reset.

5.1.7.4.10 ~~5.1.3.6.3.13~~ Medical Air Quality Monitoring.

Medical air quality shall be monitored downstream of the medical air regulators and upstream of the piping system as follows:

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

(2) Carbon monoxide shall be monitored and shall activate a local alarm when the CO level exceeds 10 ppm. [See {ed note: former 5.1.9.5.3(2)} .]

(3) Dew point and carbon monoxide monitors shall activate their individual monitor's signal at the alarm panels where their signals are required when their power is lost.

~~5.1.3.6.3.14~~5.1.7.5 Category 1 Medical Air Proportioning Supply Sources.

(A) General.

(1) *Medical air reconstituted from oxygen USP and nitrogen NF, produced using a proportioning system(s), shall be required to meet the following:

(a) The quality of medical air shall be in accordance with ~~5.1.3~~5.1.7.4.1~~.6.1~~.

(b) The system shall be capable of supplying this quality of medical air ~~, in accordance with 5.1.3.6.1,~~ over the entire range of flow.

(c) The system shall produce medical air with an oxygen content of 19.5 percent to 23.5 percent.

(2) The medical air proportioning system shall operate automatically.

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

(4) The analyzing system specified in ~~5.1.3.6.3~~5.1.7.5 ~~.14~~(A)(3) shall be a dedicated and independent analyzer used to control the medical air proportioning system.

(5) If the mixture goes out of specification, an alarm shall be activated automatically, the primary medical air proportioning system shall be disconnected, and the reserve supply shall be activated.

(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 health care facility pipeline system.

(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.

(8) If dedicated sources of oxygen USP and nitrogen NF supply the medical air proportioning system, they shall not be used as the reserves for oxygen and nitrogen systems supplying the pipelines of the health care facility.

(9) *If the sources of oxygen USP and nitrogen NF that supply the medical air proportioning system are the same sources that supply the health care facility, engineering controls shall be provided to prevent cross contamination of oxygen and nitrogen supply lines, as provided in 5.1.~~3.5.7.~~4.5.4.

(10) A risk analysis and approval from the authority having jurisdiction shall be required.

(B) Location.

The medical air proportioning system shall be located per 5.1.~~3~~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~~4~~.3~~ 1 and ~~NFPA 55~~5.1.3 and 5.1.7.9, 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~~3~~.1~~5.

(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) per *NFPA 5000*.

(5) The indoor location shall be ventilated and heated per Chapter 9 and the manufacturer's recommendations.

(C) Required Components.

The medical air proportioning system shall consist of the following:

(1) Supply of oxygen USP and supply of nitrogen NF as follows:

(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) Mixing device with analyzers and engineering controls per manufacturer's recommendations to include, as a minimum, the following:

(a) At least two oxygen analyzers capable of independently monitoring oxygen concentration
(b) Mechanism where each analyzer based upon nonconforming 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) Mechanism where each analyzer, based upon nonconforming 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) Provision for manual resetting of the proportioning system after detection of nonconforming oxygen concentration and subsequent shutdown once conforming oxygen concentration is established, in order to re-establish flow to the medical air piping system
(e) Means of verifying the performance of the analyzers by reference to an air standard, with known traceable oxygen content

(3) Minimum of one recorder for recording the medical air proportioning system performance and air quality for a period of not less than 24 hours

(4) Continuous analysis of the mixture and a recording capability provided (e.g., via a data port)

(5) 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) Capability of the reserve supply to automatically activate if the primary supply is isolated

(7) Reserve supply of medical air USP sized, at minimum, for one average day's supply and consisting of one of the following:

(a) Additional medical air proportioning unit with a dedicated supply of oxygen USP and nitrogen NF
(b) Medical air compressor system per ~~5.1.3.6.3~~5.1.7.4, with the exception of the allowance of a simplex medical air compressor system
(c) Medical air cylinder manifold per ~~5.1.3.5.~~5.1.7.~~10~~2

(8) Receiver fitted with a pressure relief valve and pressure gauge as follows:

(a) The receiver shall be constructed of corrosion-resistant materials.
(b) The receiver, relief valves, and pressure gauges shall comply with ASME *Boiler and Pressure Vessel Code* and manufacturer's recommendations.

(9) *Warning systems per *{ed note: former 5.1~~5.1~~.9}* , including a local signal and master alarm that indicates nonconforming oxygen concentration per manufacturer's recommendations

(10) Final line pressure regulators complying with 5.1.~~3~~4.~~5.5~~3

(11) Pressure relief complying with 5.1.~~3~~4.~~5.6~~4

(12) Local signals complying with *{ed note: former* 5.1.3.5.8.2}

5.1.7.6~~5.1.3.7~~* Medical–Surgical Vacuum Central Supply Systems.

5.1.7.6.1 ~~5.1.3.7.1 Medical–Surgical Vacuum Central Sources~~Location~~.~~
Medical–surgical vacuum central supply systems shall be located per 5.1.~~3~~3~~.3 as follows:~~
~~(1) Indoors in a dedicated mechanical equipment area, adequately ventilated and with any required utilities~~
~~(2) In a room ventilated per 5.1.3.3.3.3~~
~~(3) For air-cooled equipment, in a room designed to maintain the ambient temperature range as recommended by the equipment manufacturer~~

5.1.7.6.2 ~~5.1.3.7.1.1~~

Medical–surgical vacuum central supply systems shall consist of the following:

(1) Two or more vacuum pumps sufficient to serve the peak calculated demand with the largest single vacuum pump out of service

(2) Automatic means to prevent backflow from any on-cycle vacuum pumps through any off-cycle vacuum pumps

(3) Shutoff valve or other isolation means to isolate each vacuum pump from the centrally piped system and other vacuum pumps for maintenance or repair without loss of vacuum in the system

(4) Vacuum receiver

(5) Piping between the vacuum pump(s), discharge(s), receiver(s), and vacuum source shutoff valve in accordance with *{ed note: former 5.1~~5.1~~.10.2}* , except brass, galvanized, or black steel pipe, which is permitted to be used as recommended by the manufacturer

(6) Except as defined in ~~5.1.3.7.1.1~~5.1.7.6.2(1) through ~~5.1.3.7.1.1~~5.1.7.6.2(~~5~~5), materials and devices used between the medical vacuum exhaust and the medical vacuum source that are permitted to be of any design or construction appropriate for the service as determined by the manufacturer

(7) Vacuum filtration per ~~5.1.3.7.4~~5.1.7.6.5.

5.1.7.6.3 ~~5.1.3.7.2~~ Vacuum Pumps.

5.1.7.6.3.~~5.1.3.7.2.~~1
Vacuum pumps shall be constructed of materials deemed suitable by the manufacturer.

5.1.7.6.3~~5.1.3.7.2~~.2
Antivibration mountings shall be installed for vacuum pumps as required by equipment dynamics or location and in accordance with the manufacturer's recommendations.

~~5.1.3.7.2~~5.1.7.6.3.3
Flexible connectors shall connect the vacuum pumps with their intake and outlet piping.

5.1.7.6.3~~5.1.3.7.2~~.4
For liquid ring vacuum pumps, seal water shall be of a quality recommended by the vacuum pump manufacturer.

5.1.7.6.4 ~~5.1.3.7.3~~ Vacuum Receivers.
Receivers for vacuum shall meet the following requirements:

(1~~)~~) They shall be made of materials deemed suitable by the manufacturer.

(2~~)~~) They shall comply with Section VIII, "Unfired Pressure Vessels," of the ASME *Boiler and Pressure Vessel Code.*

(3~~)~~) They shall be capable of withstanding a gauge pressure of 415 kPa (60 psi) and 760 mm (30 in.) gauge HgV.

(4~~)~~) They shall be equipped with a manual drain.

(5~~)~~) They shall be of a capacity based on the technology of the pumps.

(6) The medical–surgical vacuum receiver(s) shall be serviceable without shutting down the medical–surgical vacuum system by any method to ensure continuation of service to the facility's medical–surgical pipeline distribution system.

5.1.7.6.5~~5.1.3.7.4~~ Vacuum Filtration.
Central supply systems for vacuum other than liquid ring pumps shall be provided with inlet filtration with the following characteristics:

(1) Filtration shall be at least duplex to allow one filter to be exchanged without impairing the vacuum system.

(2) Filtration shall be located on the patient side of the vacuum producer.

(3) Filters shall be efficient to 0.3 µm and 99.97 percent HEPA or better in accordance with DOE-STD-3020, *Specification for HEPA Filters Used by DOE Contractors*.

(4) Filtration shall be sized for 100 percent of the peak calculated demand while one filter or filter bundle is isolated.

(5) Grouping multiple filters into bundles to achieve the required capacities shall be permitted.

(6) The system shall be provided with isolation valves on the source side of each filter or filter bundle and isolation valves on the patient side of each filter or filter bundle, permitting the filters to be isolated without shutting off flow to the central supply system.

(7) A means shall be available to allow the user to observe any accumulations of liquids.

(8) A vacuum relief petcock shall be provided to allow vacuum to be relieved in the filter canister during filter replacement.

(9) Filter elements and canisters shall be permitted to be constructed of materials as deemed suitable by the manufacturer.

(10) In normal operation, one filter or filter bundle shall be isolated from the system to be available for service should a blockage in the operating filter occur or rotation of the filters be desired after filter element exchange.

5.1.7.6.6 ~~5.1.3.7.5~~ Piping Arrangement and Redundancies.
~~5.1.3.7.5.1~~
Piping arrangement in vacuum central supply systems shall be as follows:

(1) Piping shall be arranged to allow service (see 5.1.7.6.5) and a continuous supply of medical–surgical vacuum in the event of a single fault failure.

(2) Piping arrangement shall be permitted to vary based on the technology(ies) employed, provided that an equal level of operating redundancy is maintained.

(3) Where only one set of vacuum pumps is available for a combined medical–surgical vacuum system and an analysis, a research, or a teaching laboratory vacuum system, such laboratories shall be connected separately from the medical–surgical system directly to the receiver tank through its own isolation valve and fluid trap located at the receiver, and between the isolation valve and fluid trap, a scrubber shall be permitted to be installed.

~~**5.1.3.7.5.2**~~

~~The medical–surgical vacuum receiver(s) shall be serviceable without shutting down the medical–surgical vacuum system by any method to ensure continuation of service to the facility's medical–surgical pipeline distribution system.~~**(4)**

~~**5.1.3.7.5.3**~~

Medical–surgical vacuum central supply systems shall be provided with a source shutoff valve per *{ed note: former 5.1~~5.1~~.4.2}* .

5.1.7.6.7 Electrical power and control
Electrical controls for vacuum systems employing electrical motors shall comply with 5.1.4.5.6.
~~5.1.3.7.6 Electrical Power and Control.~~

~~**(A)**~~
~~**Medical vacuum source systems shall be controlled to ensure continuous supply of suction at pressures consistent with Table 5.1.11 under all conditions of system use as follows:**~~
~~**(1) Automatic activation of pump(s) as necessary to supply the demand.**~~
~~**(2) Managing the operation to equalize wear on all pumps. Where this equalization is achieved manually, the facility staff shall arrange a schedule for manual alternation.**~~
~~**(B)**~~
~~**Controls shall provide the following functions:**~~
~~**(1) Where medical vacuum source systems having two or more pumps employ any electrical circuit device that upon failure could prevent supply of medical vacuum, the controls shall be provided with an automatically activated alternative method for ensuring supply (e.g., redundant component(s), an alternate electrical supply path, or other equivalent method).**~~
~~**(2) Control circuits shall be arranged in such a manner that isolation of one pump or component from the system (e.g., for maintenance or repair) does not interrupt the operation of other pump(s) or component(s).**~~

~~(3) An automatic restart function shall be included, such that the supply of medical vacuum will resume normally after power interruption without manual intervention.~~
~~(C)~~
~~Each pump motor shall be provided with electrical components including, but not limited to:~~
~~(1) Dedicated disconnect switch installed in the electrical circuit ahead of each motor starter~~
~~(2) Motor starting device~~
~~(3) Overload protection~~
~~(D)~~
~~Vacuum source system controls shall be provided with electrical systems including, at a minimum:~~
~~(1) Control circuits shall be arranged so that failure of any component of the control circuit, or shutdown of one pump (e.g., for service), does not interrupt automatic operation of the standby pump.~~
~~(2) Controls shall be provided with built-in disconnect means to allow appropriate operation of multiple pump systems and protect service personnel from exposure to live voltages.~~
~~(3) Where components are common to more than one control circuit, the common device shall be provided with electrical protection to prevent loss of the control circuits(s) in the event of short circuit in the device.~~
~~(4) An automatic restart function shall be included, such that the pump(s) will restart after power interruption without manual intervention.~~
~~(E)~~
~~Electrical installation and wiring shall conform to the requirements of *NFPA 70*.~~
~~(F)~~
~~Emergency electrical service for the pumps shall conform to the requirements of the essential electrical system as described in Chapter 6.~~

~~5.1.3.7.7~~5.1.7.6.8 ~~–~~Medical–Surgical Vacuum Exhaust.

~~5.1.3.7.7.1~~
The medical–surgical vacuum pumps shall exhaust in a manner and location that minimizes the hazards of noise and contamination to the facility and its environment.

5.1.7.6.8.1 ~~5.1.3.7.7.2~~
The exhaust shall ~~be located~~ terminate as follows:

(1) Outdoors

(2) At least 7.5 m (25 ft) from any door, window, air intake, or other openings in buildings or places of public assembly

(3) At a level different from air intakes

(4) Where prevailing winds, adjacent buildings, topography, or other influences will not divert the exhaust into occupied areas or prevent dispersion of the exhaust

~~5.1.3.7.7.3~~

(5) The end of the exhaust shall be turned down and screened or otherwise be protected against the entry of vermin, debris, or precipitation by screening fabricated or composed of a noncorroding material.

5.1.7.6.8.2
~~5.1.3.7.7.4~~
Vacuum exhaust shall be labeled in accordance with *{ed note: former 5.1*~~5.1~~.11.1} with any method that would distinguish it as a vacuum exhaust.

5.1.7.6.8.3
~~5.1.3.7.7.5~~
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.

5.1.7.6.8.4
~~5.1.3.7.7.6~~
Vacuum exhausts from multiple pumps shall be permitted to be joined together to one common exhaust where the following conditions are met:

(1) The common exhaust is sized to minimize back pressure in accordance with the pump manufacturer's recommendations.

(2) Each pump can be isolated by manual or check valve, blind flange, or tube cap to prevent open exhaust piping when the pump(s) is removed for service from consequent flow of exhaust air into the room.

5.1.7.6.8.5
~~5.1.3.7.7~~
Vacuum exhaust piping shall be permitted to be made of materials and use a joining technique as permitted under *{ed note: former* 5.1.10.2} and *{ed note: former* 5.1.10.3} .

5.1.7.6.9
~~5.1.3.7.8~~ Operating Alarms.
When the capacity of the medical vacuum supply system not in use is less than the equivalent capacity of one pump, a local alarm shall activate *[see {ed note: former 5.1.9.5.3(4)}]*. This signal shall require manual reset.

5.1.7.7~~5.1.3.8~~* Waste Anesthetic Gas Disposal (WAGD) Central Supply Systems.
~~5.1.3.8.1* Supply Sources.~~
WAGD supply sources shall be chosen in consultation with the medical staff having knowledge of the requirements to determine the type of system, number and placement of terminals, and other required safety and operating devices.

5.1.7.7.1 WAGD Supply Sources
~~5.1.3.8.1.1~~
WAGD shall be permitted to be produced through the medical–surgical vacuum source, by a dedicated producer, or by venturi.

5.1.7.7.1.1
~~5.1.3.8.1.2~~
If WAGD is produced by the medical–surgical vacuum source, the following shall apply:

(1) The medical–surgical vacuum source shall comply with ~~5.1.3.7.~~5.1.7.6.

(2) The total concentration of oxygen shall be maintained below 23.6 percent unless one of the following conditions is met:

(a) The vacuum pump complies with ~~5.1.3.8.2.1~~5.1.7.7.3.1(2)
(b) The combined medical–surgical vacuum/WAGD system is monitored for oxygen and an alarm will initiate at all master alarm panels if the oxygen concentration exceeds 23.6 percent.

(3) The medical–surgical vacuum source shall be sized to accommodate the additional volume.

5.1.7.7.1~~5.1.3.8.1~~.3 ~~2~~
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:

(1) The WAGD source shall be located in accordance with 5.1.~~3~~3~~.3~~.

~~(2) The WAGD source shall be located indoors in a dedicated mechanical equipment area with any required utilities.~~

~~(3) The WAGD source shall be ventilated per 5.1.3.3.3.3.~~

~~(4) For air-cooled equipment, the WAGD source shall be located to maintain the ambient temperature range as recommended by the manufacturer.~~

(5) The WAGD producers shall comply with ~~5.1.3.8~~5.1.7.6.3~~.2.~~.

5.1.7.7.1~~5.1.3.8.1~~.~~4~~ 3
If WAGD is produced by a dedicated WAGD producer with a total power less than 1 horsepower in total (both producers), the following shall apply:

(1) The WAGD source shall be permitted to be located near the inlet(s) served.

(2) For air-cooled equipment, the WAGD source shall be located to maintain the ambient temperature range as recommended by the manufacturer.

5.1.7.7.2
For a WAGD source produced by venturi the following shall apply:

(1) The venturi shall not be user-adjustable (i.e., require the use of special tools).

(2) The venturi shall be driven using water, inert gas, instrument air, or other dedicated air source.

(3) Medical air shall not be used to power the venturi.

~~5.1.3.8.1.5~~
~~For liquid ring pumps in WAGD service, seal water shall be of a quality as recommended by the pump manufacturer.~~

5.1.7.7.3 ~~5.1.3.8.2~~ WAGD Producers.

5.1.7.7.3~~5.1.3.8.2~~.1
Vacuum pumps dedicated for WAGD service shall be as follows:

(1) Compliant with ~~5.1.3.7.2~~5.1.7.6.3

(2) Designed of materials and using lubricants and sealants that are inert in the presence of oxygen, nitrous oxide, and halogenated anesthetics

(3) For liquid ring pumps in WAGD service, seal water shall be of a quality as recommended by the pump manufacturer.

5.1.7.7.3.2
~~5.1.3.8.2.2~~
Vacuum producers (e.g., fans or blowers) designed for operation at vacuums below 130 mm (5 in.) HgV shall be as follows:

(1) Permitted to be made of any materials determined by the manufacturer as suitable for the service

(2) Provided with antivibration mountings as required by equipment dynamics or location and in accordance with the manufacturer's recommendation

(3) Connected with their intake and outlet piping through flexible connections

(4) Used only for WAGD service and not employed for other services

(5) Interconnected via piping, ductwork, and so forth, made of materials determined by the manufacturer as suitable to the service

5.1.7.7.4~~5.1.3.8.1.6~~

~~The~~ A WAGD source produced by other than venturi shall consist of the following:

(1) Two or more WAGD producers sufficient to serve the peak calculated demand with the largest single WAGD producer out of service

(2) Automatic means to prevent backflow from any on-cycle WAGD producers through any off-cycle WAGD producers

(3) Shutoff valve to isolate each WAGD producer from the centrally piped system and other WAGD producers for maintenance or repair without loss of WAGD in the system

(4) Piping between the WAGD producers and the source shutoff valve compliant with *{ed note: former 5.1.10.2}*, as recommended by the manufacturer

(5) Antivibration mountings installed for WAGD producers as required by equipment dynamics or location and in accordance with the manufacturer's recommendations

(6) Flexible connectors interconnecting the producers with their intake and outlet piping as required by equipment dynamics or location and in accordance with the WAGD producer manufacturer's recommendations

~~**5.1.3.8.1.7**~~
~~**If WAGD is produced by a venturi, the following shall apply:**~~
~~**(1) The venturi shall not be user-adjustable (i.e., require the use of special tools).**~~
~~**(2) The venturi shall be driven using water, inert gas, instrument air, or other dedicated air source.**~~
~~**(3) Medical air shall not be used to power the venturi.**~~

~~5.1.3.8.2 WAGD Producers.~~

~~5.1.3.8.2.1~~

~~Vacuum pumps dedicated for WAGD service shall be as follows:~~

~~(1) Compliant with 5.1.3.7.2~~

~~(2) Designed of materials and using lubricants and sealants that are inert in the presence of oxygen, nitrous oxide, and halogenated anesthetics~~

~~5.1.3.8.2.2~~

~~Vacuum producers (e.g., fans or blowers) designed for operation at vacuums below 130 mm (5 in.) HgV shall be as follows:~~

~~(1) Permitted to be made of any materials determined by the manufacturer as suitable for the service~~

~~(2) Provided with antivibration mountings as required by equipment dynamics or location and in accordance with the manufacturer's recommendation~~

~~(3) Connected with their intake and outlet piping through flexible connections~~

~~(4) Used only for WAGD service and not employed for other services~~

~~(5) Interconnected via piping, ductwork, and so forth, made of materials determined by the manufacturer as suitable to the service~~

~~5.1.3.8.3 WAGD Alarms.~~

~~5.1.3.8.3.1~~

~~When the WAGD system is served by a central source(s), a local alarm complying with 5.1.9.5 shall be provided for the WAGD source.~~

~~5.1.3.8.3.2~~

~~Where WAGD source systems have two or more producers, and the capacity of the WAGD system not in use is less than the equivalent capacity of one producer, a local alarm shall activate *[see 5.1.9.5.3(5)]*. This signal shall require manual reset.~~

5.1.7.7.5 Electrical power and control

Electrical controls for WAGD systems employing electrical motors shall comply with 5.1.4.5.

~~5.1.3.8.4 Electrical Power and Control.~~

~~5.1.3.8.4.1~~

~~WAGD source systems shall be controlled to ensure continuous flow under all conditions of system use as follows:~~

~~(1) Automatic activation of producer(s) as necessary to supply the demand.~~

~~(2) Managing the operation to equalize wear on all producers. Where this equalization is achieved manually, the facility staff shall arrange a schedule for manual alternation.~~

~~5.1.3.8.4.2~~

~~Controls shall provide the following functions:~~

~~(1) Where WAGD source systems having two or more producers employ any electrical circuit device which upon failure could stop the WAGD, the controls shall be provided with an automatically activated alternative method for ensuring supply (i.e., redundant component(s), an alternate electrical supply path or other equivalent method).~~

~~(2) Control circuits shall be arranged in such a manner that isolation of one producer or component from the system (e.g., for maintenance or repair) does not interrupt the operation of other pump(s) or component(s).~~

~~(3) An automatic restart function shall be included, such that the supply of WAGD will resume normally after power interruption without manual intervention.~~

~~5.1.3.8.4.3~~

~~Each producer motor shall be provided with electrical components including, but not limited to, the following:~~

~~(1) Dedicated disconnect switch installed in the electrical circuit ahead of each motor starter~~

~~(2) Motor starting device~~

~~(3) Overload protection~~

~~5.1.3.8.4.4~~

~~WAGD source system controls shall be provided with electrical systems including at least:~~

~~(1) Control circuits shall be arranged so that failure of any component of the control circuit, or shutdown of one producer (e.g., for service) does not interrupt automatic operation of the standby producer.~~

~~(2) Controls shall be provided with built in disconnect means to allow appropriate operation of multiple producer systems and protect service personnel from exposure to live voltages.~~

~~(3) Where components are common to more than one control circuit, the common device shall be provided with electrical protection to prevent loss of the control circuits(s) in the event of short circuit in the device.~~

~~(4) An automatic restart function shall be included, such that the pump(s) will restart after power interruption without manual intervention.~~

~~5.1.3.8.4.5~~

~~Electrical installation and wiring shall conform to the requirements of *NFPA 70*.~~

~~5.1.3.8.4.6~~

~~**Emergency electrical service for the producers shall conform to the requirements of the essential electrical system as described in Chapter 6.**~~

5.1.7.7.6~~5.1.3.8.5~~ WAGD Exhaust.

WAGD producers shall exhaust in compliance with ~~5.1.3.7.~~5.1.7.6.~~7~~ 8 unless otherwise permitted by one of the following:

(1) Producers under 1 hp and venturi producers shall be permitted to exhaust individually in a manner that will allow for dispersion of the exhaust gases and not allow the exhaust gas to reenter the building through openable windows, nearby intakes, or other openings.

(2) Anesthetic gas recovery (AGR) and anesthetic gas destruction systems shall be permitted to be installed in the WAGD exhaust piping if the AGR and anesthetic gas destruction systems can be bypassed without compromising the flow of exhaust when required.

5.1.7.7.7 ~~5.1.3.8.3~~ WAGD Alarms.

5.1.7.7.7~~5.1.3.8.3~~.1
When the WAGD system is served by a central source(s), a local alarm complying with *{ed note: former 5.1.9.5}* shall be provided for the WAGD source.

5.1.7.7.7~~5.1.3.8.3~~.2
Where WAGD source systems have two or more producers, and the capacity of the WAGD system not in use is less than the equivalent capacity of one producer, a local alarm shall activate *[{ed note: former see 5.1.9.5.3(5)}].* This signal shall require manual reset.

5.1.7.8~~5.1.3.9~~* Oxygen Central Supply Systems Using Concentrators.

Any oxygen central supply system that includes one or more oxygen concentrator supply systems shall comply with ~~5.1.3.9~~5.1.7.8.1~~.1~~ through ~~5.1.3.9~~5.1.7.8.5~~.5.~~

~~5.1.3.9.~~5.1.7.8.1* Oxygen Concentrator Supply ~~Units~~Sources.

5.1.7.8.~~5.1.3.9.~~1.1
Oxygen concentrator supply ~~units~~ sources for use with medical gas pipelines shall produce oxygen meeting the requirements of Oxygen 93 USP or Oxygen USP.

5.1.7.8.~~5.1.3.9.~~1.2
Output shall have less than or equal to 1 mg/m^3 (1.685 × 10^{-6} lb/yd^3) of permanent particulates sized 1 micron or larger at normal atmospheric pressure.

~~5.1.3.9.~~5.1.7.8.1.3
Materials of construction on the air side of the oxygen concentrator supply source ~~unit~~ shall be suitable for the service as determined by the manufacturer.

~~5.1.3.9.~~5.1.7.8.1.4
Materials of construction on the oxygen side of the oxygen concentrator ~~unit~~ supply source shall comply with 5.1.~~3.5.4~~4.2.

5.1.7.8.~~5.1.3.9.~~1.5
The components that make up the oxygen concentrator supply source ~~unit~~ shall be as follows:

(1) The manufacturer of the concentrator supply source ~~unit~~ shall be permitted to use such components and arrangement of such components as needed to produce oxygen complying with ~~5.1.3.9.~~5.1.7.8.1.1 in the quantity as required by the facility, except where otherwise specifically defined in this code.

(2) Air receivers and oxygen accumulators, where used, shall comply with Section VIII, "Unfired Pressure Vessels," of the ASME *Boiler and Pressure Vessels Code* and be provided with overpressure relief valves.

5.1.7.8.~~5.1.3.9.~~1.6
The supply air to the concentrator(s) shall be of a quality to ensure the oxygen concentrator supply source ~~unit~~ can produce oxygen complying with ~~5.1.3.9~~5.1.7.8.1.1 ~~.1.1~~ and shall not be subject to normally anticipated contamination (e.g., vehicle or other exhausts, gas leakage, discharge from vents, flooding).

5.1.7.8.~~5.1.3.9.~~1.7

The oxygen concentrator supply source ~~supply unit~~ and any associated electrical equipment shall be provided with, at a minimum, the following electrical components:

(1) Either a disconnect switch for each major electrical component or a single disconnect that deactivates all electrical components in the concentrator unit

(2) Motor-starting devices with overload protection for any component with an electrical motor over 2 hp

5.1.7.8.~~5.1.3.9.~~1.8
A vent valve shall be provided as follows:
(1) Located on the source side of the concentrator outlet isolation valve to permit the operation of the oxygen concentrator supply source ~~unit~~ for validation, calibration, and testing while the unit is isolated from the pipeline system

(2) Sized to allow for at least 25 percent of the oxygen concentrator ~~unit~~ supply source flow

(3) Vented to a location compliant with 5.1.~~3.3.3.~~4.4.2~~2~~ (5)

~~5.1.3.9.~~5.1.7.8.1.9
A DN8 (NPS 1/4) valved sample port shall be provided near the oxygen concentration monitor sensor connection for sampling of the gas from the oxygen concentrator supply source ~~unit~~.

5.1.7.8.~~5.1.3.9.~~1.10
At least one 0.1 micron filter suitable for oxygen service shall be provided at the outlet of the oxygen concentrator supply source~~supply unit~~.

5.1.7.8.~~5.1.3.9.~~1.11
A check valve shall be provided at the outlet of the oxygen concentrator supply source ~~supply unit~~ to prevent backflow into the oxygen concentrator supply unit and to allow service to the unit.

5.1.7.8.~~5.1.3.9.~~1.12
An outlet valve shall be provided to isolate all components of the oxygen concentrator from the pipeline with the following characteristics:

(1) The valve shall have both manual and automatic actuation with visual indication of open or closed.

(2) The valve shall close automatically whenever the oxygen concentrator supply source~~unit~~ is not producing oxygen of a concentration equal to that in ~~5.1.3.9~~5.1.7.8.1.1~~.1.1~~.

(3) Continuing operation of the oxygen concentrator supply source ~~supply unit~~ through the vent mode shall be permitted with the isolating valve closed.

(4) The isolating valve, when automatically closed due to low concentration, shall require manual reset to ensure the oxygen concentrator supply unit is examined prior to return to service.

(5) Closing the isolating valve, whether automatically or manually, shall activate an alarm signal at the master alarms *(see 5.1.9.2)* indicating that the oxygen concentrator supply source ~~supply unit~~ is disconnected.

5.1.7.8.~~5.1.3.9.~~1.13
The oxygen concentrator supply source shall be provided with an oxygen concentration monitor with the following characteristics:

(1) The monitor shall be capable of monitoring 99 percent oxygen concentration with 1 percent accuracy.

(2) The monitor shall continuously display the oxygen concentration and activate the local alarm and master alarms in accordance with ~~5.1.3.9~~5.1.6.6.5 when a concentration lower than 91 percent is observed.

(3) The monitor shall continuously display the oxygen concentration.

(4) The monitor shall be permitted to be inserted into the pipeline without a demand check.

~~5.1.3.9.~~5.1.7.8.2 Location.
An oxygen central supply system using a concentrator(s) shall be located in accordance with 5.1.3~~.3~~ and as follows:

~~(1) Indoors in a dedicated mechanical equipment area, ventilated, and with any required utilities (e.g., electricity, drains, lighting).~~

~~(2) *In a room ventilated in accordance with 5.1.3.3.3.3.~~

~~(3) For air cooled equipment, in a room designed to maintain the ambient temperature range as recommended by the manufacturer.~~

(41) A room containing an oxygen central supply system using a concentrator(s) that does not have the concentrator purge gas vented to the outside shall be equipped with oxygen depletion monitors with alarm indicators at the entrance(s) that will indicate ambient oxygen levels in the room below 19.~~5~~ 5 percent.

(~~5~~2) *Individual elements of the oxygen central supply system using a concentrator(s) shall be permitted to be located in separate rooms or enclosures as necessary to meet ~~5.1.3.9~~5.1.3.4.~~2(1.) through 5.1.3.9.2(4).~~

5.1.7.8.~~5.1.3.9.~~3 Arrangement and Redundancies.
An oxygen central supply system using a concentrator(s) shall be permitted to consist of two or three supply sources, as follows:

(1) If two supply sources are provided, the following shall apply:

(a) One source shall be an oxygen concentrator supply source.
(b) The second source shall be a cylinder header complying with 5.1.~~3.5.9~~4.6 with sufficient cylinder connections for one average day's supply.
(c) Containers shall not be used as a supply source.

(2) If three supply sources are provided, the following shall apply:

(a) Each source shall be capable of independently supplying the full system demand in the event of the unavailability of one or both of the other sources.
(b) Each source shall be permitted to be either of the following:
(i)~~i.~~ An oxygen concentrator supply source complying with ~~5.1.3.9~~5.1.7.8.~~1~~ OR
(ii)~~.~~ A cylinder header complying with ~~5.1.3.5.9~~5.1.4.6 with sufficient cylinder connections for one average day's supply
(c) Containers shall not be used as a supply source.

(3) Use of oxygen concentrator supply systems as all three sources shall only be permitted after a documented risk analysis by the governing authority of the health care facility indicates an understanding of the inherent risks and defines how those risks will be mitigated.

(4) An isolation valve and automatic check valve shall be provided to isolate each of the three sources from the others and from the pipeline. The valves in 5.1.7.8.1.11 and 5.1.7.8.1.12~~5.1.3.5.9(4), 5.1.3.5.9(6), 5.1.3.9.1.11, and 5.1.3.9.1.12~~ shall be permitted to be used for this purpose.

(5) Each of the three supply sources shall be provided with a pressure relief valve complying with 5.1.~~3.5.6~~4.4 on the source side of its respective isolating valve.

(6) The three supply sources shall join to the pipeline systems through control arrangements with at least the following characteristics:

(a) The control arrangements shall be able to maintain stable pressures within the limits of *{ed note: former Table 5.1.11}.*
(b) The control arrangements shall be able to flow 100 percent of the peak calculated demand.
(c) The control arrangements shall be redundant, such that each component of the control mechanism can be isolated for service or replacement while maintaining normal operation.
(d) The cascade of sources shall comply with ~~5.1.3.9.~~5.1.7.8.4.
(e) The system shall be protected against overpressure *(see 5.1.~~3.5.~~4.~~46~~)*.

(7) A pressure relief valve shall be provided in the common line between the sources and the line pressure controls.

(8) A source valve in accordance with *[{ed note: former 5.1.4.2}* shall be provided on the patient side of the line pressure controls.

(9) A gauge and switch or sensor shall be located between the three sources and the line pressure controls to monitor the pressure feeding the line pressure controls.

(10) An oxygen concentration monitor, sampling the gas on the patient side of the line pressure controls and on the source side of the source valve, shall be provided with the following characteristics:

(a) The monitor shall be capable of monitoring 99 percent oxygen concentration with ±1.0 percent accuracy.

(b) The monitor shall be attached to the pipeline through a demand check in accordance with *{ed note: former 5.1.8.2.3.}*

(c) The monitor shall continuously display the oxygen concentration and activate the local alarm and master alarms when an oxygen concentration lower than 91 percent is observed.

(11) A DN8 (NPS 1/4) valved sample port shall be provided on the patient side of the line pressure controls and source side of the source valve for sampling the oxygen.

~~(12) An auxiliary source connection complying with 5.1.4.10 shall be provided.~~

(~~13~~12) Electrical installation and wiring shall conform to the requirements of *NFPA 70*.

(~~14~~13) Emergency electrical service for all components of the oxygen supply system shall conform to the requirements of the essential electrical system as described in Chapter 6.

5.1.7.8.~~5.1.3.9.~~4 Operating Controls.

An oxygen central supply system using a concentrator(s) shall include means to provide the following functions:

(1) Selection of an appropriate primary supply source. When the primary supply source is in operation and oxygen quality is suitable, the secondary and reserve supply sources shall be prevented from supplying the system.

(2) Automatic activation of the secondary supply source shall be available if the primary supply source is not able to maintain pressure or concentration of oxygen.

(3) Automatic activation of the reserve supply source shall be available if the primary and secondary supply source are not able to maintain supply pressure or concentration of oxygen.

(4) Where two or more concentrator supply sources are included in the system, the oxygen concentrator supply sources shall be permitted to rotate as the primary supply source.

(5) Automatic operation such that the supply of gas will continue through interruption of the main electrical source.

(6) The oxygen concentrator supply source(s) in the system shall be capable of automatically returning to normal operation following a power interruption. If required by the technology, it shall be permitted to isolate the concentrator supply source(s) using the automatic valve(s) to restore normal oxygen concentration prior to reconnecting the oxygen concentrator supply source to the system by opening the automatic valve. The valve can be actuated automatically for this purpose as an exception to ~~5.1.3.9~~5.1.7.8.1.12 ~~.1.12~~(4).

~~5.1.3.9.~~5.1.7.8.5 Operating Alarms and Local Signals.

~~5.1.3.9.~~5.1.7.8.5.1

For each oxygen concentrator supply source in the system, the supply source's concentration monitor *(see* 5.1.7.8.1.13 s*~~5.1.3.9.1.13)~~* shall be able to perform the following:

(1) Indicate low oxygen concentration when a concentration lower than 91 percent is observed

(2) Activate a local alarm *(see {ed note: former 5.1.9.5})*

(3) Activate an alarm signal at the master alarm *(see {ed note: 5.1.9.2} ~~5.1.9.2~~)* indicating that the oxygen concentration from that supply source is low

(4) Activate the automatic isolating valve for that oxygen concentrator supply source *(see ~~5.1.3.9~~5.1.6.6.1.12)* to prevent supply from that oxygen concentrator supply source

(5) Close the automatic isolating valve for that oxygen concentrator supply source *(see ~~5.1.3.9~~5.1.6.6.1.12)*, which activates an alarm signal at the master alarm *(see {ed note: former 5.1.9.2})* indicating that the oxygen concentrator supply source is disconnected

5.1.7.8.~~5.1.3.9.~~5.2
For the entire oxygen central supply system, the system concentration monitor *[see ~~5.1.3.9~~5.1.7.8.3 (10))] ~~.3(10)]~~* shall be able to perform the following:

(1) Indicate low oxygen concentration when a concentration lower than 91 percent is observed

(2) Activate a local alarm *(see {ed note: former 5.1.9.5})*

(3) Activate an alarm signal at the master alarm *(see {ed note: former 5.1.9.2})* indicating the oxygen concentration is low

5.1.7.8.~~5.1.3.9.~~5.3
For each header source *(see 5.1.3.5.9)* in the supply system, local signals and alarms shall be provided as follows:

(1) A pressure gauge for delivery pressure

(2) A means to activate an alarm signal at the master alarm *(see {ed note: 5.1.9.2} ~~5.1.9.2~~)* indicating the oxygen cylinders are in use

(3) A means to activate an alarm signal at the master alarm *(see {ed note: 5.1.9.2} ~~5.1.9.2~~)* indicating the content of the oxygen cylinder header is reduced below one average day's supply

5.1.7.8.~~5.1.3.9.~~5.4
An oxygen central supply system using a concentrator(s) shall be provided with operating alarms as follows:

(1) *Change of Source*. An operating alarm shall be provided as follows:

(a) If the supply source in use fails to supply the system and is changed in accordance with ~~5.1.3.9.~~5.1.7.8.4(2) or ~~5.1.3.9.~~5.1.7.8.4(3), a local alarm and a signal at the master alarm shall be activated, indicating an oxygen supply change has occurred.

(b) The signal in ~~5.1.3.9.~~5.1.7.8.5.4(1)(a) shall not be activated if the system has rotated sources in accordance with ~~5.1.3.9.~~5.1.7.8.4(6).

(2) *Internal Pressure Low*. A local alarm and a signal at the master alarm shall be activated when or just before the pressure falls below the pressure required to drive the calculated required flow rate through the line pressure controls indicating the oxygen supply internal pressure is low *[see ~~5.1.3.9.~~5.1.7.8.3(9) for sensor location]*.

5.1.7.9~~5.1.3.10~~* Cryogenic Fluid Central Supply Systems.

~~5.1.3.10.~~5.1.7.9.1 General.*

~~5.1.3.10.1.1*~~
The storage, use, and handling of cryogenic fluid central supply systems that deliver compressed medical gases (CMGs) to health care facilities shall be in accordance with the requirements of this section. [55:17.1.1]

5.1.7.9.~~5.1.3.10.~~1.2 Applicability.

(A)

The source valve shall be the line separating the applicability between NFPA 55 and this code. [**55:**17.1.2.1]

(B)

Cryogenic fluid central supply system installations up to, but not including, the source valve shall be covered by NFPA 55. [**55:**17.1.2.2]

(C)

The source valve and all downstream piping and components, including wiring to storage system alarms, shall be covered by this code. [**55:**17.1.2.3]

~~5.1.3.10.~~5.1.7.9.2 Cryogenic Fluid Central Supply Systems Installation.

5.1.7.9.~~5.1.3.10.~~2.1
Cryogenic fluid central supply systems shall be installed by personnel qualified in accordance with CGA M-1, *Standard for Medical Gas Supply Systems at Health Care Facilities,* or ASSE/IAPMO/ANSI 6015, *[Professional Qualifications Standard for] Bulk Medical Gas/Cryogenic Fluid Central Supply Systems Installers.* [**55:**17.2.1]

~~5.1.3.10.~~5.1.7.9.2.2
Initial inspection and testing of the cryogenic fluid central supply system shall be conducted by a party technically competent and experienced in the field of cryogenic fluid systems and that meets the requirements of ASSE/IAPMO/ANSI 6035, *[Professional Qualifications Standard for] Bulk Medical Gas/Cryogenic Fluid Central Supply Systems Verifiers*, in accordance with this code and the requirements of CGA M-1, *Standard for Medical Gas Supply Systems at Health Care Facilities*. [**55:**17.2.2]

~~5.1.3.10.~~5.1.7.9.2.3
Cryogenic fluid central supply systems shall be installed in compliance with the Food and Drug Administration (FDA) Current Good Manufacturing Practices per 21 CFR 210 and 21 CFR 211. [**55:**17.2.3]

~~5.1.3.10.~~5.1.7.9.2.4
Cryogenic fluid central supply systems shall be installed in accordance with CGA M-1, *Standard for Medical Gas Supply Systems at Health Care Facilities*. [**55:**17.2.4]

~~5.1.3.10.~~5.1.7.9.2.5
Cryogenic fluid central supply systems shall have a minimum work space clearance of 3 ft (1 m) around the storage container, vaporizer(s), and cabinet opening or front side of the pressure-regulating manifold for system maintenance and operation. [**55:**17.2.5]

~~5.1.3.10.~~5.1.7.9.2.6
Inert cryogenic fluid central supply systems shall be sited in accordance with Chapter 8 of NFPA 55 and CGA P-18, *Standard for Bulk Inert Gas Systems*. [**55:**17.2.6]

~~5.1.3.10.~~5.1.7.9.2.7
Oxygen cryogenic fluid central supply systems shall be sited in accordance with Chapters 8 and 9 of NFPA 55, as applicable, and CGA M-1, *Standard for Medical Gas Supply Systems at Health Care Facilities*. [**55:**17.2.7]

~~5.1.3.10.~~5.1.7.9.2.8
Carbon dioxide refrigerated liquid central supply systems shall be sited in accordance with Chapter 13 of NFPA 55 and CGA G-6.1, *Standard for Insulated Liquid Carbon Dioxide Systems at Consumer Sites*. [**55:**17.2.8]

~~5.1.3.10.~~5.1.7.9.2.9
Nitrous oxide refrigerated liquid central supply systems shall be sited in accordance with Chapter 16 of NFPA 55 and CGA G-8.1, *Standard for Nitrous Oxide Systems at Customer Sites*. [**55:**17.2.9]

~~5.1.3.10.~~5.1.7.9.2.10
Outdoor bulk cryogenic liquid systems shall have at least two means of egress provided from any enclosure. [**55:**17.2.10]

~~5.1.3.10.~~5.1.7.9.2.11
Outdoor bulk cryogenic liquid systems shall be in accordance with CGA M-1, *Standard for Medical Gas Supply Systems at Health Care Facilities*. [**55:**17.2.10.1]

~~**5.1.3.10.**~~**5.1.7.9.3 Cryogenic Fluid Central Supply Systems Operation.**

~~5.1.3.10.~~5.1.7.9.3.1
The following components of the cryogenic fluid central supply system shall be accessible and visible to delivery personnel during filling operations:

(1) Fill connection

(2) Top and bottom fill valves

(3) Hose purge valve

(4) Vent valve

(5) Full trycock valve

(6) Liquid level indicator

(7) Tank pressure indicator

[**55:**17.3.1]

~~5.1.3.10.~~5.1.7.9.3.2
Cryogenic fluid central supply systems shall consist of the following:

(1) One or more main supply vessel, with capacity determined after consideration of the customer usage requirements, delivery schedules, proximity of the facility to alternative supplies, and the emergency plan

(2) A contents gauge on every main vessel

(3) A reserve supply sized for greater than an average day's supply, with the size of vessel or number of cylinders determined after consideration of delivery schedules, proximity of the facility to alternative supplies, and the emergency plan

(4) At least two main vessel relief valves and rupture discs installed downstream of a three-way (i.e., three-port) valve

(5) A check valve located in the primary supply piping upstream of the intersection with a secondary supply or reserve supply

[**55:**17.3.2]

~~5.1.3.10.~~5.1.7.9.3.3
Reserve CMG supply systems consisting of either a second cryogenic fluid source or a compressed gas source shall include the following:

(1) Where the reserve source is a compressed gas source, the reserve shall be equipped with the following:

(a) A cylinder manifold having not less than three gas cylinder connections or as otherwise required for an average of one day's gas supply

(b) A pressure switch to monitor the pressure in the cylinder manifold

(2) Where the reserve source is a second cryogenic fluid vessel, the reserve tank shall be equipped with the following:

(a) An actuating switch or sensor to monitor the internal tank pressure

(b) A contents gauge to monitor the liquid level

(3) Where the reserve source is either a cryogenic fluid or compressed gas source, a check valve shall be provided to prevent backflow into the reserve system.

[**55:**17.3.3]

~~5.1.3.10.~~5.1.7.9.3.4
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 follows for primary, secondary, and reserve operation:

(a) If provided with two liquid container headers, one cryogenic liquid header shall be the primary and the other shall be the secondary, with either being capable of either role.
(b) If provided with one liquid container header and one gas cylinder header (i.e., a hybrid arrangement), the liquid container header shall be the primary and the gas cylinder header shall be the secondary.
(c) When the primary header is supplying the system, the secondary header shall be prevented from supplying the system.
(d) When the primary header is depleted, the secondary header shall automatically begin to supply the system.

(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, provided that an operating cascade (i.e., primary–secondary–reserve) 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.

[**55:**17.3.4]

~~5.1.3.10.~~5.1.7.9.4 Main Supply System.
The main supply vessel for a cryogenic fluid central supply system shall be a cryogenic storage tank. [**55:**17.4]

~~5.1.3.10.~~5.1.7.9.5 Reserve Supply System.

~~5.1.3.10.~~5.1.7.9.5.1
A CMG reserve supply system shall consist of either of the following:

(1) A secondary cryogenic vessel

(2) A high-pressure compressed gas source

[**55:**17.5.1]

~~5.1.3.10.~~5.1.7.9.5.2
A cryogenic source reserve supply shall have a switch or sensor to monitor the tank pressure. [**55:**17.5.2]

~~5.1.3.10.~~5.1.7.9.5.3
A compressed gas reserve supply shall meet the following requirements:

(1) It shall be manifolded with no fewer than three gas cylinders.

(2) It shall have a pressure switch or sensor to monitor the contents using manifold pressure.

(3) It shall have a check valve to prevent backflow into the system.

(4) It shall have a check valve at each connection on the cylinder header to minimize loss of gas from the reserve system.

[**55:**17.5.3]

~~5.1.3.10.~~5.1.7.9.6 Cryogenic Fill System.
Cryogenic fluid central supply systems shall include a fill mechanism consisting of the following components:

(1) A nonremovable product-specific fill connection in compliance with CGA V-6, Standard Bulk Refrigerated Liquid Transfer Connections

(2) A means to cap and secure the fill connection inlet

(3) A check valve to prevent product backflow from the fill inlet

(4) A fill hose purge valve

(5) Supports that hold the fill piping off the ground

(6) A secure connection between the bulk tank and the fill piping

(7) Supports, as necessary, to hold the fill line in position during all operations associated with the filling procedure

[55:17.6]

~~5.1.3.10.~~5.1.7.9.7 Vaporizers.

~~5.1.3.10.~~5.1.7.9.7.1
Vaporizers used to convert cryogenic CMG to a gaseous state shall meet the following requirements:

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

(2) Vaporizers using a heat source other than ambient air shall be protected in the event of a loss of the energy source.

[55:17.7.1]

~~5.1.3.10.~~5.1.7.9.7.2
Vaporizers shall be designed to provide capacity for the customer's use under the following conditions:
(1) Customer's average and peak flows
(2) Local conditions (e.g., structures that obstruct air circulation or sunlight)
(3) Seasonal conditions (e.g., freeze periods)
[**55:**17.7.2]

~~5.1.3.10.~~5.1.7.9.7.3
A system design that uses switching vaporizers shall meet all of the following requirements:

(1) Valves shall be permitted to be manual or automatic.

(2) Valves and piping shall allow an operating vaporizer or an operating section of a vaporizer to be switched to a nonoperating condition for deicing.

(3) The system design shall provide continuous flow of CMG to the health care facility during vaporizer switchover.

(4) The system design shall provide continuous flow of CMG to the health care facility if vaporizer switchover fails.

[**55:**17.7.3]

~~5.1.3.10.~~5.1.7.9.7.4
Where a vaporizer uses an external thermal source, the flow of the CMG shall be unaffected by the loss of the external thermal source by one of the following methods:

(1) Reserve ambient heat transfer vaporizers sized for at least one day's average supply and piped so that the flow of the CMG is unaffected by flow stoppage through the external thermal source vaporizer

(2) A noncryogenic source capable of providing at least one day's average supply

[**55:**17.7.4]

~~5.1.3.10.~~5.1.7.9.7.5
Where vaporizers are used in the reserve system, they shall be as follows:

(1) Sized by the supplier to provide a source of vaporized CMG from the reserve bulk liquid storage vessel during times when the reserve system is operational

(2) Able to provide a flow rate equal to at least that of the main system vaporizer(s); however, the duration of flow might be different

(3) Indirectly heated by ambient air

[55:17.7.5]

~~5.1.3.10.~~5.1.7.9.7.6
Low-temperature protection systems that interrupt or reduce flow shall not be used on the reserve system of cryogenic fluid central supply systems. [**55:**17.7.6]

~~5.1.3.10.~~5.1.7.9.8 High-Pressure Manifolds.

~~5.1.3.10.~~5.1.7.9.8.1
Manifold assemblies shall be fit for service and shall have supports that are independent of the cylinders.
[**55:**17.8.1]

~~5.1.3.10.~~5.1.7.9.8.2
Cylinders on the manifold shall be secured against falling. [**55:**17.8.2]

~~5.1.3.10.~~5.1.7.9.8.3*

Cylinders on the manifold shall have the same service pressure rating or the filled pressure of each cylinder shall not exceed the service pressure rating of the lowest rated cylinder on the manifold. [**55:**17.8.3]

~~5.1.3.10.~~5.1.7.9.9 Pressure Control Devices.
The final pressure control device assembly or assemblies shall not be fabricated on-site. [**55:**17.9]

~~5.1.3.10.~~5.1.7.9.10 Pressure Relief Devices.

~~5.1.3.10.~~5.1.7.9.10.1
Pressure relief devices (PRDs) shall meet the following requirements:

(1) PRDs shall have a relief pressure setting not higher than the maximum allowable working pressure (MAWP) of the component with the lowest working pressure rating in the portion of the system being protected.

(2) PRDs shall be of brass or bronze construction.

(3) PRDs shall be designed for the specific gas service.

(4) PRDs shall have the discharge protected to prevent the entry of rain or snow.

(5) PRDs shall be designed in accordance with ASME B31.3, *Process Piping*.

[**55:**17.10.1]

~~5.1.3.10.~~5.1.7.9.10.2
PRDs shall have an identifier that contains the date of manufacture or test. [**55:**17.10.2]

~~5.1.3.10.~~5.1.7.9.10.3
The final line pressure relief valves shall be approved by a nationally recognized organization and shall have a relief capacity greater than or equal to the maximum throughput of the final line regulator. [**55:**17.10.3]

(A)

The pressure relief valve shall be set at 50 percent above the normal working pressure, but no higher than the MAWP, of the health care facility pipeline. [55:17.10.3.1]

(B)

The relief valve information shall be permanently identified either on the nameplate of the relief valve or on a permanently attached metal tag. [55:17.10.3.2]

~~5.1.3.10.~~5.1.7.9.11 Tubing and Valves.

~~5.1.3.10.~~5.1.7.9.11.1
New, hard-drawn Type K or L copper tube shall be used for all process piping. [**55:**17.11.1]

(A)

Tubing shall comply with ASTM B819, Standard Specification for Seamless Copper Tube for Medical Gas Systems. [55:17.11.1.1]

(B)

Tubing shall be capped and bear the marking OXY or MEDICAL or be otherwise packaged and labeled to indicate it is clean for oxygen service according to the supplier's policy. [55:17.11.1.2]

~~5.1.3.10.~~5.1.7.9.11.2 Copper Tubing.

(A)

Instrumentation tubing shall be constructed of annealed copper tubing or seamless stainless steel tubing. [**55:**17.11.2.1]

(B)

Copper tubing shall comply with ASTM B88, *Standard Specification for Seamless Copper Water Tube*. [**55:**17.11.2.2]

~~5.1.3.10.~~5.1.7.9.11.3

Valves of quick-open or quarter-turn designs, such as ball or plug valves, shall not be permitted in the portion of an oxygen piping system operating above 435 psi [3000 kPa]. [**55:**17.11.3]

~~5.1.3.10.~~5.1.7.9.11.4 Alternate Materials.

(A)*****

Alternate materials of construction for piping, tubing, valves, and instruments shall be permitted for installation at the request of the health care facility or the supplier. [**55:**17.11.4.1]

(B)

Technical documentation of alternate materials shall be submitted to the health care facility QA representative to demonstrate equivalency. [**55:**17.11.4.2]

~~5.1.3.10~~5.1.8.10.12* Alarms.
The cryogenic fluid central supply system 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 low reserve

(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

[**55:**17.12]

ED NOTE - NO CHANGES IN CONTENT IN THE SECTIONS between existing 5.1.4 and 5.1.13. However renumbering will be required, therefore all cross references will need to be checked, including those in 5.1.13 and beyond, if renumbering extends so far.

~~5.1.4* Valves.~~
~~5.1.4.1 General.~~
~~5.1.4.1.1 Gas and Vacuum Shutoff Valves.~~
~~Shutoff valves shall be provided to isolate sections or portions of the piped distribution system for maintenance, repair, emergencies, or planned future expansion needs and to facilitate periodic testing.~~
~~5.1.4.1.2 Security.~~
~~All valves, except valves in zone valve box assemblies, shall be secured by any of the following means:~~
~~(1) Located in secured areas~~
~~(2) Locked or latched in their operating position~~
~~(3) Located above ceilings, but remaining accessible and not obstructed~~
~~5.1.4.1.3 Labeling.~~
~~All valves shall be labeled as to gas supplied and the area(s) controlled, in accordance with 5.1.11.2.~~
~~5.1.4.1.4 Accessibility.~~
~~(A)~~
~~Zone valves shall be installed in valve boxes with removable covers large enough to allow manual operation of valves.~~
~~(B)~~
~~Zone valves for use in certain areas, such as psychiatric or pediatric areas, shall be permitted to be secured with the approval of the authority having jurisdiction to prevent inappropriate access.~~
~~5.1.4.1.5 Flammable Gases.~~
~~Valves for nonflammable medical gases shall not be installed with valves for flammable gases in the same zone valve box assembly with flammable gases.~~
~~5.1.4.1.6 Valve Types.~~
~~New or replacement valves shall be permitted to be of any type as long as they meet the following conditions:~~
~~(1) They have a minimum Cv factor in accordance with either Table 5.1.4.1.6(a) or Table 5.1.4.1.6(b).~~
~~(2) They use a quarter turn to off.~~
~~(3) They are constructed of materials suitable for the service.~~

(4) They are provided with copper tube extensions by the manufacturer for brazing or with corrugated medical tubing (CMT) fittings.
(5) They indicate to the operator if the valve is open or closed.
(6) They permit in-line serviceability.
(7) They are cleaned for oxygen service by the manufacturer if used for any positive-pressure service.
(8) They have threaded purge ports on the patient side and the source side.
(9) They have a minimum working pressure equal to or greater than the relief valve protecting the piping system on which the valve is installed for any positive-pressure service.
(10) Seals necessary for the operation of the valve and prevention of leaks comply with 5.1.3.5.4 and are replaceable.

Table 5.1.4.1.6(a) Positive-Pressure Gases

Valve Size (in.)	Minimum Cv (full open)
1/2	17
3/4	31
1	60
1 1/4	110
1 1/2	169
2	357
2 1/2	390
3	912
4	1837

Table 5.1.4.1.6(b) Vacuum and WAGD

Valve Size (in.)	Minimum Cv (full open)
1/2	17
3/4	31
1	60
1 1/4	110
1 1/2	169
2	357
2 1/2	196
3	302
4	600
5	1022
6	1579
8	3136

5.1.4.2 Source Valve.
5.1.4.2.1
A shutoff valve shall be placed at the immediate connection of each central supply system to the piped distribution system to allow the entire central supply system, including all accessory devices (e.g., air dryers, final line regulators), to be isolated from the facility.
5.1.4.2.2
The source valve shall be located in the immediate vicinity of the central supply system.
5.1.4.3* Main Line Valve.
5.1.4.3.1
A shutoff valve shall be provided in the main supply line inside of the buildings being served, except where one or more of the following conditions exist:
(1) The source and source valve are located inside the building served.

(2) The source system is physically mounted to the wall of the building served, and the pipeline enters the building in the immediate vicinity of the source valve.

5.1.4.3.2

The main line valve shall be located on the facility side of the source valve and outside of the source room, the enclosure, or where the main line first enters the building.

5.1.4.4 Riser Valve.

Each riser supplied from the main line shall be provided with a shutoff valve in the riser adjacent to the main line.

5.1.4.5 Service Valves.

5.1.4.5.1

Service 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.

5.1.4.5.2

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

5.1.4.5.3

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

5.1.4.6 Zone Valves.

5.1.4.6.1

All station outlets/inlets shall be supplied through a zone valve, which shall be placed as follows:

(1) It is installed so that a wall intervenes between the valve and the outlets/inlets that it controls.

(2) *It is readily operable from a standing position.

(3) *It is installed where it is visible and accessible at all times.

(4) It is not installed where it can be hidden from plain view, such as behind normally open or normally closed doors.

(5) It is not installed in a room with the station outlets/inlets that it controls.

(6) It is not installed in rooms, areas, or closets that can be closed or locked.

5.1.4.6.2*

A zone valve in each medical gas and vacuum line shall be provided for each Category 1 space and be located as follows:

(1) In patient care spaces that are not anesthetizing locations, they shall be installed immediately outside the area or zone being controlled.

(2) In anesthetizing locations, they shall be installed immediately outside each room.

5.1.4.6.3

Piping on the patient side of zone valves shall be arranged to provide the following:

(1) Shutting off the supply of medical gas or vacuum to one zone will not affect the supply of medical gas or vacuum to another zone or the rest of the system.

(2) Service will only be to outlets/inlets located on that same story.

(3) All gas delivery columns, hose reels, ceiling tracks, control panels, pendants, booms, or other special installations are located on the patient side of the zone valve.

5.1.4.6.4

A pressure/vacuum indicator shall be provided on the station outlet/inlet side of each zone valve.

5.1.4.7 In-Line Shutoff Valves.

Optional in-line valves shall be permitted to be installed to isolate or shut off piping for servicing of individual rooms or areas.

5.1.4.8 Valves for Future Connections.

5.1.4.8.1

Future connection valves shall be labeled as to gas content.

5.1.4.8.2

Downstream piping shall be closed with a brazed cap with tubing allowance for cutting and rebrazing.

5.1.4.9 In-Line Check Valves.

New or replacement check valves shall be as follows:

(1) They shall be of brass or bronze construction.

(2) They shall have brazed extensions.

(3) They shall have in-line serviceability.

(4) They shall not have threaded connections.

(5) They shall have threaded purge points of 1/8 in. NPT.

(6) They shall be sized to have a maximum velocity which does not exceed the manufacturer's recommendations.

5.1.4.10 Auxiliary Source Connection.

All cryogenic fluid central supply systems shall be provided with an auxiliary source connection point of the same size as the main line, which shall be located immediately on the patient side of the source valve.

5.1.4.10.1

The connection shall consist of a tee, a valve, and a removable plug or cap.

5.1.4.10.2

The auxiliary source connection valve shall be normally closed and secured.

5.1.5* Station Outlets/Inlets.

5.1.5.1
Each station outlet/inlet for medical gases or vacuums shall be gas-specific, whether the outlet/inlet is threaded or is a noninterchangeable quick coupler.
5.1.5.2
Each station outlet shall consist of a primary and a secondary valve (or assembly).
5.1.5.3
Each station inlet shall consist of a primary valve (or assembly) and shall be permitted to include a secondary valve (or assembly).
5.1.5.4
The secondary valve (or assembly) shall close automatically to stop the flow of gas (or vacuum, if provided) when the primary valve (or assembly) is removed.
5.1.5.5
Each outlet/inlet shall be legibly identified in accordance with 5.1.11.3.
5.1.5.6
Threaded outlets/inlets shall be noninterchangeable connections complying with the mandatory requirements of CGA V-5, *Standard for Diameter Index Safety System (Noninterchangeable Low-Pressure Connections for Medical Gas Applications)*.
5.1.5.7
Each station outlet/inlet, including those mounted in columns, hose reels, ceiling tracks, or other special installations, shall be designed so that parts or components that are required to be gas-specific for compliance with 5.1.5.1 and 5.1.5.9 cannot be interchanged between the station outlet/inlet for different gases.
5.1.5.8
The use of common parts in outlets/inlets, such as springs, O-rings, fasteners, seals, and shutoff poppets, shall be permitted.
5.1.5.9
Components of a vacuum station inlet necessary for the maintenance of vacuum specificity shall be legibly marked to identify them as components or parts of a vacuum or suction system.
5.1.5.10
Components of inlets not specific to a vacuum shall not be required to be marked.
5.1.5.11
Factory-installed copper inlet tubes on station outlets extending no further than 205 mm (8 in.) from the body of the terminal shall be not less than DN8 (NPS 1/4) (3/8 in. O.D.) size, with 8 mm (0.3 in.) minimum inside diameter.
5.1.5.12
Factory-installed outlet tubes on station inlets extending no further than 205 mm (8 in.) from the body of the terminal shall be not less than DN10 (NPS 3/8) (1/2 in. O.D.) size, with 10 mm (0.4 in.) minimum inside diameter.
5.1.5.13
Station outlets/inlets shall be permitted to be recessed or otherwise protected from damage.
5.1.5.14
When multiple wall outlets/inlets are installed, they shall be spaced to allow the simultaneous use of adjacent outlets/inlets with any of the various types of therapy equipment.
5.1.5.15
Station outlets in systems having nonstandard operating pressures shall meet the following additional requirements:
(1) They shall be gas-specific.
(2) They shall be pressure-specific where a single gas is piped at more than one operating pressure [e.g., a station outlet for oxygen at 550 kPa (80 psi) shall not accept an adapter for oxygen at 345 kPa (50 psi)].
(3) If operated at a pressure in excess of 550 kPa (80 psi), they shall be either D.I.S.S. connectors or comply with 5.1.5.15(4).
(4) If operated at a gauge pressure between 1380 kPa and 2070 kPa (200 psi and 300 psi), the station outlet shall be designed so as to prevent the removal of the adapter until the pressure has been relieved to prevent the adapter injuring the user or others when removed from the outlet.
5.1.5.16
WAGD networks shall provide a WAGD inlet in all locations where nitrous oxide or halogenated anesthetic gas is intended to be administered.
5.1.5.16.1
Station inlets for WAGD service shall have the following additional characteristics:
(1) They shall not be interchangeable with any other systems, including medical-surgical vacuum.
(2) Components necessary for the maintenance of WAGD specificity shall be legibly marked to identify them as components of a WAGD inlet.
(3) They shall be of a type appropriate for the flow and vacuum level required by the facility's gas anesthetic machines.
(4) They shall be located to avoid physical damage to the inlet.
5.1.5.17
Where installed in a down-facing position, such as in a ceiling or ceiling column, station outlets/inlets shall be D.I.S.S. connectors.
5.1.6* Manufactured Assemblies.

5.1.6.1

Manufactured assemblies and manufactured rough-in assemblies shall be tested by the manufacturer prior to arrival at the installation site in accordance with the following:

(1) Initial blowdown test in accordance with 5.1.12.2.2

(2) Initial pressure test in accordance with 5.1.12.2.3

(3) Piping purge test in accordance with 5.1.12.2.5

5.1.6.2

Manufactured assemblies shall be tested by the manufacturer prior to arrival at the installation site in accordance with the following:

(1) Standing pressure test in accordance with 5.1.12.2.6 or 5.1.12.2.7, except as permitted by 5.1.6.3

(2) Operational pressure test in accordance with 5.1.12.4.10, except that the test gas is permitted to be in accordance with the manufacturer's process requirements

5.1.6.3

The leakage from a completed manufactured assembly shall not exceed 0.006 cm^3/sec (0.00037 $in.^3$/sec) when tested at 20 percent above operating pressure for pressure pipelines and shall not exceed 0.002 cm^3/sec (0.00012 $in.^3$/sec) for vacuum and WAGD systems when started at 635 mm (25 in.) HgV.

5.1.6.4

The manufacturer of the assembly shall provide documentation certifying the performance and successful completion of the tests required in 5.1.6.1.

5.1.6.5

Manufactured assemblies employing flexible hose shall use hose and flexible connectors with a minimum burst gauge pressure of 6895 kPa (1000 psi).

5.1.6.6

The manufacturer of the assembly shall provide documentation certifying that the flexible hose assembly has a minimum burst gauge pressure of 6895 kPa (1000 psi).

5.1.6.7

Components of manufactured assemblies shall have a flame spread index of not greater than 200 when tested in accordance with ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or UL 723, *Test for Surface Burning Characteristics of Building Materials*, or shall comply with the requirements for heat release in accordance with NFPA 286 as described in Section 10.2 of NFPA *101*.

5.1.6.8

Manufactured assemblies employing flexible hose or tubing shall be attached to the pipelines using station outlets/inlets.

5.1.6.9

Manufactured assemblies employing hose or flexible connectors, where the station outlet/inlet attached to the piping is not fully and immediately accessible (i.e., cannot be manipulated without the removal of panels, doors, and so forth), shall have station outlets/inlets with the following additional characteristics:

(1) They shall 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).

(2) In pressure gases, they shall be permitted to omit the secondary valve (or assembly) required in 5.1.5.2.

(3) In vacuum and WAGD, they shall be permitted to omit both primary and secondary valves (or assemblies) for minimum restriction to flow.

(4) They shall be provided with a second terminal at which the user connects and disconnects that complies with 5.1.5.

5.1.6.10

Hose or flexible connectors employed in manufactured assemblies shall be labeled by stenciling or adhesive markers that identify the patient medical gas, the medical support gas, or the vacuum system and include the following:

(1) Name of the gas or vacuum system or the chemical symbol in accordance with Table 5.1.11

(2) Gas or vacuum system color code in accordance with Table 5.1.11

(3) Where positive pressure piping systems operate at pressures other than the standard gauge pressure in Table 5.1.11, the operating pressure in addition to the name of the gas

(4) Recommended or required replacement date based on manufacture date

5.1.6.11

Station outlets/inlets installed in manufactured assemblies connected to the pipeline by brazing shall comply with 5.1.5.

5.1.6.12

The installation of manufactured assemblies shall be tested in accordance with 5.1.12.

5.1.7* Surface-Mounted Medical Gas Rails (MGR).

5.1.7.1

Medical gas rail (MGR) assemblies shall be permitted to be installed where multiple uses of medical gases and vacuum at a single patient location are required or anticipated.

5.1.7.2

MGR assemblies shall be entirely visible in the room, not passing into or through walls, partitions, and so forth.

5.1.7.3

MGR assemblies shall be made of materials with a melting point of at least 538°C (1000°F).

5.1.7.4
MGR assemblies shall be cleaned per 5.1.10.1.1.
5.1.7.5
Station outlets or inlets shall not be placed on the ends of MGR assemblies.
5.1.7.6
Openings for station outlets/inlets in the MGR shall be gas-specific.
5.1.7.7
Openings in the MGR not occupied by station outlets/inlets (e.g., for future use) shall be capped or plugged so that a special tool is required for removal (i.e., cannot be removed by a wrench, pliers, a screwdriver, or other common tool).
5.1.7.8
MGR assemblies shall connect to the pipeline through fittings that are brazed to the pipeline.
5.1.7.9
Where the pipeline and the MGR assembly are of dissimilar metals, the connections shall be plated or otherwise protected from interaction between the metals.
5.1.7.10
The installation of the MGR shall be tested in accordance with 5.1.12.
5.1.8 Pressure and Vacuum Indicators.
5.1.8.1 General.
5.1.8.1.1
Pressure indicators and manometers for medical gas piping systems shall be cleaned for oxygen service.
5.1.8.1.2
Gauges shall comply with ASME B40.100, *Pressure Gauges and Gauge Attachments*.
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 to 2070 kPa (0 to 300 psi) would have a lower third of 0 to 690 kPa (0 to 100 psig), a middle third of 690 kPa to 1380 kPa (100 psig to 200 psig), and a top third of 1380 kPa to 2070 kPa (200 psig to 300 psig)].
5.1.8.1.4
The accuracy of digital indicators shall be ±5 percent of the operating pressure at which they are used.
5.1.8.1.5
The scale range of vacuum indicators shall be 0 to 760 mm (0 to 30 in.) gauge HgV. Indicators with a normal range display shall indicate normal only above 300 mm (12 in.) gauge HgV.
5.1.8.1.6
Indicators adjacent to master alarm actuators and area alarms shall be labeled to identify the name of, or chemical symbol for, the particular piping system that they monitor.
5.1.8.1.7
Pressure and vacuum indicators used for testing shall be in accordance with 5.1.12.1.14.
5.1.8.2 Locations.
5.1.8.2.1
Pressure/vacuum indicators shall be readable from a standing position.
5.1.8.2.2
Pressure/vacuum indicators shall be provided at the following locations, as a minimum:
(1) Adjacent to the alarm-initiating device for source main line pressure and vacuum alarms in the master alarm system
(2) At or in area alarm panels to indicate the pressure/vacuum at the alarm-activating device for each system that is monitored by the panel
(3) On the station outlet/inlet side of zone valves
5.1.8.2.3
All pressure-sensing devices and main line pressure gauges downstream of the source valves shall be provided with a gas-specific demand check fitting to facilitate service testing or replacement.
5.1.8.2.3.1
Gas-specific demand check fittings shall not be required on zone valve pressure indicators.
5.1.8.2.4
Demand check fittings shall be provided for all monitors.
5.1.9 Category 1 Warning Systems.
5.1.9.1 General.
All master, area, and local alarm systems used for medical gas and vacuum systems shall include the following:
(1) Separate visual indicators for each condition monitored, except as permitted in 5.1.9.2.4(10) for local alarms that are displayed on master alarm panels
(2) Visual indicators that remain in alarm until the situation that has caused the alarm is resolved
(3) Cancelable audible indication of each alarm condition that produces a sound with a minimum level of 80 dBA at 0.92 m (3 ft)
(4) Means to indicate a lamp or LED failure and audible failure
(5) Visual and audible indication that the communication with an alarm-initiating device is disconnected
(6) Labeling of each indicator, indicating the condition monitored

(7) Labeling of each alarm panel for its area of surveillance
(8) Reinitiating of the audible signal if another alarm condition occurs while the audible alarm is silenced
(9) Power for master alarms, area alarms, sensors, and switches from the life safety branch of the essential electrical system as described in Chapter 6
(10) Power for local alarms, dew point sensors, and carbon monoxide sensors permitted to be from the same essential electrical branch as is used to power the air compressor system
(11) Where used for communications, wiring from switches or sensors that is supervised or protected as required by 517.30(C)(3) of *NFPA 70* for life safety and critical branches circuits in which protection is any of the following types:
(a) Conduit
(b) Free air
(c) Wire
(d) Cable tray
(e) Raceways
(12) Communication devices that do not use electrical wiring for signal transmission and are supervised such that failure of communication initiates an alarm
(13) Assurance by the responsible authority of the facility that the labeling of alarms, where room numbers or designations are used, is accurate and up-to-date
(14) Provisions for automatic restart after a power loss of 10 seconds (e.g., during generator start-up) without giving false signals or requiring manual reset
(15) Alarm switches/sensors installed so as to be removable and accessible for service and testing

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 source (if any), and the pressure in the main lines of each medical gas and vacuum piping system.

5.1.9.2.1

The master alarm system shall consist of two or more alarm panels located in at least two separate locations, as follows:
(1) One master alarm panel shall be located in the office or work space of the on-site individual responsible for the maintenance of the medical gas and vacuum piping systems.
(2) In order to ensure continuous surveillance of the medical gas and vacuum systems while the facility is in operation, the second master alarm panel shall be located in an area of continuous observation (e.g., the telephone switchboard, security office, or other continuously staffed location).

5.1.9.2.2

A centralized computer system shall be permitted to be substituted for one of the master alarms required in 5.1.9.2.1 if the computer system complies with 5.1.9.3.

5.1.9.2.3

The master alarm panels required in 5.1.9.2.1 shall communicate directly to the alarm initiating devices that they monitor.

5.1.9.2.3.1

If communication is achieved by wires, the following shall apply:
(A)
Each of the two mandatory alarms shall be wired independently to the initiating device(s) for each signal.
(B)
The wiring between each mandatory alarm(s) and the initiating device(s) shall not utilize common conductors that, if interrupted, would disable more than one signal.
(C)
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.
(D)
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 5.1.9.2.3.1(B) and 5.1.9.2.3.1(C) 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(A) through 5.1.9.2.3.1(C), 5.1.9.2.3.4, and 5.1.9.2.3.5 in all respects.

5.1.9.2.3.2

If communication is achieved by means other than wires, the following shall apply:
(A)
Each of the mandatory alarms shall communicate independently to the initiating device(s) for each signal.
(B)
The means of communication between each mandatory alarm(s) and the initiating device(s) shall not utilize a common communication device that, if interrupted, would disable the signal from another initiating device(s).

5.1.9.2.3.3

A single initiating device shall be permitted to actuate multiple master alarms.

5.1.9.2.3.4

The mandatory master alarm panels shall not be arranged such that failure of either panel would disable any signal on the other panel.

5.1.9.2.3.5

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.

5.1.9.2.3.6

Master alarm signals shall not be relayed from one master alarm panel to another.

5.1.9.2.3.7

Where multi-pole alarm relays are used to isolate the alarm-initiating signals to master alarm panels, the control power source for the relays shall be independent of any of the master alarm panels.

5.1.9.2.3.8

Multiple master alarms shall be permitted to monitor a single initiating device.

5.1.9.2.4

Master alarm panels for medical gas and vacuum systems shall each include the following signals:

(1) Alarm indication when or just before changeover occurs in a medical gas system that is supplied by a manifold or other alternating-type bulk system that has, as a part of its normal operation, a changeover from one portion of the operating supply to another

(2) Alarm indication for a cryogenic fluid central supply system when the main supply reaches one average day's supply, indicating low contents

(3) Alarm indication when or just before changeover to the reserve supply occurs in a medical gas system that consists of one or more units that continuously supply the piping system while another unit remains as the reserve supply and operates only in an emergency

(4) Alarm indication for cylinder reserve pressure low when the content of a cylinder reserve header is reduced below one average day's supply

(5) For cryogenic fluid central supply systems, alarm indication when or at a predetermined set point before the reserve supply contents fall to one average day's supply, indicating low reserve

(6) Where a cryogenic liquid storage unit is used as a reserve for a cryogenic fluid central supply system, alarm indication when the gas pressure available in the reserve unit is below that required for the medical gas system to function

(7) Alarm indication when the pressure in the main line of each separate medical gas system increases 20 percent from the normal operating pressure

(8) Alarm indication when the pressure in the main line of each separate medical gas system decreases 20 percent from the normal operating pressure

(9) Alarm indication when the medical-surgical vacuum pressure in the main line of each vacuum system drops to or below 300 mm (12 in.) gauge HgV

(10) Single alarm indication from the local alarm panel(s) as described in 5.1.3.6.3.12 and 5.1.9.5.3 to indicate when one or more of the conditions being monitored at a site is in alarm

(11) Medical air dew point high alarm from each compressor site to indicate when the line pressure dew point is greater than +2°C (+35°F)

(12) WAGD low alarm when the WAGD vacuum level or flow is below effective operating limits

(13) Instrument air dew point high alarm from each compressor site to indicate when the line pressure dew point is greater than −30°C (−22°F)

(14) Alarm indication if the primary or reserve production stops on a proportioning system

(15) When oxygen is supplied from an oxygen central supply system using concentrators *(see 5.1.3.9)*, the following signals:

(a) For each concentrator supply source used in the oxygen central supply system, alarm indication that oxygen concentration from that oxygen concentrator supply source is below 91 percent

(b) For each oxygen concentrator supply source used in the oxygen central supply system, alarm indication that the isolating valve for that oxygen concentrator supply source is closed and the supply source is isolated

(c) For each cylinder header used as a source, alarm indication that the header is in use

(d) For each cylinder header used as a source, alarm indication that the cylinder contents are below one average day's supply

(e) If the supply source in use changes because of a failure to appropriately supply the system, alarm indication that an unexpected oxygen supply change has occurred

(f) Alarm indication that the pressure in the common line on the source side of the line pressure controls is low

(g) Alarm indication that the oxygen concentration from the central supply system is below 91 percent

(16) For combined medical-surgical vacuum/WAGD systems that are monitored for oxygen concentration, an alarm indication when the concentration of oxygen exceeds 23.6 percent

5.1.9.2.5

The alarm indications required in 5.1.9.2.4(7) and 5.1.9.2.4(9) shall originate from sensors installed in the main lines immediately downstream (on the patient or use side) of the source valves. Where it is necessary to install a main line valve in addition to a source valve *(see 5.1.4.3)*, the sensors shall be located downstream (on the patient or use side) of the main valve.

5.1.9.3 Master Alarms by Computer Systems.

~~Computer systems used as substitute master alarms as required by 5.1.9.2.1(2) shall have the mechanical and electrical characteristics described in 5.1.9.3.1 and the programming characteristics described in 5.1.9.3.2.~~

~~5.1.9.3.1~~

~~Computer systems used to substitute for alarms shall have the following mechanical and electrical characteristics:~~

~~(1) The computer system shall be in continuous uninterrupted operation and provided with power supplies as needed to ensure such reliability.~~

~~(2) The computer system shall be continuously attended by responsible individuals or shall provide remote signaling of responsible parties (e.g., through pagers, telephone autodialers, or other such means).~~

~~(3) Where computer systems rely on signal interface devices (e.g., electronic interfaces, other alarm panels, 4-mA to 20-mA cards), such interfaces shall be supervised such that failure of the device(s) shall initiate an alarm(s).~~

~~(4) If the computer system does not power the signaling switches/sensors from the same power supply required in 5.1.9.3.1(1), the power supply for the signaling switches/sensors shall be powered from the life safety branch of the essential electrical system as described in Chapter 6.~~

~~(5) 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.~~

~~(6) Communication from the computer system to the signaling switches or sensors shall be supervised such that failure of communication shall initiate an alarm.~~

~~(7) Computer systems shall be provided with an audio alert per 5.1.9.1(3), except the audio alert shall be permitted to be only as loud as needed to alert the system operator.~~

~~(8) The facility shall ensure compliance with 5.1.9.1(13).~~

~~5.1.9.3.2~~

~~The operating program for computer systems used to substitute for alarms shall include the following:~~

~~(1) The medical gas alarm shall be allocated the priority of a life safety signal.~~

~~(2) A medical gas alarm signal shall interrupt any other activity of a lesser priority to run the alarm algorithm(s).~~

~~(3) The alarm algorithm shall include activation of an audible alert, activation of any remote signaling protocol, and display of the specific condition in alarm.~~

~~(4) The alarm algorithm shall provide for compliance with 5.1.9.1(1) through 5.1.9.1(5), and 5.1.9.1(8).~~

~~5.1.9.4* Area Alarms.~~

~~Area alarm panels shall be provided to monitor all medical gas, medical-surgical vacuum, and piped WAGD systems supplying the following:~~

~~(1) Anesthetizing locations~~

~~(2) *Category 1 spaces~~

~~5.1.9.4.1*~~

~~Area alarms shall be located at a nurse's station or other similar location that will provide for surveillance.~~

~~5.1.9.4.2~~

~~Area alarm panels for medical gas systems shall have separate visual indicators for an alarm condition when either of the following occurs:~~

~~(1) The pressure in the main line of each separate medical gas system increases 20 percent from the normal operating pressure.~~

~~(2) The pressure in the main line of each separate medical gas system decreases 20 percent from the normal operating pressure.~~

~~5.1.9.4.3~~

~~Area alarm panels for medical-surgical vacuum systems shall indicate if the vacuum in the area drops to or below 300 mm (12 in.) gauge HgV.~~

~~5.1.9.4.4*~~

~~Alarm sensors for area alarms shall be located as follows:~~

~~(1) *Category 1 spaces, other than anesthetizing locations addressed in 5.1.9.4.4(2), shall have the alarm sensors installed on the patient or use side of each of the individual zone valves.~~

~~(2) *Anesthetizing locations, including those that are part of a group of anesthetizing locations, shall have the sensors installed in either of the following locations:~~

~~(a) On the source side of each group of anesthetizing location zone valves on the same branch line~~

~~(b) On the patient or use side of each of the individual zone valves~~

~~5.1.9.4.5~~

~~One area alarm panel shall be acceptable to monitor multiple rooms located within an immediate vicinity meeting the requirements of 5.1.9.4.4(2).~~

~~5.1.9.4.6~~

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

~~5.1.9.5* Local Alarms.~~

~~Local alarms shall be installed to monitor the function of the air compressor system(s), medical-surgical vacuum pump system(s), WAGD systems, instrument air systems, and proportioning systems.~~

~~5.1.9.5.1~~

~~The signals referenced in 5.1.9.5.3 shall be permitted to be located as follows:~~

~~(1) On or in the control panel(s) for the central supply system or supply source being monitored~~

~~(2) Within a monitoring device (e.g., dew point monitor or carbon monoxide monitor)~~

~~(3) On a separate alarm panel(s)~~

5.1.9.5.2

If there is more than one central supply system, for a specific gas or vacuum pipeline or more than one central supply system and pipeline for the same gas in the building, then it shall be necessary for each location to have separate local alarms per 5.1.9.5.3 and signals at the master panels per 5.1.9.2.4.

5.1.9.5.3

The following functions shall be monitored at each local alarm site:

(1) Low medical air reserve capacity, to indicate when the medical air source is operating under a demand that could not be managed if one compressor ceased to operate

(2) High carbon monoxide level, to indicate when the carbon monoxide level in the medical air system is 10 ppm or higher

(3) Medical air dew point high, to indicate when the line pressure dew point is greater than +2°C (+35°F)

(4) Low medical vacuum reserve capacity, to indicate when the medical vacuum source is operating under a demand that could not be managed if one pump ceased to operate

(5) Low WAGD reserve capacity, to indicate when the WAGD source is operating under a demand that could not be managed if one producer ceased to operate

(6) Instrument air dew point high, to indicate when the line pressure dew point is greater than −30°C (−22°F)

(7) Low instrument air reserve capacity, if instrument air is provided by a source with more than one compressor, to indicate when the instrument air source is operating under a demand that could not be managed if one compressor ceased to operate

(8) For compressor systems using liquid ring compressors or compressors with water-cooled components, high water in the receiver tank, to indicate when the water level in the receiver tank has reached a level determined to be detrimental to the operation of the system

(9) For compressor systems using liquid ring compressors, high water in the separator

(10) For compressor systems using other than liquid ring compressors, high discharge air temperature

(11) Proportioning systems high/low indicator when the oxygen concentration is outside the 19.5 percent to 23.5 percent oxygen range

(12) Proportion systems reserve system in operation

(13) When oxygen is supplied from an oxygen central supply system using concentrators *(see 5.1.3.9)*, the following signals shall be provided at the system's local alarm site(s):

(a) For each cylinder header used as a source, an alarm indication that the header is in use

(b) For each cylinder header used as a source, an alarm indication that the cylinder contents are below one average day's supply

(c) If the source in use changes because of a failure to appropriately supply the system, an alarm indication indicating an unexpected oxygen supply change has occurred

(d) An alarm indication that the pressure in the common line on the source side of the line pressure controls is low

(e) An alarm indication that the oxygen concentration from the supply system is below 91 percent

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 the mandatory requirements of 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 and labeled and kept sealed until prepared for installation.

5.1.10.1.4*

Tubes shall be one of the following:

(1) Hard-drawn seamless copper in accordance with ASTM B819, *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 (3⅛ in. O.D.)].

(2) *Listed corrugated medical tubing (CMT) fabricated from copper alloy No. 51000 strip, meeting ASTM B103/B103M, *Standard Specification for Phosphor Bronze Plate, Sheet, Strip, and Rolled Bar*, with a design margin of 3.5, externally coated with a nonmetallic sheath marked with the manufacturer's marking. The listing shall include testing to demonstrate that CMT systems can be consistently gas-purged with results equivalent to comparable medical gas copper tubing.

5.1.10.1.5

CMT shall have a flame spread index of 25 or less and a smoke developed index of 50 or less as determined by ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*.

5.1.10.1.6

CMT shall be identified by the manufacturer as suitable for oxygen service at a minimum of every 0.92 m (3 ft).

5.1.10.1.7

ASTM B819, *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).

5.1.10.1.8

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 and WAGD Systems at Vacuums Greater than 125 mm (5 in.) HgV.

Piping for vacuum and WAGD systems at vacuums greater than 125 mm (5 in.) HgV shall be constructed of any of the following:

(1) Hard-drawn seamless copper tube in accordance with the following:

(a) ASTM B88, *Standard Specification for Seamless Copper Water Tube*, copper tube (Type K, Type L, or Type M)

(b) ASTM B280, *Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service*, copper ACR tube

(c) ASTM B819, *Standard Specification for Seamless Copper Tube for Medical Gas Systems*, copper medical gas tubing (Type K or Type L)

(2) Stainless steel tube in accordance with the following:

(a) ASTM A269/A269M, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service, TP304L or 316L

(b) ASTM A312/A312M, *Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes,* TP304L or 316L

(c) A312 TP 304L/316L, Sch. 5S pipe, and A403 WP304L/316L, Sch. 5S fittings

(3) CMT meeting the requirements of 5.1.10.1.4(2)

5.1.10.2.2 Vacuum and WAGD Tube Marking Where Required.

5.1.10.2.2.1

Copper tubing for vacuum or WAGD service that is installed along with any medical gas 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 in accordance with ASTM B819, *Standard Specification for Seamless Copper Tube for Medical Gas Systems,* or CMT in accordance with 5.1.10.1.4(2), 5.1.10.1.5, and 5.1.10.1.6 is used for vacuum or WAGD piping, special marking in accordance with 5.1.10.2.2.1 shall not be required.

5.1.10.2.3 Piping Materials for Field-Installed WAGD.

Piping for WAGD systems operated at no greater than 130 mm (5 in.) HgV shall be constructed of either of the following:

(1) Any materials complying with 5.1.10.2.1

(2) Any noncorroding tube or ductwork suitable to the vacuum level

5.1.10.2.3.1

WAGD system piping that is joined to the vacuum piping shall be connected at a minimum distance of 1.5 m (5 ft) from any vacuum inlet.

5.1.10.2.3.2*

Systems complying with 5.1.10.2.3.1 shall be labeled as indicated in 5.1.11 for both WAGD and vacuum.

5.1.10.3 Joints.

5.1.10.3.1*

Positive pressure patient gas systems, medical support gas systems, vacuum systems, and WAGD systems constructed of hard-drawn seamless copper or stainless steel tubing 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 fittings, as described in 5.1.10.7

(5) Threaded, as described in 5.1.10.8

5.1.10.3.2

Positive pressure patient gas systems, medical support gas systems, vacuum systems, and WAGD systems constructed of CMT shall have turns, offsets, and other changes in direction made by bending the tubing up to the minimum bend radius or by fittings in accordance with 5.1.10.3.1.

5.1.10.3.3

Vacuum systems and WAGD systems fabricated from copper tubing 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.

5.1.10.3.4

Branch connections made using mechanically formed, drilled, and extruded tee-branch connections shall be prohibited in CMT systems.

5.1.10.3.5

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 5.1.12.4.2.

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 ANSI/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 A5.8M/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 cryogenic fluid central supply system 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 the mandatory requirements of CGA M-1, *Standard for Medical Gas Supply Systems at Health Care Facilities*.
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
Braze 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 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 allowed 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, stainless steel or brass 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 that 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, using a solution of 450 g (1 lb) of sodium carbonate or trisodium phosphate to 11 L (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 in accordance with the mandatory requirements of CGA G-4.1, *Cleaning Equipment 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.

5.1.10.4.3.13

Joints shall be brazed within 8 hours after the surfaces are cleaned for brazing.

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) (⅞ 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 ensure 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 begins.

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 5.1.12.4.9.

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 ANSI/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 allow 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 *(see 5.1.12.2.3)* and standing pressure test *(see 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 the conditions of 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 the conditions of 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 gas tungsten arc welding (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 in accordance with 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 of 75 percent helium (±5 percent) and 25 percent argon (±5 percent).

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 tube.

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 fittings providing metal-to-metal seals, suitable for service at 2070 kPa (300 psig) and able to withstand a temperature of 538°C (1000°F) and that, 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 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) They shall be limited to connections for pressure and vacuum indicators, alarm devices, gas specific demand check fittings, and source equipment on the source side of the source valve.

(2) They shall be tapered pipe threads complying with ASME B1.20.1, *Pipe Threads, General Purpose, Inch*.

(3) *They shall be made up with polytetrafluoroethylene (PTFE) 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* Fittings with Internal Seals.

Fittings with internal seals shall be permitted where they meet all of the following requirements:

(1) The fittings shall be brass, bronze, or copper.

(2) All materials used shall comply with 5.1.3.5.4.

(3) Internal seals, insulators, and other polymeric materials shall be limited only to those parts essential for sealing or creating the dielectric break.

(4) Internal seals, insulators, and other elastomeric materials shall be replaceable.

(5) The fittings shall be cleaned for oxygen when used for patient gases or medical support gases.

(6) The fittings shall be installed only where visible and accessible, allowing for testing and servicing.

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) Pipe-crimping tools used to permanently stop the flow of medical gas and vacuum piping

(4) Removable and nonremovable push-fit fittings that employ a quick-assembly push fit connector

5.1.10.11 Pipe Sizing and System Design.

5.1.10.11.1 Pipe Sizing.

5.1.10.11.1.1

The system designer shall size the piping such that calculated pressure or vacuum losses across the piping as designed do not exceed 10 percent of the intended operating pressure or vacuum at the source valve.

5.1.10.11.1.2

The pressure drop calculations required by 5.1.10.11.1.1 shall become part of the facility's permanent records.

5.1.10.11.1.3

The design and installation of piping shall meet the following requirements:

(1) Mains and branches supplying medical gas to more than a single terminal shall not be smaller than DN15 (NPS ½) (⅝ in. O.D.) size.

(2) Mains and branches supplying medical vacuum to more than a single terminal shall not be smaller than DN20 (NPS ¾) (⅞ in. O.D.) size.

(3) Mains and branches supplying WAGD or support gases to more than a single terminal shall not be smaller than DN15 (NPS ½) (⅝ in O.D.) size.

(4) Drops to individual terminals shall not be smaller than DN15 (NPS ½) (⅝ in. O.D.) size.

(5) Runouts to pressure-sensing devices shall be permitted to be DN8 (NPS ¼) (⅜ 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, stairwells, elevator shafts, elevator machine rooms, areas with open flames, electrical service equipment over 600 volts, and areas prohibited under *NFPA 70* 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 as fuel gas lines, fuel oil lines, electrical lines, steam lines, and similar utilities if 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.

5.1.10.11.4.2

Hangers and supports shall comply with and be installed in accordance with MSS SP-58, Pipe Hangers and Supports — Materials, Design, Manufacture, Selection, Application, and Installation.

5.1.10.11.4.3

Supports for copper tube shall be sized for copper tube.

5.1.10.11.4.4*

Supports for CMT shall be in accordance with the CMT manufacturer's installation instructions.

5.1.10.11.4.5

In potentially damp locations, copper tube hangers or supports that are in contact with the tube shall be plastic-coated or otherwise electrically insulated from the tube by a material that will not absorb moisture.

5.1.10.11.4.6

Maximum support spacing shall be in accordance with Table 5.1.10.11.4.6.

Table 5.1.10.11.4.6 Maximum Pipe Support Spacing

-	Hanger Spacing	
Pipe Size	mm	ft
DN8 (NPS 1/4) (3/8 in. O.D.)	1520	5
DN10 (NPS 3/8) (1/2 in. O.D.)	1830	6
DN15 (NPS 1/2) (5/8 in. O.D.)	1830	6
DN20 (NPS 3/4) (7/8 in. O.D.)	2130	7
DN25 (NPS 1) (1 1/8 in. O.D.)	2440	8
DN32 (NPS 1 1/4) (1 3/8 in. O.D.)	2740	9
DN40 (NPS 1 1/2) (1 5/8 in. O.D.) and larger	3050	10
Vertical risers, all sizes, every floor, but not to exceed	4570	15

5.1.10.11.4.7

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, prior to backfilling over them, 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 comply with the following requirements:~~

~~(1) Except as permitted by 5.1.10.11.5.5(2), it shall be 900 mm (36 in.).~~

~~(2) It shall be permitted to be reduced to 450 mm (18 in.) where there is no potential for damage from surface loads or surface conditions.~~

~~5.1.10.11.5.6~~

~~Trenches shall be excavated such 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 be provided above the pipeline at approximately one-half the depth of burial.~~

~~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~~

~~Metallic and nonmetallic hose and flexible connectors shall be no longer than necessary and not penetrate or be concealed in walls, floors, ceilings, or partitions.~~

~~5.1.10.11.6.2~~

~~Connections that are part of a manufactured assembly shall be permitted to be concealed above a ceiling in accordance with 5.1.6.9 where access is provided to the ceiling space for inspection and maintenance.~~

~~5.1.10.11.6.3~~

~~Metallic and nonmetallic flexible connectors shall have a minimum burst pressure, with a gauge pressure of 6895 kPa (1000 psi).~~

~~5.1.10.11.6.4~~

~~Metallic flexible joints shall be permitted in the pipeline where required for expansion joints, seismic protection, thermal expansion, or vibration control and meet the following requirements:~~

~~(1) For 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) or above and able to withstand temperatures of 538°C (1000°F)~~

~~(4) Provided with brazing extensions to allow brazing into the pipeline in accordance with 5.1.10.4~~

~~(5) Supported with pipe hangers and supports as required for their additional weight~~

~~5.1.10.11.6.5~~

~~Metallic flexible joints in accordance with 5.1.10.11.6.4 shall be permitted to be concealed in walls, ceilings, or partitions.~~

~~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 except as permitted by 5.1.10.11.7.2.~~

~~5.1.10.11.7.2~~

~~Medical gas and vacuum systems with the same contents shall be permitted to be interconnected with an in-line valve installed between the systems.~~

~~5.1.10.11.7.3~~

~~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 comply with the manufacturer's instructions.~~

~~5.1.10.11.8.2~~

~~The manufacturer's 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 the 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 use at one pressure and for one gas is converted for operation at another pressure or for another gas, the requirements 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 performing such installations, including all personnel who actually install the piping system.

5.1.10.11.10.2

Installers of medical gas and vacuum piped distribution systems, all appurtenant piping supporting pump and compressor source systems, and appurtenant piping supporting source gas manifold systems not including permanently installed bulk source systems shall be certified in accordance with ASSE/IAPMO/ANSI 6010, *Professional Qualifications Standard for Medical Gas Systems Installers*.

5.1.10.11.10.3

CMT systems shall be installed by ASSE 6010–qualified installers using the CMT manufacturer's instructions.

5.1.10.11.10.4

Installers of medical gas and vacuum systems shall not use their certification to oversee installation by noncertified personnel.

5.1.10.11.10.5

Brazing shall be performed by individuals who are qualified in accordance with the provisions of 5.1.10.11.11.

5.1.10.11.10.6

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 required by 5.1.10.11.11.

5.1.10.11.10.7

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/B2.2M, *Specification 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 brazer performance qualification record shall document filler metal used, base metals, cleaning, joint clearance, overlap, internal purge gas and flow rate during brazing of coupon, and 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 records 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.

5.1.10.11.11.6

An employer shall be permitted to accept the 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 brazer performance qualification test records 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 breaching or penetrating process shall ensure that any debris created by the process remains contained within the work area.

5.1.11* Labeling, Identification, and Operating Pressure.

Color and pressure requirements shall be in accordance with Table 5.1.11.

Table 5.1.11 Standard Designation Colors and Operating Pressures for Gas and Vacuum Systems

Gas Service	Abbreviated Name	Colors (Background/Text)	Standard Gauge Pressure	
			kPa	psi
Medical air	Med air	Yellow/black	345–380	50–55
Carbon dioxide	CO_2	Gray/black or gray/white	345–380	50–55
Helium	He	Brown/white	345–380	50–55
Nitrogen	N_2	Black/white	0–2070	0–300
Nitrous oxide	N_2O	Blue/white	345–380	50–55
Oxygen	O_2	Green/white or white/green	345–380	50–55
Oxygen/carbon dioxide mixtures	$O_2/CO_2n\%$ (*n* = % of CO_2)	Green/white	345–380	50–55
Medical–surgical vacuum	Med vac	White/black	380 mm to 760 mm (15 in. to 30 in.) HgV	
Waste anesthetic gas disposal	WAGD	Violet/white	Varies with system type	
Medical–surgical vacuum/WAGD combination	Med–surg/WAGD	White/black and violet/white	380 mm to 760 mm (15 in. to 30 in.) HgV	
Other mixtures	Gas A%/Gas B%	Colors as above	None	
-	-	Major gas for background/minor gas for text	-	
Nonmedical air and dental air	—	Yellow and white diagonal stripe/black	None	
Nonmedical vacuum and dental vacuum	—	White and black diagonal stripe/black boxed	None	
Laboratory air	—	Yellow and white checkerboard/black	None	
Laboratory vacuum	—	White and black checkerboard/black boxed	None	
Instrument air	—	Red/white	0–2070	0–300

5.1.11.1 Pipe Labeling.

5.1.11.1.1

Piping shall be labeled by stenciling or adhesive markers that identify the patient medical gas, the medical support gas, or the vacuum system and include the following:

(1) Name of the gas or vacuum system or the chemical symbol per Table 5.1.11

(2) Gas or vacuum system color code per Table 5.1.11

5.1.11.1.2
Where positive-pressure gas piping systems operate at pressures other than the standard gauge pressure in Table 5.1.11, the operating pressure in addition to the name of the gas shall be labeled.
5.1.11.1.3
Where vacuum systems are used to serve WAGD systems in accordance with 5.1.10.2.3.1, piping in the immediate area of the WAGD system shall be labeled to indicate both systems.
5.1.11.1.4
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 traversed by risers
5.1.11.1.5
Medical gas piping shall not be painted.
5.1.11.1.6
Labeling of piping for compressor intakes, vacuum exhausts, and relief valve vent lines shall meet the requirements of 5.1.11.1.1 and state the specific function to distinguish them from the patient supply piping.
5.1.11.2 Shutoff Valves.
5.1.11.2.1
Shutoff valves shall be identified with the following:
(1) Name or chemical symbol for the specific medical gas or vacuum system
(2) Gas or vacuum system color code in accordance with Table 5.1.11
(3) Room or areas served
(4) Caution to not close or open the valve except in emergency5.1.11.2.2
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 or instrument air, the valve identification shall also include the nonstandard operating pressure.
5.1.11.2.3*
Where vacuum systems are used to serve WAGD systems in accordance with 5.1.10.2.3.1, valves that are on the source side of the connection to the WAGD system shall be labeled to indicate both systems.
5.1.11.2.4
Source valves shall be labeled in substance as follows:
"SOURCE VALVE FOR THE (GAS/VACUUM NAME) SERVING (NAME OF THE AREA/BUILDING SERVED BY THE SOURCE VALVE)."
5.1.11.2.5
Main line valves shall be labeled in substance as follows:
"MAIN LINE VALVE FOR THE (GAS/VACUUM NAME)
,
SERVING (NAME OF THE BUILDING)."
5.1.11.2.6
The riser valve(s) shall be labeled in substance as follows:
"RISER FOR THE (GAS/VACUUM NAME) SERVING
,
(NAME OF THE AREA/BUILDING SERVED BY THE
,
PARTICULAR RISER)."
5.1.11.2.7
The service valve(s) shall be labeled in substance as follows:
"SERVICE VALVE FOR THE (GAS/VACUUM NAME)
,
SERVING (NAME OF THE AREA/BUILDING
,
SERVED BY THE PARTICULAR VALVE)."
5.1.11.2.8*
Zone valve box assemblies shall be labeled with the rooms, areas, or spaces that they control as follows:
"ZONE VALVES FOR THE (GAS/VACUUM NAME)
,
SERVING (NAME OF ROOMS OR SPACES SERVED
,
BY THE PARTICULAR VALVE)."
Labeling shall either be visible from outside the zone valve box assembly through the cover or be replicated on the outside, but not affixed to the removable cover.
5.1.11.3 Station Outlets and Inlets.
5.1.11.3.1
Station outlets and inlets shall be identified as to the name or chemical symbol for the specific medical gas or vacuum provided and shall include the following:

(1) Name of the gas or vacuum system or the chemical symbol in accordance with Table 5.1.11
(2) Gas or vacuum system color code in accordance with Table 5.1.11
5.1.11.3.1.1
In sleep labs, where the outlet is downstream of a flow control device, the station outlet identification shall include a warning not to use the outlet for ventilating patients. 5.1.11.3.2
Where medical gas 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 outlet identification shall include the nonstandard operating pressure in addition to the name of the gas.
5.1.11.4 Alarm Panels.

5.1.11.4.1
Labeling of alarm panels for each indicator shall indicate the condition monitored and its area of surveillance.
5.1.11.4.2*
Area alarm panels shall be identified with the following:
(1) Name or chemical symbol of the specific medical gas or vacuum system being monitored
(2) Gas or vacuum system color code, in accordance with Table 5.1.11, of the specific medical gas or vacuum system being monitored
(3) Area(s) monitored by the alarm panel
5.1.11.4.3
Where medical gas 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 or instrument air, the area alarm panel identification shall include the nonstandard operating pressure in addition to the name of the gas.
5.1.11.4.4
Where vacuum systems are used to serve WAGD systems per 5.1.10.2.3.1, an area alarm panel(s) monitoring the area in which the WAGD system is used shall be labeled to indicate both systems.
5.1.11.5 Source Equipment.
5.1.11.5.1
Source equipment shall be labeled or tagged to identify the patient medical gas, the medical support gas, or the vacuum system and include the following information:
(1) Name of the gas or vacuum system
(2) Gas or vacuum system color code
(3) Rooms, areas, or buildings served
(4) Emergency contact information for the department or individual responsible for maintaining the equipment
5.1.11.5.2
Where vacuum systems are used to serve WAGD systems in accordance with 5.1.10.2.3.1, labeling for the medical–surgical vacuum source shall indicate that it serves both systems.
5.1.12* Performance Criteria and Testing — Category 1 (Gases, Medical–Surgical Vacuum, and WAGD).
5.1.12.1 General.
5.1.12.1.1
Inspection and testing shall be performed on all new piped medical gas and vacuum systems, additions, renovations, temporary installations, or repaired systems to ensure, by a documented process and procedure, that all applicable provisions of this document have been adhered to and system integrity has been achieved or maintained.
5.1.12.1.2
Inspection and testing shall include all components of the system, or portions thereof, including, but not limited to, gas bulk source(s); manifolds; compressed air source systems (e.g., compressors, dryers, filters, regulators); source alarms and monitoring safeguards; master alarms; pipelines; isolation valves; area alarms; zone valves; and station inlets (vacuum) and outlets (pressure gases).
5.1.12.1.3*
All systems that are breached and all components that are subject to additions, renovations, or replacement shall be inspected and tested.
5.1.12.1.4
Systems shall be deemed breached at the point of pipeline intrusion by physical separation or by system component removal, replacement, or addition.
5.1.12.1.5
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 and any other areas affected by the breach.
5.1.12.1.6
The inspection and testing reports shall be submitted directly to the party that contracted for the testing, who shall submit the report through channels to the responsible facility authority and any others that are required.
5.1.12.1.7
Reports shall contain detailed listings of all findings and results.
5.1.12.1.8

The responsible facility authority shall review these inspection and testing records prior to the use of all systems to ensure that all findings and results of the inspection and testing have been successfully completed.

5.1.12.1.9

All documentation pertaining to inspections and testing shall be maintained on-site within the facility.

5.1.12.1.10

Before piping systems are initially put into use, the facility authority shall be responsible for ascertaining that the gas/vacuum delivered at the outlet/inlet is that shown on the outlet/inlet label and that the proper connecting fittings are installed for the specific gas/vacuum service.

5.1.12.1.11*

New medical gas and vacuum pipeline distribution systems shall not be connected to the existing in-use systems until the initial pressure test is successfully completed in accordance with 5.1.12.2.3.

5.1.12.1.12

Acceptance of the verifier's final report shall be permitted to satisfy the requirements in 5.1.12.1.10.

5.1.12.1.13

The removal of components within a source system for repair and reinstallation, or the replacement of components like for like, shall be treated as new work for the purposes of testing whenever such work involves cutting or brazing new piping, or both.

5.1.12.1.13.1

Where no piping is changed, functional testing shall be performed as follows:

(1) To verify the function of the replaced device

(2) To ensure no other equipment in the system has been adversely impacted

5.1.12.1.13.2

Where no piping is changed, in addition to tests of general function required by 5.1.12.1.13.1, testing shall be performed as follows:

(1) Pressure gas sources shall be tested for compliance with 5.1.12.4.14.2 as applicable to the equipment type.

(2) Medical air and instrument air sources shall be tested to 5.1.12.4.14.3.

(3) Vacuum and WAGD systems shall be tested to 5.1.12.4.14.6.

(4) Alarm systems shall be tested to 5.1.12.4.5.2 and 5.1.12.4.5.3.

(5) All affected components shall be tested as appropriate to that specific component (e.g., a replaced dew point monitor would be tested to 5.1.3.6.3.13).

5.1.12.1.14

The rated accuracy of pressure and vacuum indicators used for testing shall be 1 percent (full scale) or better.

5.1.12.2 Installer-Performed Tests.

5.1.12.2.1 General.

5.1.12.2.1.1

The tests required by 5.1.12.2 shall be performed and documented by the installer prior to the tests listed in 5.1.12.4.

5.1.12.2.1.2

The test gas shall be oil-free, dry nitrogen NF.

5.1.12.2.1.3

Where manufactured assemblies are to be installed, the tests required by 5.1.12.2 shall be performed as follows:

(1) After completion of the distribution piping, but before the standing pressure test

(2) Prior to installation of manufactured assemblies supplied through flexible hose or flexible tubing

(3) At all station outlets/inlets on installed manufactured assemblies supplied through copper tubing

5.1.12.2.2* Initial Piping Blowdown.

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 outlet/inlet rough-in assemblies and other system components.

5.1.12.2.3 Initial Pressure Test.

5.1.12.2.3.1

Each section of the piping in medical gas and vacuum systems shall be pressure tested.

5.1.12.2.3.2

Initial pressure tests shall be conducted as follows:

(1) After blowdown of the distribution piping

(2) After installation of station outlet/inlet rough-in assemblies

(3) *Prior to the installation of components of the distribution piping system that would be damaged by the test pressure

5.1.12.2.3.3

The source shutoff valve shall remain closed during the tests specified in 5.1.12.2.3.

5.1.12.2.3.4

The test pressure for pressure gases and vacuum systems shall be 1.5 times the system operating pressure but not less than a gauge pressure of 1035 kPa (150 psi).

5.1.12.2.3.5*

The test pressure shall be maintained until each joint has been examined for leakage by means of a leak detectant that is safe for use with oxygen and does not contain ammonia.

5.1.12.2.3.6

Leaks, if any, shall be located, repaired (if permitted), replaced (if required), and retested.

5.1.12.2.4 Initial Cross-Connection Test.

It shall be determined that no cross-connections exist between the various medical gas and vacuum piping systems.

5.1.12.2.4.1

All piping systems shall be reduced to atmospheric pressure.

5.1.12.2.4.2

Sources of test gas shall be disconnected from all piping systems, except for the one system being tested.

5.1.12.2.4.3

The system under test shall be charged with oil-free, dry nitrogen NF to a gauge pressure of 345 kPa (50 psi).

5.1.12.2.4.4

After the installation of the individual faceplates with appropriate adapters matching outlet/inlet labels, each individual outlet/inlet in each installed medical gas and vacuum piping system shall be checked to determine that the test gas is being dispensed only from the piping system being tested.

5.1.12.2.4.5

The cross-connection test referenced in 5.1.12.2.4 shall be repeated for each installed medical gas and vacuum piping system.

5.1.12.2.4.6

The proper labeling and identification of system outlets/inlets shall be confirmed during these tests.

5.1.12.2.5 Initial Piping Purge Test.

The outlets in each medical gas piping system shall be purged to remove any particulate matter from the distribution piping.

5.1.12.2.5.1

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.

5.1.12.2.5.2

The purging required in 5.1.12.2.5.1 shall be started at the closest outlet/inlet to the zone valve and continue to the furthest outlet/inlet within the zone.

5.1.12.2.6 Standing Pressure Test for Positive Pressure Medical Gas Piping.

After successful completion of the initial pressure tests under 5.1.12.2.3, medical gas distribution piping shall be subject to a standing pressure test.

5.1.12.2.6.1*

Tests shall be conducted after the final installation of station outlet valve bodies, faceplates, and all other distribution system components.

5.1.12.2.6.2

The source valve shall be closed during this test.

5.1.12.2.6.3

The piping systems shall be subjected to a 24-hour standing pressure test using oil-free, dry nitrogen NF.

5.1.12.2.6.4

Test pressures shall be 20 percent above the normal system operating line pressure.

5.1.12.2.6.5*

The leakage over the 24-hour test shall not exceed 0.5 percent of the starting pressure [e.g., 2 kPa (0.3 psi) starting at 415 kPa (60 psig)], except that attributed to specific changes in ambient temperature.

5.1.12.2.6.6

Leaks, if any, shall be located, repaired (if permitted) or replaced (if required), and retested.

5.1.12.2.6.7

The 24-hour standing pressure test of the positive-pressure system shall be witnessed by an ASSE 6020 inspector, an ASSE 6030 verifier, or the authority having jurisdiction or its designee. A form indicating that this test has been performed and witnessed shall be provided to the verifier at the start of the tests required in 5.1.12.4.

5.1.12.2.7 Standing Vacuum Test for Vacuum Piping.

After successful completion of the initial pressure tests under 5.1.12.2.3, vacuum distribution piping shall be subjected to a standing vacuum test.

5.1.12.2.7.1

Tests shall be conducted after installation of all components of the vacuum system.

5.1.12.2.7.2

The piping systems shall be subjected to a 24-hour standing vacuum test.

5.1.12.2.7.3

Test pressure shall be between 300 mm (12 in.) HgV and full vacuum.

5.1.12.2.7.4

During the test, the source of test vacuum shall be disconnected from the piping system.

5.1.12.2.7.5*

The leakage over the 24-hour test shall not exceed 0.5 percent of the starting pressure [e.g., 0.3 mm (0.125 in.) HgV starting at 635 mm (25 in.) HgV] except that attributed to specific changes in ambient temperature.

5.1.12.2.7.6

The 24-hour standing pressure test of the vacuum system shall be witnessed by the authority having jurisdiction or its designee. A form indicating that this test has been performed and witnessed shall be provided to the verifier at the start of the tests required in 5.1.12.4.

5.1.12.2.7.7

Leaks, if any, shall be located, repaired (if permitted) or replaced (if required), and retested.

5.1.12.3 System Inspection.

5.1.12.3.1 General.

5.1.12.3.1.1

System inspections shall be performed prior to concealing piping distribution systems in walls, ceilings, chases, trenches, underground, or otherwise hidden from view.

5.1.12.3.1.2

The test gas shall be nitrogen NF.

5.1.12.3.1.3

Inspections shall be conducted by a party technically competent and experienced in the field of medical gas and vacuum pipeline inspections and testing and meeting the requirements of ASSE/IAPMO/ANSI 6020, *Professional Qualifications Standard for Medical Gas Systems Inspectors*, or ASSE/IAPMO/ANSI 6030, *Professional Qualifications Standard for Medical Gas Systems Verifiers*.

5.1.12.3.1.4

Inspections shall be performed by a party other than the installing contractor.

5.1.12.3.1.5

Where systems have not been installed by in-house personnel, inspections shall be permitted by personnel of the organization who meet the requirements of 5.1.12.3.1.3.

5.1.12.3.2 Inspections.

5.1.12.3.2.1

The initial pressure tests performed by the installing contractor shall be witnessed by an ASSE 6020 inspector, an ASSE 6030 verifier, or the authority having jurisdiction or its designee. A form indicating that this test has been performed and witnessed shall be provided to the verifier at the start of the tests required in 5.1.12.4.

5.1.12.3.2.2

The presence and correctness of labeling and valve tagging required by this code for all concealed components and piping distribution systems shall be inspected.

5.1.12.4 System Verification.

5.1.12.4.1 General.

5.1.12.4.1.1

Verification tests shall be performed only after all tests required in 5.1.12.2 have been completed.

5.1.12.4.1.2

The test gas shall be oil-free, dry nitrogen NF or the system gas where permitted.

5.1.12.4.1.3

Testing shall be conducted by a party technically competent and experienced in the field of medical gas and vacuum pipeline testing and meeting the requirements of ASSE/IAPMO/ANSI 6030, *Professional Qualifications Standard for Medical Gas Systems Verifiers*, except as required by 5.1.12.4.1.4.

5.1.12.4.1.4

Testing of the cryogenic fluid central supply system shall be conducted by a party technically competent and experienced in the field of cryogenic fluid systems and meeting the requirements of ASSE/IAPMO/ANSI 6035, *Professional Qualifications Standard for Bulk Medical Gas/Cryogenic Fluid Central Supply Systems Verifiers*, in accordance with the mandatory requirements in CGA M-1, *Standard for Medical Gas Supply Systems at Health Care Facilities*.

5.1.12.4.1.5

Testing shall be performed by a party other than the installing contractor.

5.1.12.4.1.6

When systems have not been installed by in-house personnel, testing shall be permitted by personnel of that organization who meet the requirements of 5.1.12.4.1.3.

5.1.12.4.1.7

All tests required under 5.1.12.4 shall be performed after installation of any manufactured assemblies supplied through tubing or flexible hose.

5.1.12.4.1.8

Where there are multiple possible connection points for terminals, each possible position shall be tested independently.

5.1.12.4.1.9

The gas-of-system designation shall be permitted to be used for all tests, regardless of the size of the system, which include the following:

(1) Standing pressure *(see 5.1.12.4.2)*
(2) Cross-connection *(see 5.1.12.4.3)*
(3) Alarms *(see 5.1.12.4.5)*
(4) Piping purge *(see 5.1.12.4.6)*
(5) Piping particulates *(see 5.1.12.4.7)*

5.1.12.4.2* Standing Pressure Test.

Piping systems shall be subjected to a 10-minute standing pressure test at operating line pressure using the following procedure:
(1) After the system is filled with nitrogen or source gas, the source valve and all zone valves shall be closed.
(2) The piping system shall show no decrease in pressure after 10 minutes.
(3) Any leaks found shall be located, repaired, and retested per 5.1.12.2.6.
5.1.12.4.3 Cross-Connection Test.
After the closing of walls and completion of the requirements of 5.1.12.2, it shall be determined that no cross-connection of piping systems exists by either of the methods detailed in 5.1.12.4.3.1 or 5.1.12.4.3.2.
5.1.12.4.3.1 Individual Pressurization Method.
(A)
All medical gas and vacuum piping systems shall be reduced to atmospheric pressure.
(B)
All sources of test gas from all of the medical gas and vacuum systems, with the exception of the one system to be checked, shall be disconnected.
(C)
The system being checked shall be pressurized to a gauge pressure of 345 kPa (50 psi).
(D)
With adapters matching outlet labels, each individual station outlet/inlet of all medical gas and vacuum systems installed shall be checked to determine that test gas is being dispensed only from the outlets/inlets of the piping system being tested.
(E)
The source of test gas shall be disconnected, and the system tested reduced to atmospheric pressure.
(F)
Proceed to test each additional piping system until all medical gas and vacuum piping systems are free of cross-connections.
5.1.12.4.3.2 Pressure Differential Method.
(A)
The pressure in all medical gas systems shall be reduced to atmospheric.
(B)
The test gas pressure in all medical gas piping systems shall be increased to the values indicated in Table 5.1.12.4.3.2(B), simultaneously maintaining these nominal pressures throughout the test.
Table 5.1.12.4.3.2(B) Alternate Test Pressures

Medical Gas	Pressure (Gauge)	Vacuum (HgV)
Gas mixtures	140 kPa (20 psi)	—
Nitrogen/instrument air	210 kPa (30 psi)	—
Nitrous oxide	275 kPa (40 psi)	—
Oxygen	345 kPa (50 psi)	—
Medical air	415 kPa (60 psi)	—
Systems at nonstandard pressures	70 kPa (10 psi) greater or less than any other system	—
Vacuum	—	510 mm (20 in.) HgV
WAGD	—	380 mm (15 in.) HgV (if so designed)

(C)
Systems with nonstandard operating pressures shall be tested at a gauge pressure of at least 70 kPa (10 psi) higher or lower than any other system being tested.
(D)
Any vacuum systems shall be in operation so that these vacuum systems are tested at the same time the medical gas systems are tested.
(E)
Following the adjustment of pressures in accordance with 5.1.12.4.3.2(B) and 5.1.12.4.3.2(C), each station outlet for each medical gas system shall be tested using the gas-specific connection for each system with test gauge attached to verify that the correct test pressure/vacuum is present at each outlet/inlet of each system as listed in Table 5.1.12.4.3.2(B).
(F)
Each test gauge used in performing this test shall be calibrated with the pressure indicator used for the line pressure regulator used to provide the source pressure.

(G)
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 Table 5.1.12.4.3.2(B) for the system being tested.
5.1.12.4.4 Valve Test.
Valves installed in each medical gas and vacuum piping system shall be tested to verify proper operation and rooms or areas of control.
5.1.12.4.4.1
Records shall be made listing the rooms or areas controlled by each valve for each gas.
5.1.12.4.4.2
The information shall be utilized to assist and verify the proper labeling of the valves.
5.1.12.4.5 Alarm Test.
5.1.12.4.5.1 General.
(A)
All warning systems for each medical gas and vacuum system(s) shall be tested to ensure that all components function properly prior to placing the system in 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 the connection of the new piping to the existing system.
(D)
Tests of warning systems for new installations (initial tests) shall be performed after the cross-connection testing *(see 5.1.12.4.3)*, but before purging the piping *(see 5.1.12.4.6)* and performing the remaining verification tests. *(See 5.1.12.4.7 through 5.1.12.4.14.)*
(E)
Initial tests of warning systems that can be included in an addition or extension to an existing piping system shall be completed before connection of the addition to the existing system.
(F)
Test gases for the initial tests shall be oil-free, dry nitrogen NF, the gas of system designation, or operating vacuum.
(G)
Where computer systems are used as substitutes for a required alarm panel as permitted under 5.1.9.2.2, the computer system shall be included in the alarm tests as modified in 5.1.9.3.
5.1.12.4.5.2 Master Alarms.
(A)
The master alarm system tests shall be performed for each of the medical gas and vacuum piping systems.
(B)
Permanent records of these tests shall be maintained with those required under 5.1.12.1.7.
(C)
The audible and noncancelable visual signals of 5.1.9.1 shall indicate if the pressure in the main line increases or decreases 20 percent from the normal operating pressure.
(D)
The operation of all master alarm signals referenced in 5.1.9.2.4 shall be verified.
5.1.12.4.5.3 Area Alarms.
The warning signals for all medical gas piping systems shall be tested to verify an alarm condition if the pressure in the piping system increases or decreases 20 percent from the normal operating pressure for positive-pressure gases, or when the vacuum system(s) drops below a gauge pressure of 300 mm (12 in.) HgV.
5.1.12.4.6 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 the pipeline shall be done.
5.1.12.4.6.1
The appropriate adapter shall be obtained from the facility or manufacturer, and high purge rates of at least 225 Nl/min (8 SCFM) shall be put on each outlet.
5.1.12.4.6.2
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.
5.1.12.4.6.3
In order to avoid possible damage to the outlet and its components, this test shall not be conducted using any implement other than the proper adapter.
5.1.12.4.6.4*
No pronounced or objectionable odor shall be discernible from any positive pressure outlet.
5.1.12.4.7 Piping Particulate Test.
For each positive-pressure gas system, the cleanliness of the piping system shall be verified.
5.1.12.4.7.1
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 Nl/min (3.5 SCFM).

5.1.12.4.7.2
Twenty-five percent of the zones shall be tested at the outlet most remote from the source.
5.1.12.4.7.3
The filter shall accrue no more than 0.001 g (1 mg) of matter from any outlet tested.
5.1.12.4.7.4
If any outlet fails this test, the most remote outlet in every zone shall be tested.
5.1.12.4.7.5
The test shall be performed with the use of oil-free, dry nitrogen NF.
5.1.12.4.8* Verifier Piping Purity Test.
For each medical gas system, the purity of the piping system shall be verified in accordance with 5.1.12.4.8.
5.1.12.4.8.1
These tests shall be performed with oil-free, dry nitrogen NF or the system gas.
5.1.12.4.8.2
The outlet most remote from the source shall be tested for total nonmethane hydrocarbons and halogenated hydrocarbons and compared to the source gas.
5.1.12.4.8.3
If the system gas is used as the source gas, it shall be tested at the source equipment.
5.1.12.4.8.4
The difference between the two tests shall in no case exceed 5 ppm of total non-methane hydrocarbons.
5.1.12.4.8.5
The difference between the two tests shall in no case exceed 5 ppm halogenated hydrocarbons.
5.1.12.4.8.6
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).
5.1.12.4.9 Final Tie-In Test.
5.1.12.4.9.1
Prior to the connection of any work or any extension or addition to an existing piping system, the tests in 5.1.12.4.1 through 5.1.12.4.8 shall be successfully performed on the new work.
5.1.12.4.9.2
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 a leak detectant that is safe for use with oxygen and does not contain ammonia.
5.1.12.4.9.3
Vacuum joints shall be tested using an ultrasonic leak detector or other means that will allow detection of leaks in an active vacuum system.
5.1.12.4.9.4
For pressure gases, immediately after the final brazed connection is made and leak tested, 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 5.1.12.4.6.
5.1.12.4.9.5
Before the new work is used for patient care, positive-pressure gases shall be tested for operational pressure and gas concentration in accordance with 5.1.12.4.10 and 5.1.12.4.11.
5.1.12.4.9.6
Permanent records of these tests shall be maintained in accordance with 5.1.14.7.
5.1.12.4.10 Operational Flow Pressure Drop Test.
Operational flow pressure drop tests shall be performed at each station outlet/inlet or terminal where the user makes connections and disconnections.
5.1.12.4.10.1
Tests shall be performed with the gas of system designation or the operating vacuum.
5.1.12.4.10.2
All gas outlets with a gauge pressure of 345 kPa (50 psi), including, but not limited to, oxygen, nitrous oxide, medical air, and carbon dioxide, shall deliver 100 SLPM (3.5 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).
5.1.12.4.10.3
Medical support gas outlets shall deliver 140 SLPM (5.0 SCFM) with a pressure drop of not more than 35 kPa (5 psi) gauge and static pressure of 1100 kPa to 1275 kPa (160 psi to 185 psi) gauge.
5.1.12.4.10.4
Medical-surgical vacuum inlets shall draw 85 Nl/min (3 SCFM) without reducing the vacuum pressure below 300 mm (12 in.) gauge HgV at any adjacent station inlet.
5.1.12.4.10.5
Oxygen and medical air outlets serving Category 1 spaces shall allow a transient flow rate of 170 SLPM (6 SCFM) for 3 seconds and a pressure drop of not more than 70 kPa (10 psi) gauge.
5.1.12.4.10.6*
Where outlets are being fed with non-standard line pressure, volume, or gas content, for clinical reasons, they shall be labeled in accordance with 5.1.11.
5.1.12.4.11 Medical Gas Concentration Test.

After purging each system with the gas of system designation, the following shall be performed:
(1) Each pressure gas source and outlet 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 indicated in Table 5.1.12.4.11.
Table 5.1.12.4.11 Gas Concentrations

Medical Gas	Concentration
Oxygen USP	≥99% oxygen
Oxygen 93 USP	≥90% oxygen ≤96%
Nitrous oxide USP	≥99% nitrous oxide
Nitrogen NF	≤1% oxygen or ≥99% nitrogen
Medical air USP	19.5%–23.5% oxygen
Other gases	Named gases by ±1%, or per specification

5.1.12.4.12 Medical Air Purity Test for Compressor Sources.
5.1.12.4.12.1
The medical air source shall be analyzed for concentration of contaminants by volume prior to the source valve being opened.
5.1.12.4.12.2
A sample(s) shall be taken for the air system test at the system sample port.
5.1.12.4.12.3
The test results shall not exceed the parameters in Table 5.1.12.4.12.3.
Table 5.1.12.4.12.3 Contaminant Parameters for Medical Air

Parameter	Limit Value
Pressure dew point	2°C (35°F)
Carbon monoxide	10 ppm
Carbon dioxide	500 ppm
Gaseous hydrocarbons	25 ppm (as methane)
Halogenated hydrocarbons	2 ppm

5.1.12.4.13 Labeling.
The presence and correctness of labeling required by this code for all components (e.g., station outlets/inlets, shutoff valves, and alarm panels) shall be verified.
5.1.12.4.14 Source Equipment Verification.
5.1.12.4.14.1 General.
Source equipment verification shall be performed following the installation of the interconnecting pipelines, accessories, and source equipment.
5.1.12.4.14.2 Gas Supply Sources.
(A)
The system apparatus shall be tested for proper function, including the changeover from primary to secondary supply (with its changeover signal) and the operation of the reserve (with its reserve-in-use signal), before the system is put into service.
(B)
If the system has an actuating switch and signal to monitor the contents of the reserve, its function shall be tested before the system is put into service.
(C)
If the system has an actuating switch and signal to monitor the pressure of the reserve unit, its function shall be tested before the system is put into service.
(D)
Testing of the bulk supply signal and the master signal panel installations shall be arranged with the owner or the organization responsible for the operation and maintenance of the supply system for the testing of the bulk supply signals to ensure proper identification and activation of the master signal panels so that the facility can monitor the status of that supply system.
(E)
The tests required in 5.1.12.4.14.2(D) shall also be conducted when the storage units are changed or replaced.
5.1.12.4.14.3 Medical Air Compressor Systems.
(A)
Tests of the medical air compressor system shall include the purity test for air quality, and the test of the alarm sensors after calibration and setup per the manufacturer's instructions, as well as reserve capacity controls.

~~(B)~~
~~Tests shall be conducted at the sample port of the medical air system.~~
~~(C)~~
~~The operation of the system control sensors, such as dew point, air temperature, and all other air quality monitoring sensors and controls, shall be checked for proper operation and function before the system is put into service.~~
~~(D)~~
~~The quality of medical air as delivered by the compressor air supply shall be verified after installation of new components prior to use by patients.~~
~~(E)~~
~~The air quality tests in 5.1.12.4.14.3(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 percent of the rated system capacity.~~
~~(H)~~
~~A demand of approximately 25 percent of the rated compressor capacity shall be created to cause the compressors to cycle on and off continuously and the dryers to operate for the 12-hour period.~~
~~5.1.12.4.14.4 Oxygen Central Supply System Using Concentrators.~~
~~The oxygen central supply system using concentrators shall be tested according to the following:~~
~~(1) The oxygen central supply system shall be tested for purity of the oxygen.~~
~~(2) Tests of the alarms after calibration and setup per the manufacturer's instructions shall be conducted as well as tests of the operational controls.~~
~~(3) Each concentrator supply system shall be operated with the supply system's isolating valve closed and the unit venting at a flow of 25 percent or more of nameplate capacity for an elapsed time of at least 12 hours prior to the tests in 5.1.12.4.14.4(4).~~
~~(4) The oxygen quality from each concentrator supply system shall be validated as follows:~~
~~(a) The operation of all control sensors/switches and the oxygen monitor shall be checked for proper operation and function.~~
~~(b) The quality of the oxygen shall be confirmed to meet the USP monograph appropriate for the technology in use.~~
~~(c) The accuracy of the oxygen monitor shall be validated against oxygen of known concentration, and the monitor calibrated in accordance with the manufacturer's specifications.~~
~~(5) The central supply system shall be tested for correct operation of the cascade (i.e., primary — secondary — reserve). It shall be permitted to test source rotation for systems so constructed.~~
~~(6) The operation of all alarms *[see 5.1.9.2.4(15) and 5.1.9.5.3(13)]* shall be tested.~~
~~(7) The accuracy of the central system oxygen monitor shall be calibrated in accordance with the manufacturer's specifications.~~
~~(8) Tests in 5.1.12.4.14.4(3) to 5.1.12.4.14.4(5) shall be performed when any concentrator supply system has been opened to atmosphere (e.g., during service or replacement).~~
~~5.1.12.4.14.5 Proportioning Systems 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 into service.~~
~~(B)~~
~~Tests shall include the purity of the air quality and test of the alarm sensors after calibration and setup per the manufacturer's 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.~~
~~5.1.12.4.14.6 Medical–Surgical Vacuum Systems.~~
~~The proper functioning of the medical–surgical vacuum source system(s) shall be tested before it is put into service.~~

5.1.13 Category 1 Medical Support Gases.

5.1.13.1* Applicability.

5.1.13.1.1
Medical support gases consist of nitrogen NF or instrument air and are used primarily for powering equipment used in patient care procedures. Medical support gas applications require delivery at pressures, cleanliness, or purities specific to their intended function(s) (e.g., to operate medical–surgical tools). Medical support gases shall be

permitted to be piped into areas intended for any medical support purpose and, if appropriate to the procedures, to be piped into laboratories.

5.1.13.1.2~~* –~~
Medical support gas sources shall be permitted to be used for many general utility uses.

5.1.13.1.3~~–~~
Medical support gas systems shall not convey oxidizing gases other than air or gases intended for patient or staff respiration.

5.1.13.2 Nature of Hazards.
Design, installation, and operation of medical support gas systems shall consider all hazards involved with any pressurized gas and hazards associated with the elevated pressures typical of these systems. - Hazards associated with ~~except those associated with~~ oxidizing gases shall be excluded.~~and hazards associated with the elevated pressures typical of these systems.~~

5.1.13.3 Medical Support Gas Central Supply Systems.
~~**5.1.13.3.1 General.**~~
~~Medical support gas central supply systems shall be located to meet the requirements of 5.1.3.3.1 through 5.1.3.3.1.10.~~

5.1.13.3.~~2 –~~1 Design and Construction.
5.1.13.3.~~2~~1.1
Locations for medical support gas central supply systems, excluding cryogenic fluid central supply systems, and for the storage of positive-pressure gases shall meet the requirements of 5.1.3~~.3.2~~.

5.1.13.3.~~2~~1.2

Design and construction of locations for cryogenic fluid central supply systems shall meet the requirements of 5.1.3 and ~~5.1.3.10~~5.1.7.9.~~.~~

5.1.13.3.3 Ventilation.
Ventilation for medical support gas central supply systems shall meet the requirements of 5.1.~~3.3.3~~3.7.

5.1.13.3.4 Storage.
Storage for medical support gas central supply systems shall meet the requirements of 5.1.~~.3.3.4~~3.

5.1.13.3.5 Control Equipment.
Control equipment for medical support gas central supply systems shall meet the requirements of 5.1.~~3~~4.~~4~~3.

5.1.13.3.6 Nitrogen NF Central Supply Systems.
Nitrogen NF central supply systems shall be permitted to consist of the following:
(1) Manifolds for gas cylinders in accordance with 5.1.~~3.5.11~~7.2
(2) Manifolds for cryogenic liquid containers in accordance with ~~5.1.3.10~~5.1.7.3
(3) Cryogenic fluid central supply systems in accordance with ~~5.1.3.10~~5.1.7.9

5.1.13.3.6.1 General.

(A)

Nitrogen NF central supply systems shall be obtained from a supplier or manufacturer familiar with their proper construction and use.

(B)

Nitrogen NF central supply systems shall be installed in accordance with the manufacturer's instructions.

5.1.13.3.6.2 Medical Support Gases.
Nitrogen NF central supply systems for medical support gases shall not be piped to, or used for, any purpose except medical support application.

5.1.13.3.6.3 Materials.
Materials used in nitrogen NF central supply systems shall meet the requirements of 5.1.~~3.5.4~~4.2.

5.1.13.3.6.4 Controls for Line Pressure.
Controls for line pressure used for nitrogen central supply systems shall meet the criteria in 5.1.~~3.5.~~4.3~~5~~.

5.1.13.3.6.5 Relief Valves.
Relief Valves used for nitrogen central supply systems shall meet the criteria in 5.1.~~3.5.6~~4.4.

5.1.13.3.6.6 Multiple Pressures.
Where a single nitrogen central supply system supplies separate piped distribution networks, operating at different pressures, each piped distribution network shall meet the criteria in 5.1.~~3.5.7~~4.3.2.

5.1.13.3.6.7 Local Signals.

(A)

The following nitrogen NF central supply systems shall have local signals located at the source equipment:

(1) Manifolds for gas cylinders without reserve supply *(see 5.1.~~3.5.11~~7.2)*
(2) Manifolds for cryogenic liquid containers *(see 5.1.~~3.10~~7.3)*
(3) Cryogenic fluid central supply systems *(see ~~5.1.3.10~~5.1.7.9)*

(B)

Local signals shall meet the requirements of 5.1.~~3.5.8.2~~4.6.

5.1.13.3.6.8 Headers.
In nitrogen NF central supply systems using cylinders or portable containers~~containing either gas or liquid~~, each header shall meet the requirements of 5.1.~~3.5.9~~4.6.

5.1.13.3.6.9 Nitrogen NF Manifolds for Gas Cylinders.
Manifolds for gas cylinders shall be in accordance with ~~5.1.3.3.1~~5.1.7.2. ~~and shall meet the requirements of 5.1.3.5.11.~~

5.1.13.3.6.10 Nitrogen NF Manifolds for Cryogenic Liquid Containers.
Manifolds for cryogenic liquid containers shall be in accordance with ~~5.1.3.3.1~~5.1.7.3. ~~and shall meet the requirements of 5.1.3.5.1.~~

5.1.13.3.6.11 Nitrogen NF Cryogenic Fluid Central Supply Systems.
Cryogenic fluid central supply systems shall be in accordance with ~~5.1.3.3.1~~5.1.7.9 ~~and shall meet the requirements of 5.1.3.10.~~

5.1.13.3.7* Instrument Air Supply Systems.

5.1.13.3.7.1 Quality of Instrument Air.
The quality of instrument air shall be as follows:

(1) Compliant with ANSI/ISA S-7.0.01, *Quality Standard for Instrument Air*
(2) Filtered to 0.01 micron
(3) Free of liquids (e.g., water, hydrocarbons, solvents)
(4) Free of hydrocarbon vapors
(5) Dry to a dew point of −40°C (−40°F)

5.1.13.3.7.2
Instrument air supply systems shall be located per 5.1.3.~~3 as follows:~~
~~(1) Indoors, in a dedicated mechanical equipment area that is adequately ventilated and with any required utilities~~
~~(2) In a room ventilated per 5.1.3.3.3.3~~
~~(3) For air-cooled equipment, in a room designed to maintain the ambient temperature range as recommended by the equipment manufacturer~~

5.1.13.3.7.3
Instrument air sources shall provide air with the following characteristics:

(1) A gauge pressure adequate for the intended line pressure and pressure controls *(see {ed note: former Table 5.1.11})*
(2) The quality of instrument air, as described in 5.1.13.3.7.1

5.1.13.3.7.4
Instrument air sources shall be of either of the following formats:

(1) At least two compressors

(2) One compressor and a standby header complying with 5.1.~~3.5.9~~4.6

5.1.13.3.7.5
Instrument air compressors shall be permitted to be of any type capable of the output pressure needed for the intended line pressure *(see {ed note: former Table 5.1.11}~~Table 5.1.11~~)*, and of providing air meeting the definition of instrument air in 5.1.13.3.7.1.

5.1.13.3.7.6 Instrument Air Standby Headers.
Where instrument air systems are provided with a standby header, the header shall meet the following requirements:

(1) It shall comply with 5.1.~~3.5.9~~4.6, except that the number of attached cylinders shall be sufficient for 1 hour of normal operation.

(2) It shall use connectors as for medical air in the mandatory requirements of CGA V-1, Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections (ANSI B57.1).

(3) It shall enter the system upstream of the final line filters.

(4) It shall automatically serve the system in the event of a failure of the compressor.

5.1.13.3.7.7***** Intake Air.
Intake air for instrument air compressors shall be permitted to be drawn from outside, from ducted air, or from the equipment location.

5.1.13.3.7.8 Instrument Air Filters.
Instrument air sources shall be provided with filtration sized for 100 percent of the system peak calculated demand at design conditions and with the following elements and characteristics:

(1) Activated carbon filters located upstream (source side) of the final line filters

(2) Line filters located upstream (source side) of the final line regulators and downstream of the carbon filters rated for a minimum of 98 percent efficiency at 0.01 micron

(3) Equipped with a continuous visual indicator showing the status of the line filter element life

(4) Constructed of materials deemed suitable by the manufacturer

(5) Filters combining the functions in 5.1.13.3.7.8(1) to 5.1.13.3.7.8(4) in a single unit shall be permitted to be used

5.1.13.3.7.9 Instrument Air Accessories.
Accessories used for instrument air sources shall comply with the following subparagraphs:

(1) For aftercoolers, ~~5.1.3.6.3~~5.1.7.4.4.1~~.5~~

(2) For air receivers, ~~5.1.3.6.3~~5.1.7.4.5~~.6~~

(3) For air dryers, ~~5.1.3.6.3~~5.1.7.4.4.2~~.7~~ ~~[except 5.1.3.6.3.7~~(2) through (5)~~1)~~]

(4) For required components, ~~5.1.3.6.3~~5.1.6.2.2

5.1.13.3.7.10 Instrument Air Piping Arrangement and Redundancies.
Instrument air sources shall comply with ~~5.1.3.6.3~~5.1.7.4.8~~.9~~, except for the following:

(1) Systems employing a standby header shall be permitted to have simplex aftercoolers and dryers.

(2) Systems employing a standby header shall not require a three-valve receiver bypass.

(3) Standby headers, where provided, shall be isolated from the compressor by a check valve to prevent backflow through the compressor.

5.1.13.3.7.11 Instrument Air Monitoring and Alarms.

(A)
Instrument air sources shall include the following alarms:

(1) A manual-reset local alarm that indicates when the capacity of the instrument air central supply system not in use is less than the equivalent capacity of one compressor

(2) Local alarm and alarms at all master alarm panels that activate when the dew point at system pressure exceeds −30°C (−22°F), indicating a high dew point

(B)
For sources with standby headers, the following additional conditions shall activate a local alarm at the compressor site, a local signal at the header location, and alarms at all master alarm panels:

(1) Alarm that activates when or just before the reserve begins to supply the system, indicating reserve in use

(2) Alarm that activates when or just before the reserve falls below one average hour's supply, indicating reserve is low

5.1.13.3.7.12 Electrical Power and Control.
(A)
Instrument air source systems with compressors shall be controlled to ensure continuous supply of air at pressures consistent with Table 5.1.11 under all conditions of system use as follows:

5.1.13.8~~3~~.7.13 Line Pressure Control.
Instrument air systems shall be provided with means to control line pressure compliant with 5.1.4.3.~~at the source with at least the following characteristics:~~
~~(1) Able to maintain stable pressures within the limits of Table 5.1.11~~
~~(2) Able to flow 100 percent of the peak calculated demand~~
~~(3) Redundant, such that each component of the control mechanism can be isolated for service or replacement while maintaining normal operation~~
~~(4) Protected against overpressure (see 5.1.3.5.6)~~
~~(5) Be constructed of materials deemed suitable for the service by the manufacturer~~

~~(1) Automatic activation of compressor(s) as necessary to supply the demand.~~

~~**(2) If provided with more than one compressor, managing the operation to equalize wear on all compressors. Where this equalization is achieved manually, the facility staff shall arrange a schedule for manual alternation.**~~
~~**(B)**~~
~~**Controls shall provide the following functions:**~~
~~**(1) Where instrument air source systems having two or more compressors employ any electrical circuit device that upon failure could prevent supply of air, the controls shall be provided with an automatically activated alternative method for ensuring supply (e.g., redundant component(s), an alternate electrical supply path, or other equivalent method).**~~
~~**(2) Control circuits shall be arranged in such a manner that isolation of one compressor or component from the system (e.g., for maintenance or repair) does not interrupt the operation of other compressor(s) or component(s).**~~
~~**(3) An automatic restart function shall be included, such that the supply of air will resume normally after power interruption without manual intervention.**~~
~~**(C)**~~
~~**Each compressor motor shall be provided with electrical components including, but not limited to, the following:**~~
~~**(1) Dedicated disconnect switch installed in the electrical circuit ahead of each motor starter**~~
~~**(2) Motor starting device**~~
~~**(3) Overload protection**~~
~~**(D)**~~
~~**Instrument air compressor system controls shall be provided with electrical systems including, at a minimum, the following:**~~
~~**(1) Built-in disconnect means to allow appropriate operation of multiple compressor systems and protect service personnel from exposure to live voltages**~~
~~**(2) Control circuits arranged so that failure of any component of the control circuit, or shutdown of one compressor (e.g., for service), does not interrupt automatic operation of the standby compressor**~~
~~**(3) An automatic restart function such that the compressor(s) will restart after power interruption without manual intervention**~~
~~**(4) Where components are common to more than one control circuit (e.g., autodrains), a common device provided with electrical protection to prevent loss of the control circuits(s) in the event of short circuit in the device**~~
~~**(E)**~~
~~**Electrical installation and wiring shall conform to the requirements of *NFPA 70*.**~~

~~(F)~~
~~Emergency electrical service for the compressors shall conform to the requirements of the essential electrical system, as described in Chapter 6.~~

5.1.13.4 Valves.
Requirements for medical support gas valves shall be in accordance with 5.1.4.1.1 through 5.1.4.8.

5.1.13.5 Outlets.
Requirements for medical support gas outlets shall be in accordance with 5.1.5.1, 5.1.5.2, 5.1.5.4 through 5.1.5.8, 5.1.5.11, and 5.1.5.13 through 5.1.5.15.

5.1.13.6 Manufactured Assemblies.
Requirements for medical support gases in manufactured assemblies shall be in accordance with 5.1.6.1 through 5.1.6.12.

5.1.13.7 Pressure Indicators.
Requirements for medical support gas pressure indicators shall be in accordance with 5.1.8.1.1 through 5.1.8.1.4, 5.1.8.1.6, and 5.1.8.2.

~~**5.1.13.8 Line Pressure Control.**~~
~~**Instrument air systems shall be provided with means to control line pressure at the source with at least the following characteristics:**~~

~~**(1) Able to maintain stable pressures within the limits of Table 5.1.11**~~

~~**(2) Able to flow 100 percent of the peak calculated demand**~~

~~**(3) Redundant, such that each component of the control mechanism can be isolated for service or replacement while maintaining normal operation**~~

~~**(4) Protected against overpressure (see 5.1.3.5.6)**~~

~~**(5) Be constructed of materials deemed suitable for the service by the manufacturer**~~

5.1.13.~~9~~ 8 Warning Systems.

5.1.13.~~9~~8.1
General requirements for medical support gas warning systems shall be in accordance with *{ed note: former 5~~5~~*.1.9.1.

5.1.13.~~9~~8.2
Master alarm requirements for medical support gas shall be in accordance with *{ed note: former 5.1.~~5.1.~~*9.2.

5.1.13.~~9~~8.3
Area alarm requirements for medical support gas shall be in accordance with *{ed note: former* 5.1.9.4.

5.1.13.~~9~~8.4
Local alarm requirements for medical support gas shall be in accordance with *{ed note: former* 5.1.9.5.

5.1.13.~~10~~ 9 Distribution.
Requirements for medical support gas piping distribution shall be in accordance with *{ed note: former 5.1.10.1, 5.1.10.3, 5.1.10.4, 5.1.10.4.1 through 5.1.10.4.6, 5.1.10.10, 5.1.10.10(1), 5.1.10.10(2), 5.1.10.10(3), and 5.1.10.11.}*

5.1.13.11 Labeling and Identification.
Requirements for medical support gas labeling shall be in accordance with *{ed note: former* 5.1.11.1 through 5.1.11.4.

5.1.13.12 Performance Testing.
Requirements for medical support gas performance testing shall be in accordance with *{ed note: former* 5.1.12, with the following exceptions:

(1) The piping purity test *(see {ed note: former 5.1.12.4.8)* shall be permitted to be omitted.

(2) The medical gas concentration test *(see {ed note: former 5.1.12.4.11)* shall be permitted to be omitted.

5.1.14* Category 1 Operation and Management.

5.1.14.1 Existing Facilities

The following sections of this chapter shall apply to the operation, management, and maintenance of Category 1 medical gas and vacuum systems in both new and existing facilities:

(1) 5.1.2

(2) 5.1.3.3 (2)

(3) 5.1.3.5.1

(4) 5.1.4.5 (A) (2)

(5) 5.1.14

5.1.14.~~1~~ 2 Responsible Facility Authority.
~~**5.1.14.1.1 General.**~~
Each health care facility shall designate one or more individuals to be the responsible facility authority with respect to the facility's medical gas and vacuum systems.

5.1.14.~~1.2~~2.1 Responsibilities.

5.1.14.~~.1.~~2.1.1
The responsible facility authority shall have primary responsibility for implementation of the piped medical gas and vacuum system requirements of this code for the health care facility, including all medical gas, support gas, medical vacuum, and WAGD systems.

5.1.14.~~1.2~~2.1.2
The responsible facility authority shall be responsible for the following:

(1) Advising on Section 1.3 and the risk assessment in accordance with Section 4.2, as these apply to piped medical gas and vacuum systems, and the interpretations of Sections 5.1 through 5.3, as they apply to the facility

(2) Writing and upkeep of the portions of the health care facility's emergency plan that might affect or be affected by piped medical gas and vacuum quality, quantity, and continuity of supply

(3) Ensuring that the health care facility's emergency plan specifically addresses unusual or exceptional requirements necessary for patient and staff safety arising from elements of design or construction of the building

(4) Developing and enforcing permit-to-work rules pertaining to the piped medical gas and vacuum systems and equipment to maintain patient, staff, and visitor safety during repair, modification, or construction of those systems

(5) Evaluation and acceptance of the test reports required in accordance with *{ed note: former* 5.1.12

(6) Maintenance of the facility's records on piped medical gas and vacuum system installations and operations

5.1.14.2.1.3 Qualifications.

~~**5.1.14.1.3.1**~~
The person(s) designated as the responsible facility authority shall be qualified to interpret, implement, and advise on this Code.

5.1.14.~~1.3.2~~2.1.3.1
Appropriate qualification shall be demonstrated by any of the following:

(1) Completion of an educational program acceptable to the health care facility's governing body and substantially equivalent or superior to either 5.1.14.1.3.2(2) or 5.1.14.1.3.2(3)

(2) Credentialing to the requirements of ASSE/IAPMO/ANSI 6010, *Professional Qualifications Standard for Medical Gas Systems Installers*, and technical competence on the specific equipment and design of that facility

(3) Credentialing to the requirements of ASSE/IAPMO/ANSI 6020, *Professional Qualifications Standard for Medical Gas Systems Inspectors*, and technical competence on the specific equipment and design of that facility

(4) Credentialing to the requirements of ASSE/IAPMO/ANSI 6030, *Professional Qualifications Standard for Medical Gas Systems Verifiers*, and technical competence on the specific equipment and design of that facility

(5) Credentialing to the requirements of ASSE/IAPMO/ANSI 6040, *Professional Qualifications Standard for Medical Gas Maintenance Personnel*, and technical competence on the specific equipment and design of that facility

5.1.14.~~2~~ 3 Permit-to-Work System.

5.1.14.~~2~~3.1*
The responsible facility authority of the health care facility shall develop, maintain, and manage a permit-to-work system ensuring uninterrupted quality, quantity, and continuity of supply during all piped medical gas and vacuum system maintenance, repair, or construction work.

5.1.14.~~2~~3.2
The responsible facility authority's plan shall include processes to assure at least the following:

(1) The affected medical staff and facility administration is appropriately in communication prior to any work on piped medical gas and vacuum systems

(2) Alternative supply or adjustments in patient care arrangements are in place prior to system interruption, including monitoring, as appropriate, of the work being performed and the alternate arrangements in use

(3) All work on piped medical gas and vacuum systems is performed by competent individuals holding appropriate qualifications for the work

(4) *Procedures for shutdown and restoration of medical gases are described, communicated, and observed by all persons working on or with the systems

(5) Safety procedures are in place and are observed for all persons involved in working on the systems

(6) This code is observed in the execution of maintenance, repair, or construction procedures

(7) The affected portions of the systems are correctly tested in accordance with *{ed note: former* 5.1.12 and 5.1.13} and demonstrated to be acceptable for patient use

5.1.14.~~3~~ 4 Special Precautions — Patient Gas, Vacuum, WAGD, and Medical Support Gas Systems.

5.1.14.4~~3~~.1 C~~Central Supply System~~ylinder and Container Identification and Labeling.

5.1.14.4.~~5.1.3.1.~~1.1*~~—~~
Cylinders, containers, and tanks shall be designed, fabricated, tested, and marked (i.e., stamped) in accordance with Department of Transportation (DOT) regulations, Transport Canada's (TC) *Transportation of Dangerous Goods Regulations*, or the ASME *Boiler and Pressure Vessel Code*. [**55:**7.1.5.1]

5.1.14.4.1~~5.1.3.1.~~2*~~—~~
Cylinder contents shall be identified by attached labels or stencils naming the contents in accordance with the mandatory requirements of CGA C-7, *Guide to Classification and Labeling of Compressed Gases*.

5.1.14.4.1.~~5.1.3.1.~~3~~—~~
Liquid containers shall have additional product identification visible from all directions with a minimum of 51 mm (2 in.) high letters such as a 360-degree wraparound tape for medical liquid containers.

5.1.14.4.1.~~5.1.3.1.~~4
Cryogenic liquid containers shall be provided with gas-specific outlet connections in accordance with the mandatory requirements of CGA V-5, *Standard for Diameter Index Safety System (Noninterchangeable Low Pressure Connections for Medical Gas Applications)*, or CGA V-1, *Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections*.

5.1.14.4.1.~~5.1.3.1.~~5

Cylinder and cryogenic liquid container outlet connections shall be affixed in such a manner as to be integral to the valve(s), unremovable with ordinary tools, or so designed as to render the attachment point unusable when removed.

5.1.14.4.1.~~5.1.3.1.~~6
The contents of cylinders and cryogenic liquid containers shall be verified prior to use.

5.1.14.4.1.~~5.1.3.1.~~7
Labels shall not be defaced, altered, or removed, and connecting fittings shall not be modified.

5.1.14.~~3.1~~4.2* Operational limitations for use of piped systems
Piped medical gas and vacuum systems shall not be used for the following:

(1) ~~Piping systems shall not be used for~~ the distribution of flammable anesthetic gases.

(2) ~~**5.1.14.3.2**~~

~~Piping systems shall not be used~~ as a grounding electrode.

(3) as a means for disposal of liquid or debris

(4) ~~**5.1.14.3.3***~~

~~Liquid or debris shall not be introduced into the medical-surgical vacuum or WAGD systems for disposal.~~
~~**5.1.14.3.4***~~

~~The medical-surgical vacuum and WAGD systems shall not be used~~ for nonmedical applications (e.g., vacuum steam condensate return).

5.1.14.~~3.5~~4.3* Decommissioned spaces
When clinical spaces are converted to nonclinical spaces, medical gas inlets and outlets that are not accessible for maintenance and testing shall be either removed or decommissioned.

5.1.14.~~3.6~~4.4* Access in ~~–~~Emergency
Access to and, in case of an adverse event, protection of cylinder and container manifolds and cryogenic fluid central supply systems shall be considered in the emergency operations plan.

~~**5.1.14.4 Maintenance of Medical Gas, Vacuum, WAGD, and Medical Support Gas Systems.**~~
~~**5.1.14.4.1* General.**~~
~~Health care facilities with installed medical gas, vacuum, WAGD, or medical support gas systems, or combinations thereof, shall develop and document periodic maintenance programs for these systems and their subcomponents as appropriate to the equipment installed.~~
~~**5.1.14.4.2 Maintenance Programs.**~~
~~**5.1.14.4.2.1 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.~~
~~**5.1.14.4.2.2* Inspection Schedules.**~~
~~Scheduled inspections for equipment and procedures shall be established through the risk assessment of the facility and developed with consideration of the original equipment manufacturer recommendations and other recommendations as required by the authority having jurisdiction.~~
~~**5.1.14.4.2.3 Inspection Procedures.**~~
~~The facility shall be permitted to use any inspection procedure(s) or testing methods established through its own risk assessment.~~
~~**5.1.14.4.2.4 Maintenance Schedules.**~~
~~Scheduled maintenance for equipment and procedures shall be established through the risk assessment of the facility and developed with consideration of the original equipment manufacturer recommendations and other recommendations as required by the authority having jurisdiction.~~
~~**5.1.14.4.2.5 Qualifications.**~~
~~(A)~~
~~Persons maintaining these systems shall be qualified to perform these operations.~~
~~(B)~~
~~Appropriate qualification shall be demonstrated by any of the following:~~

~~(1) A documented training program acceptable to the health care facility by which such persons are employed or contracted to work with specific equipment as installed in that facility~~
~~(2) Credentialing to the requirements of ASSE/IAPMO/ANSI 6040, *Professional Qualifications Standard for Medical Gas Systems Maintenance Personnel*, and technically competent on the specific equipment as installed in that facility.~~
~~(3) Credentialing to the requirements of ASSE/IAPMO/ANSI 6030, *Professional Qualifications Standard for Medical Gas Systems Verifiers*, and technically competent on the specific equipment as installed in that facility.~~

5.1.14.~~4.3~~5 ~~* Inspection and Testing Operations.~~

~~5.1.3.2~~ Central Supply System Operations.

5.1.14.5.1~~5.1.3.2.1~~
The use of adapters or conversion fittings to adapt one gas-specific fitting to another shall be prohibited.

5.1.14.5.2~~5.1.3.2.2~~
Cylinders and containers shall be handled in strict accordance with 11.6.2.

5.1.14.5.3~~5.1.3.2.3~~
Only gas cylinders, reusable shipping containers, and their accessories shall be permitted to be stored in rooms containing central supply systems or gas cylinders.

5.1.14.5.4~~5.1.3.2.4~~
No flammable materials, cylinders containing flammable gases, or containers containing flammable liquids shall be stored in rooms with gas cylinders.

5.1.14.5.5~~5.1.3.2.5~~*
If cylinders are wrapped when received, the wrappers shall be removed prior to storage.

5.1.14.5.6~~5.1.3.2.6~~
Cylinders without correct markings or whose markings and gas-specific fittings do not match shall not be used.

5.1.14.5.7~~5.1.3.2.7~~

Cryogenic liquid storage units intended to supply gas to the facility shall not be used to transfill other liquid storage vessels.

5.1.14.5.~~5.1.3.2.~~8
Care shall be exercised when handling cylinders that have been exposed to freezing temperatures or containers that contain cryogenic liquids to prevent injury to the skin.

5.1.14.5.~~5.1.3.2.~~9
Cylinders containing compressed gases and containers for volatile liquids shall be kept away from radiators, steam piping, and like sources of heat.

5.1.14.5~~5.1.3.2~~.10
When cylinder valve protection caps are supplied, they shall be secured tightly in place unless the cylinder is connected for use.

5.1.14.5~~5.1.3.2~~.11
Cylinders in use and in storage shall be prevented from reaching temperatures in excess of 52°C (125°F).

5.1.14.5~~5.1.3.2~~.12
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 −7°C (20°F) or greater than 52°C (125°F).

~~5.1.14.4.3.1 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, per manufacturer's recommendations, every 18 months or at a duration as determined by a risk assessment.~~
~~(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.~~

~~(C)~~
~~Safe working condition of the flexible assemblies shall be confirmed.~~
~~(D)~~
~~D.I.S.S. connectors internal to the boom and assemblies shall be checked for leakage.~~
~~(E)~~
~~Leaks, if any, shall be repaired (if permitted), or the components replaced (if required), and the equipment retested prior to placing the equipment back into service.~~
~~(F)~~
~~Additional testing of nonstationary booms or articulating arms shall be performed at intervals defined by documented performance data.~~

5.1.14.5.13 Medical Gas and Vacuum Systems Information and Warning Signs.

5.1.14.5.13.~~5.1.3.1.8~~
Source locations containing positive-pressure gases other than oxygen and medical air shall be provided with signage located on or immediately adjacent to the door that is visible upon entering the space as follows:
Positive-Pressure Gases
.
NO Smoking or Open Flame
.
Room May Have Insufficient Oxygen
.
Open Door and Allow Room to Ventilate Before Entering

5.1.14.5.13.2~~5.1.3.1.8.1~~
Existing signage that is not in strict compliance with the requirements of this code shall be permitted to be continued in use unless the authority having jurisdiction has determined that such use constitutes a distinct hazard to life.

5.1.14.5.13.3~~5.1.3.1.9~~
Source locations containing only oxygen or medical air shall be provided with signage located on or immediately adjacent to the door that is visible upon entering the space as follows:

Medical Gases
.
NO Smoking or Open Flame

5.1.14.5.13.4~~5.1.3.1.9.1~~

Existing signage that is not in strict compliance with the requirements of this code shall be permitted to be continued in use unless the authority having jurisdiction has determined that such use constitutes a distinct hazard to life.

5.1.14.5.13.5~~5.1.3.1.10~~

In health care facilities where smoking is prohibited, signs required by 5.1.~~3~~14.~~1~~5.~~8~~1 and 5.1.~~3~~14.~~1~~5.~~9~~4 shall be permitted to omit the reference to smoking.

5.1.14.5.13.6~~5.1.14.5.1~~

The gas content of medical gas and vacuum piping systems shall be labeled in accordance with *{ed note: former* 5.1.11.1.

5.1.14.5.~~2~~13.7
Labels for shutoff valves shall be in accordance with *{ed note: former* 5.1.11.2 and updated when modifications are made changing the areas served.

5.1.14.5.~~3~~13.8
Station inlets and outlets shall be identified in accordance with *{ed note: former* 5.1.11.3.

5.1.14.5.~~4~~13.9
Alarm panel labeling shall be in accordance with *{ed note: former* 5.1.11.4 and updated when modifications are made changing the areas served.

5.1.14.~~6~~5.13.10
Source equipment labeling shall be in accordance with *{ed note: former* 5.1.11.5.

5.1.14.~~7~~ 6 Medical Gas and Vacuum Systems Maintenance ~~and Record Keeping.~~

5.1.14.6.1* General.
Health care facilities with installed medical gas, vacuum, WAGD, or medical support gas systems, or combinations thereof, shall develop and document periodic maintenance programs for these systems and their subcomponents as appropriate to the equipment installed.

5.1.14.6.2 Qualifications.

(A) Persons maintaining these systems shall be qualified to perform these operations.
(B) Appropriate qualification shall be demonstrated by any of the following:

(1) A documented training program acceptable to the health care facility by which such persons are employed or contracted to work with specific equipment as installed in that facility

(2) Credentialing to the requirements of ASSE/IAPMO/ANSI 6040, Professional Qualifications Standard for Medical Gas Systems Maintenance Personnel, and technically competent on the specific equipment as installed in that facility.

(3) Credentialing to the requirements of ASSE/IAPMO/ANSI 6030, Professional Qualifications Standard for Medical Gas Systems Verifiers, and technically competent on the specific equipment as installed in that facility.

5.1.14.6.3. Required Aspects of a Maintenance Program.

5.1.14.6.3.1 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.

5.1.14.6.3.2* Inspection Schedules.
Scheduled inspections for equipment and procedures shall be established through the risk assessment of the facility and developed with consideration of the original equipment manufacturer recommendations and other recommendations as required by the authority having jurisdiction.

5.1.14.6.3.3 Inspection Procedures.
The facility shall be permitted to use any inspection procedure(s) or testing methods established through its own risk assessment.

5.1.14.6.3.4 Maintenance Schedules.
Scheduled maintenance for equipment and procedures shall be established through the risk assessment of the facility and developed with consideration of the original equipment manufacturer recommendations and other recommendations as required by the authority having jurisdiction.

~~**5.1.14.7.1**~~
~~Permanent records of all tests required by 5.1.12.4.1 through 5.1.12.4.14 shall be maintained in the organization's files.~~
5.1.14.~~7~~6.~~2~~4 Maintenance Operations

5.1.14.6.4.1 Central Supply Systems

5.1.14.6.4.1.1
The supplier of the cryogenic fluid central supply system shall, upon request, provide documentation of vaporizer(s) sizing criteria to the facility.

5.1.14.6.4.1.2~~5.1.14.7.3~~

An annual review of cryogenic fluid central supply system capacity shall be conducted to ensure the source system has sufficient capacity.

5.1.14.6.4.1.3~~5.1.14.7.4~~

Central supply systems for nonflammable medical gases shall conform to the following:

(1) They shall be inspected annually.

(2) They shall be maintained by a qualified representative of the equipment owner.

(3) A record of the annual inspection shall be available for review by the authority having jurisdiction.

5.1.14.6.4.1.4~~7~~

Procedures, as specified, shall be established for the following:

(1) Maintenance program for the medical air compressor supply system in accordance with the manufacturer's recommendations

(2) Facility testing and calibration procedure that ensures carbon monoxide monitors are calibrated at least annually or more often if recommended by the manufacturer

(3) Maintenance program for 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) Maintenance program for the WAGD system to ensure performance

(5) Facility testing and calibration procedure that ensures that oxygen concentration monitors are calibrated at least every three months, or more often if recommended by the manufacturer

(6) Where oxygen sources include concentrator units, maintenance programs for the oxygen concentrator units and all essential subcomponents

5.1.14.6.4.1.5
Where oxygen central supply systems using concentrators are used and one or more of the three sources is a cylinder header, the facility shall establish procedures to ensure the facility is always provided with one average day's supply of oxygen meeting the supply system product purity specification in reserve, as follows:

(1) The facility shall establish a minimum cylinder pressure that will permit one average day's supply. That value will be included as part of the standard operating procedure for the oxygen supply system.

(2) The cylinders shall be inspected daily and any loss of pressure noted.

(3) When the cylinders are found to have lost pressure due to use or leakage and thus are below the preestablished pressure, the cylinders shall be exchanged.

5.1.14.6.~~7~~4.2.~~5~~ Alarms Maintenance
A periodic testing procedure for nonflammable medical gas and vacuum and related alarm systems shall be implemented.

5.1.14.6.~~7.8~~4.2.1
Audible and visual alarm indicators shall meet the following requirements:

(1) They shall be periodically tested to determine that they are functioning properly.

(2) Records of the test shall be maintained until the next test is performed.

5.1.14.6.4.3 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, per manufacturer's recommendations, every 18 months or at a duration as determined by a risk assessment.

(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.

(C) Safe working condition of the flexible assemblies shall be confirmed.

(D) D.I.S.S. connectors internal to the boom and assemblies shall be checked for leakage.

(E) Leaks, if any, shall be repaired (if permitted), or the components replaced (if required), and the equipment retested prior to placing the equipment back into service.

(F) Additional testing of nonstationary booms or articulating arms shall be performed at intervals defined by documented performance data.

5.1.14.6.4.5~~7.6~~ Breaches to the pipeline

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.

~~**5.1.14.7.7**~~

~~Procedures, as specified, shall be established for the following:~~

~~(1) Maintenance program for the medical air compressor supply system in accordance with the manufacturer's recommendations~~

~~(2) Facility testing and calibration procedure that ensures carbon monoxide monitors are calibrated at least annually or more often if recommended by the manufacturer~~

~~(3) Maintenance program for 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) Maintenance program for the WAGD system to ensure performance~~

~~(5) Facility testing and calibration procedure that ensures that oxygen concentration monitors are calibrated at least every three months, or more often if recommended by the manufacturer~~

~~(6) Where oxygen sources include concentrator units, maintenance programs for the oxygen concentrator units and all essential subcomponents~~

~~**5.1.14.7.8**~~

~~Audible and visual alarm indicators shall meet the following requirements:~~

~~(1) They shall be periodically tested to determine that they are functioning properly.~~

~~(2) Records of the test shall be maintained until the next test is performed.~~

5.1.14.6.4.7~~.69~~ Vacuum Inlets

Medical–surgical vacuum station inlet terminal performance, as required in *{ed note: former* 5.1.12.4.10.4, 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

~~**5.1.14.7.10**~~

~~Where oxygen central supply systems using concentrators are used and one or more of the three sources is a cylinder header, the facility shall establish procedures to ensure the facility is always provided with one average day's supply of oxygen meeting the supply system product purity specification in reserve, as follows:~~

~~(1) The facility shall establish a minimum cylinder pressure that will permit one average day's supply. That value will be included as part of the standard operating procedure for the oxygen supply system.~~

~~(2) The cylinders shall be inspected daily and any loss of pressure noted.~~

~~(3) When the cylinders are found to have lost pressure due to use or leakage and thus are below the preestablished pressure, the cylinders shall be exchanged.~~

5.1.14.6.~~7.11~~4.7* Access to valves and alarms

Access to valves and alarms shall be made part of the standard operating procedures for the facility and shall include the following:

(1) No items are to be placed in front of or affixed to any alarm panel that would restrict the view or diminish the sound of the alarm.

(2) Valves in secured areas are to be specified as follows:

(a) *The valve is visible from the intended operator's position.
(b) The valve is operable with no more than ordinary aids, such as a ladder.
(c) If the valve is provided with security hardware, such hardware is visible and readily removeable when needed.

5.1.14.~~7.1~~7 Record Keeping
Permanent records of all tests required by *{ed note: former* 5.1.12.4.1 through *{ed note: former* 5.1.12.4.14 shall be maintained in the organization's files.
~~5.2 Category 2 Piped Gas and Vacuum Systems.~~
~~5.2.1* Applicability.~~
~~5.2.1.1*~~
~~These requirements shall apply to health care facilities that require Category 2 systems as referenced in Chapter 4.~~
~~5.2.1.2~~
~~The following subsections of this chapter shall apply to the operation, management, and maintenance of Category 2 medical gas and vacuum systems in both new and existing health care facilities:~~
~~(1) 5.1.3.6.2~~
~~(2) 5.1.10.11.7.1~~
~~(3) 5.2.3.1~~
~~(4) 5.2.3.2~~
~~(5) 5.2.3.3~~
~~(6) 5.2.3.5(2)~~
~~(7) 5.2.3.7(2)~~
~~(8) 5.2.3.8(2)~~
~~(9) 5.2.13~~
~~(10) 5.2.14~~
~~5.2.1.3~~
~~Category 2 systems shall be permitted to serve spaces identified as Category 2 or Category 3.~~
~~5.2.2 Nature of Hazards of Gas and Vacuum Systems.~~
~~The requirement of 5.1.2 shall apply to the nature of hazards of gas and vacuum systems.~~
~~5.2.3 Sources.~~
~~5.2.3.1 Central Supply System Identification and Labeling.~~
~~Category 2 systems shall comply with 5.1.3.1.~~
~~5.2.3.2 Central Supply Operations.~~
~~Category 2 systems shall comply with 5.1.3.2.~~
~~5.2.3.3 Central Supply System Locations.~~
~~Category 2 systems shall comply with 5.1.3.3.~~
~~5.2.3.4 Central Supply Systems.~~
~~Category 2 systems shall comply with 5.1.3.5.~~
~~5.2.3.5 Medical Air Supply Systems.~~
~~Category 2 systems shall comply with 5.1.3.6, except as follows:~~
~~(1) Medical air compressors, dryers, aftercoolers, filters, and regulators shall be permitted to be simplex.~~
~~(2) The facility staff shall develop their emergency plan to deal with the loss of medical air.~~
~~5.2.3.6~~
~~Oxygen supply systems using concentrators shall be permitted to consist of two sources, one of which shall be a cylinder header with sufficient cylinder connections for one average day's supply.~~
~~5.2.3.7 Medical-Surgical Vacuum.~~
~~Category 2 systems shall comply with 5.1.3.7, except as follows:~~
~~(1) Medical-surgical vacuum systems shall be permitted to be simplex.~~
~~(2) The facility staff shall develop their emergency plan to deal with the loss of medical-surgical vacuum.~~
~~5.2.3.8 WAGD.~~
~~Category 2 systems shall comply with 5.1.3.8, except as follows:~~
~~(1) Medical WAGD pumps shall be permitted to be simplex.~~
~~(2) The facility staff shall develop their emergency plan to deal with the loss of WAGD.~~
~~5.2.3.9 Instrument Air Supply Systems.~~
~~Instrument air outlets in Category 2 spaces shall be supplied by any of the following:~~
~~(1) An instrument air central supply system in accordance with 5.1.13.3.7, excluding 5.1.13.3.7.4 (Category 2 systems are permitted to consist of a single compressor)~~
~~(2) A cylinder manifold in accordance with 5.1.3.5.10~~
~~(3) A cylinder header in accordance with 5.1.3.5.9, provided with a means for pressure control in accordance with 5.1.3.5.5.1, excluding 5.1.3.5.5.1(3) (the pressure control means for Category 2 systems are not required to be redundant)~~
~~5.2.4 Valves.~~
~~Category 2 systems shall comply with 5.1.4.~~
~~5.2.5 Station Outlets and Inlets.~~
~~Category 2 systems shall comply with 5.1.5.~~

5.2.6 Manufactured Assemblies.
Category 2 systems shall comply with 5.1.6.
5.2.7 Surface-Mounted Medical Gas Rails.
Category 2 systems shall comply with 5.1.7.
5.2.8 Pressure and Vacuum Indicators.
Category 2 systems shall comply with 5.1.8.
5.2.9 Warning Systems.
Warning systems associated with Category 2 systems shall provide the master, area, and local alarm functions of a Category 1 system as required in 5.1.9, except as follows:
(1) Warning systems shall be permitted to be a single alarm panel.
(2) The alarm panel shall be located in an area of continuous surveillance while the facility is in operation.
(3) Pressure and vacuum switches/sensors shall be mounted at the source equipment with a pressure indicator at the master alarm panel.
5.2.10 Distribution.
Category 2 systems shall comply with 5.1.10.
5.2.11 Labeling and Identification.
Category 2 systems shall comply with 5.1.11.
5.2.12 Performance Criteria and Testing — Gas, Medical-Surgical Vacuum, and WAGD.
Category 2 systems shall comply with 5.1.12.
5.2.13 Medical Support Gases.
Category 2 systems shall comply with 5.1.13.
5.2.14* Operation and Management.
Category 2 systems shall comply with 5.1.14.
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 require Category 3 systems as referenced in Chapter 4.
5.3.1.2
The following sections of this chapter shall apply to the operation, management, and maintenance of the medical gas and vacuum systems in both new and existing health care facilities:
(1) 5.1.3.6.2
(2) 5.1.10.11.7.1
(3) 5.3.3.1 through 5.3.3.3
(4) 5.3.3.6.1(2)
(5) 5.3.3.7(2)
(6) 5.3.3.8(2)
(7) 5.3.14
5.3.1.3
Category 3 systems shall be permitted to only serve spaces identified as Category 3.
5.3.2 Nature of Hazards of Gas and Vacuum Systems.
The requirement of 5.1.2 shall apply to the nature of hazards of gas and vacuum systems.
5.3.3 Sources.
5.3.3.1 Central Supply System Identification and Labeling.
Category 3 systems shall comply with 5.1.3.1.
5.3.3.2 Central Supply Operations.
5.3.3.2.1
Category 3 systems shall comply with the requirements of 5.1.3.2 except for emergency electrical service.
5.3.3.2.2
Emergency electrical service shall conform to the requirements of Section 6.6 and *NFPA 70*.
5.3.3.3 Central Supply System Locations.
Category 3 systems shall comply with 5.1.3.3.
5.3.3.4 Control Equipment.
Category 3 systems shall comply with 5.1.3.4.
5.3.3.5 Central Supply Systems.
Category 3 central supply systems shall be permitted to consist of the following:
(1) Gas cylinder or cryogenic liquid container headers in accordance with 5.3.3.5.10
(2) Oxygen concentrator supply units in accordance with 5.3.3.5.11
(3) Cylinder manifolds for gas cylinders in accordance with 5.3.3.5.12
(4) Manifolds for cryogenic liquid containers in accordance with 5.3.3.5.13
(5) Cryogenic fluid central supply systems in accordance with 5.3.3.5.14
(6) Medical air compressor systems in accordance with 5.3.3.6
(7) Proportioning air systems in accordance with 5.3.3.6.2
(8) Medical-surgical vacuum systems in accordance with 5.3.3.7
(9) Waste anesthetic gas disposal systems (WAGDs) in accordance with 5.3.3.8
(10) Instrument air compressor systems in accordance with 5.3.3.9
5.3.3.5.1 General.

~~Category 3 systems shall comply with 5.1.3.5.1.~~
~~5.3.3.5.2 Permitted Locations for Medical Gases.~~
~~Category 3 systems shall comply with 5.1.3.5.2.~~
~~5.3.3.5.3 Support Gases.~~
~~Category 3 systems shall comply with 5.1.3.5.3.~~
~~5.3.3.5.4 Materials.~~
~~Category 3 systems shall comply with 5.1.3.5.4.~~
~~5.3.3.5.5 Controls for Line Pressure.~~
~~With the exception of final line controls, which shall be permitted to be simplex, Category 3 systems shall comply with 5.1.3.5.~~
~~5.3.3.5.6 Relief Valves.~~
~~Category 3 systems shall comply with 5.1.3.5.6.~~
~~5.3.3.5.7 Auxiliary Source Connection.~~
~~Category 3 systems shall comply with 5.1.4.10.~~
~~5.3.3.5.8 Multiple Pressures.~~
~~With the exception of each piped distribution network from the single central supply system, the control mechanism components of which shall be permitted to be simplex, Category 3 systems shall comply with 5.1.3.5.7.~~
~~5.3.3.5.9 Local Signals.~~
~~Category 3 systems shall comply with 5.1.3.5.8.~~
~~5.3.3.5.10 Gas Cylinder or Cryogenic Liquid Container Header.~~
~~Category 3 systems shall comply with 5.1.3.5 and 5.1.3.5.9, expect as follows:~~
~~(1) Gas cylinder or cryogenic liquid container headers shall be in accordance with 5.1.3.5.9, with sufficient cylinder connections to provide for at least one average day's supply, and with the appropriate number of connections determined only after consideration of the delivery schedule, the proximity of the facility to alternate supplies, and the facility's emergency plan.~~
~~(2) The header(s) shall have a local signal that visibly indicates the operating status of the equipment and complies with 5.1.3.5.8.~~
~~(3) *The facility staff shall develop an emergency plan to deal with the loss of the headers' medical gas.~~
~~5.3.3.5.11 Oxygen Central Supply Systems Using Concentrators.~~
~~Category 3 systems shall comply with 5.1.3.5, 5.1.3.9.1, and 5.1.3.9, except as follows:~~
~~(1) Oxygen supply systems using concentrators shall be permitted to consist of one source.~~
~~(2) The facility staff shall develop an emergency plan to deal with the loss of oxygen.~~
~~(3) Emergency electrical service shall conform to the requirements of Section 6.6 and *NFPA 70*.~~
~~5.3.3.5.12 Manifolds for Gas Cylinders.~~
~~Category 3 systems shall comply with 5.1.3.5 and 5.1.3.5.10.~~
~~5.3.3.5.13 Manifolds for Cryogenic Liquid Containers.~~
~~Category 3 systems shall comply with 5.1.3.5 and 5.1.3.5.11.~~
~~5.3.3.5.14 Cryogenic Fluid Central Supply Systems.~~
~~Category 3 systems shall comply with 5.1.3.5 and 5.1.3.10.~~
~~5.3.3.6 Medical Air.~~
~~5.3.3.6.1 Medical Air Compressor Systems.~~
~~Category 3 systems shall comply with 5.1.3.5 and 5.1.3.6, except as follows:~~
~~(1) Medical air compressors, dryers, aftercoolers, filters, and regulators shall be permitted to be simplex.~~
~~(2) The facility staff shall develop an emergency plan to deal with the loss of medical air.~~
~~(3) Emergency electrical service shall conform to the requirements of Section 6.6 and *NFPA 70*.~~
~~5.3.3.6.2 Proportioning Air Systems.~~
~~Category 3 systems shall comply with 5.1.3.5, 5.1.3.6, and 5.1.3.6.3.14.~~
~~5.3.3.7 Medical–Surgical Vacuum Systems.~~
~~Category 3 systems shall comply with 5.1.3.5 and 5.1.3.7, except as follows:~~
~~(1) Medical–surgical vacuum systems shall be permitted to be simplex.~~
~~(2) The facility staff shall develop an emergency plan to deal with the loss of medical–surgical vacuum.~~
~~(3) Emergency electrical service shall conform to the requirements of Section 6.6 and *NFPA 70*.~~
~~5.3.3.8 Waste Anesthetic Gas Disposal Systems (WAGDs).~~
~~Category 3 systems shall comply with 5.1.3.5 and 5.1.3.8, except as follows:~~
~~(1) Medical WAGD pumps shall be permitted to be simplex.~~
~~(2) The facility staff shall develop an emergency plan to deal with the loss of WAGD.~~
~~(3) Emergency electrical service shall conform to the requirements of Section 6.6 and *NFPA 70*.~~
~~5.3.3.9 Instrument Air Compressor Systems.~~
~~Category 3 systems shall comply with 5.1.3.5 and 5.1.13.3.7, except as follows:~~
~~(1) Instrument air compressor systems shall be permitted to be simplex with no standby header.~~
~~(2) The facility staff shall develop an emergency plan to deal with the loss of instrument air.~~
~~(3) Emergency electrical service shall conform to the requirements of Section 6.6 and *NFPA 70*.~~
~~5.3.4 Valves.~~
~~Category 3 systems shall comply with 5.1.4.~~
~~5.3.5 Station Outlets and Inlets.~~
~~Category 3 systems shall comply with 5.1.5.~~

5.3.6 Manufactured Assemblies.
Category 3 systems shall comply with 5.1.6.
5.3.7 Surface-Mounted Medical Gas Rails.
Category 3 systems shall comply with 5.1.7.
5.3.8 Pressure and Vacuum Indicators.
Category 3 systems shall comply with 5.1.8.
5.3.9 Warning Systems.
Warning systems associated with Category 3 systems shall provide the master, area, and local alarm functions of a Category 1 system as required in 5.1.9, except as follows:
(1) Warning systems shall be permitted to be a single alarm panel (i.e., a combination master/area alarm panel).
(2) The alarm panel shall be located in an area of continuous surveillance while the facility is in operation.
(3) Pressure and vacuum switches/sensors shall be mounted at the source equipment with a pressure indicator at the master alarm panel.
(4) Electrical power for warning systems shall be in accordance with Section 6.6 for Category 3 and Category 4 spaces.
5.3.10 Distribution.
Category 3 systems shall comply with 5.1.10.
5.3.11 Labeling and Identification.
Category 3 systems shall comply with 5.1.11.
5.3.12 Performance Criteria and Testing — Gas, Medical-Surgical Vacuum, and WAGD.
Category 3 systems shall comply with 5.1.12.
5.3.13 Medical Support Gases.
Category 3 systems shall comply with 5.1.13, except as follows:
(1) Instrument air compressor systems shall be permitted to be simplex with no standby header.
(2) The facility staff shall develop an emergency plan to deal with the loss of instrument air.
5.3.14 Operation and Management.
Category 3 systems shall comply with 5.1.14.
5.4 Liquid Withdrawal and Piping.
5.4.1* General.
This section shall apply to health care facilities that draw cryogenic liquids from containers for use in liquid form.
5.4.2 Containers.
5.4.2.1
Containers used for cryogenic liquid systems shall comply with 5.1.3.
5.4.2.2
Container storage locations shall comply with 5.1.3.1.8, 5.1.3.1.9, 5.1.3.3.2, and 5.1.3.5.12.
5.4.2.3
Container operations shall comply with 5.1.3.1.6, 5.1.3.1.7, and 5.1.3.2.
5.4.3 Ventilation.
Locations holding containers for liquid withdrawal shall comply with the ventilation requirements of 5.1.3.3.3.1 or 5.1.3.3.3.4.
5.4.4 Materials.
Materials used with liquid withdrawal systems shall be compatible with the temperatures, pressures, and gases to which they could be exposed under normal use and under any conditions that can reasonably be anticipated in the event of a single fault in a protection device(s).
5.4.5 Relief Valves.
5.4.5.1
Liquid withdrawal systems and devices shall be provided with pressure relief mechanisms wherever liquid can be trapped between two valves or control devices and where, due to low or intermittent flow, liquid could convert to gas.
5.4.5.2*
All pressure relief valves shall meet the following requirements:
(1) They shall be designed for the specific gas service.
(2) They shall be designed for service with cryogenic liquids.
(3) They shall have a relief pressure setting no higher than the maximum allowable working pressure (MAWP) of the component with the lowest working pressure rating in the portion of the system being protected.
(4) They shall be vented into a safe location with the understanding that they could discharge gas or liquid at cryogenic temperatures.
5.4.6 Manifolds for Cryogenic Liquid Withdrawal.
5.4.6.1
Manifolds for cryogenic liquid withdrawal shall be located in accordance with 5.1.3.3.1 and meet one of the following requirements:
(1) If located outdoors, they shall be installed in an enclosure used only for this purpose and sited to comply with the minimum distance requirements of Table 5.1.3.5.11.1.
(2) If located indoors, they shall be installed within a room used only for the enclosure of such manifolds.
5.4.6.2*
Manifold locations for cryogenic liquid withdrawal shall comply with the following:

(1) The location shall be constructed in accordance with 5.1.3.3.2.
(2) Ventilation shall be sufficient to maintain manifold room oxygen levels between 19.5 and 23.5 percent.
5.4.6.3
Manifolds for cryogenic liquid withdrawal shall have their primary and secondary headers located in the same enclosure.
5.4.6.4
Manifolds for cryogenic liquid withdrawal shall meet the following requirements:
(1) They shall consist of two or more equal headers, each having sufficient capacity to meet the required peak flow rate and expected duration of supply.
(2) They shall consider the normal evaporation rate of the containers and piping.
5.4.6.5
Manifolds for cryogenic liquid withdrawal shall include an automatic means of controlling the two headers to accomplish the following during normal operation:
(1) *One cryogenic liquid header shall be the primary and the other, the secondary, with either being capable of either role.
(2) When the primary header is depleted, the secondary header shall automatically begin to supply the system.
5.4.6.6
Manifolds for cryogenic liquid withdrawal shall include a manual or automatic means to place either header into the role of primary header and the other into the role of secondary header.
5.4.6.7
Manifolds for cryogenic liquid withdrawal shall have a local signal(s) that visibly indicates the operating status of the container contents and the operating header.
5.4.6.8
Audible and visual alarms shall be provided to indicate the following conditions:
(1) Low contents of the containers
(2) When or at a predetermined set point before the secondary header begins to supply the system, indicating changeover has occurred or is about to occur
5.4.6.9 Piping.
5.4.6.9.1 Materials.
5.4.6.9.1.1
Piping materials for field-installed cryogenic liquid withdrawal systems shall be in accordance with the manufacturer's recommendations.
5.4.6.9.1.2
Valves and other control apparatus shall be suitable for cryogenic service.
5.4.6.9.1.3*
Special purpose devices shall meet the following requirements:
(1) They shall be constructed of materials compatible with cryogenic service.
(2) They shall be placed such that they are visible for inspection, testing, and service.
(3) They shall be placed or guarded to prevent the development of any hazards when they operate.
5.4.6.9.1.4
Electrical devices and wiring placed in proximity to cryogenic fluid or potentially exposed to ice or condensate shall be protected for wet locations.
5.4.6.9.2 Installation.
Piping for field-installed cryogenic liquid withdrawal systems shall be installed in accordance with the manufacturer's recommendations.
5.4.6.9.3 Insulation or Protection.
All piping for field-installed cryogenic liquid withdrawal systems shall be insulated or protected to prevent inadvertent contact, icing, and condensation.
5.4.6.10 Testing.
Piping for field-installed cryogenic liquid withdrawal systems shall be tested in accordance with the manufacturer's recommendations and include the following:
(1) Evaluation of relief valve locations and cracking pressures
(2) Leak tests at the higher of 1.5 times the expected normal operating pressure or the highest relief valve cracking pressure in the piping
(3) Insulation integrity
(4) *Other criteria as determined by the application

Public Input No. 173-NFPA 99-2024 [New Section after 5.1.1.2]

Referring to the risk analysis required in 4.2.2, all patient care locations with risk of patient death, major injury or other unacceptable risk in the event of total or partial loss of services shall be supplied from Category 1 medical gas, vacuum and support gas systems.

Statement of Problem and Substantiation for Public Input

The elimination of 5.1.1.2, 5.2.1.2 and 5.3.1.2 in the 2024 edition removed the essential test for categories, throwing the entire decision onto the risk analysis from 4.2.2. However, 4.2.2 gives no clear guidance for this risk analysis as it applies specifically to medical gas systems.

Adding these clauses reminds the user to refer to this risk analysis, that the risk of greatest concern is total or partial loss of services but that other considerations may also apply, and explicitly ties the categories in Chapter 5 to the categories in Chapter 4.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 174-NFPA 99-2024 [New Section after 5.2.1.1]	
Public Input No. 175-NFPA 99-2024 [New Section after 5.3.1.1]	
Public Input No. 174-NFPA 99-2024 [New Section after 5.2.1.1]	

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Committee: HEA-PIP

Public Input No. 10-NFPA 99-2024 [Section No. 5.1.1.5]

5.1.1.5

The following sections of this chapter shall apply to the operation, management, and maintenance of Category 1 medical gas and vacuum systems in both new and existing health care facilities:

(1) 5.1.2
(2) 5.1.3.1
(3) 5.1.3.2
(4) 5.1.3.3.4
(5) 5.1.3.6.2
(6) 5.1.3.6.3.10(A)(2)
(7) 5.1.3.7.6(A)(2)
(8) 5.1.3.8.4.1(2)
(9) 5.1.14

Statement of Problem and Substantiation for Public Input

The term "health care " is added for clarity and to correlate with similar language at 5.3.1.2, 5.2.1.2, 6.1.3, 11.1, 12.1 and 13.1.

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Public Input No. 249-NFPA 99-2024 [Section No. 5.1.2]

Revise 5.1.2

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to read:

5.1.2 Nature of Hazards of Gas and Vacuum Systems.

5.1.2.1 Potential fire and explosion hazards associated with positive pressure gas central piping systems , vacuum and

~~medical–surgical vacuum~~

waste gas systems shall be considered in the design, installation, testing, operation, and maintenance of these systems.

5.1.2.2* The decision to install any specific patient or support gas or vacuum services is dependent on the facility's clinical program and nothing in this code requires the installation of any system. Facilities should consider clinical, environmental, and financial factors when considering what systems to install or to omit.

Annex A.5.1.2.2 A relevant example of these considerations in action comes from the considerable research at the time this code was under development which has demonstrated that centrally piped nitrous oxide systems are generally undesirable. This is due to the small quantity of nitrous oxide actually used in current medical practice when balanced against the significant environmental damage releasing nitrous oxide is known to create and the costs of installing a central system for such limited clinical use. Facilities have therefore begun to omit these systems from new construction and to decommission systems in older facilities. They then supply any limited residual requirements using point of use cylinders.

Statement of Problem and Substantiation for Public Input

An internet search for "nix the nitrous" will bring up numerous technical and research papers on the subject of nitrous oxide and the movement to discontinue piping this gas. Two are given here as samples:
https://vimeo.com/723874254/ca3dc0d313
https://sustainablehealthcare.org.uk/what-we-do/sustainable-specialties/anaesthetics/nitrous-oxide-project

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 250-NFPA 99-2024 [New Section after 5.1.3.5.12]	
Public Input No. 250-NFPA 99-2024 [New Section after 5.1.3.5.12]	

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Submittal Date:	Mon May 27 09:16:41 EDT 2024
Committee:	HEA-PIP

Public Input No. 176-NFPA 99-2024 [New Section after 5.1.3]

5.1.3* Determination of Patient Care Spaces

5.1.3.1 For the purposes of this chapter, a patient care space shall:

(A) meet one of the definitions in 3.3.145, and;

(B) include only patients who are undergoing substantially similar treatments, and;

(D) who are under the care of a single group of clinical staff.

Annex 5.1.3

In chapter 5, the requirements for valves and alarms are dependent on how one assesses a patient care space. This clause provides a way to evaluate patient care spaces where there may be multiple patient bed locations but each does not merit a separate zone valve or alarm. Thus for example an ICU may contain multiple patient beds, but can under these rules be evaluated as a single patient care space because the treatments are similar and the staff delivering that care is the same. However, with several operating rooms, even where one might argue the treatments are similar, the staff delivering that care is clearly different, so each O.R. would be valved and alarmed separately.

Statement of Problem and Substantiation for Public Input

We have traditionally alarmed and valved areas like intensive care as multiple patient areas, and anesthetizing locations as single patient spaces. Experience demonstrates that this is been both effective and economical. In previous editions, this practice was supported by the interaction of the “anesthetizing location” definition and the use of the term “critical care and vital life support” when referring to other areas where valves and alarms were wanted.
However, “critical care and vital life support” has been replaced by "Category 1 spaces", which clearly encompasses both anesthetizing locations and areas with highly dependent patients. We have therefore lost the underpinning that supported our traditional practice.
The definition of a patient care space (3.3.145) uses the term “patients”, so it does not explicitly support this practice, but neither does it prohibit it. Beyond this, there is nowhere in the standard where it is clear how to evaluate that definition when trying to apply 5.1.4.6.2 and 5.1.9.4.
By including this method of defining the patient care space for the purposes of this chapter, both 5.1.4.6.2. and 5.1.9.4 can then be simplified.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 177-NFPA 99-2024 [Section No. 5.1.4.6.2]	
Public Input No. 178-NFPA 99-2024 [Section No. 5.1.9.4 [Excluding any Sub-Sections]]	
Public Input No. 177-NFPA 99-2024 [Section No. 5.1.4.6.2]	
Public Input No. 178-NFPA 99-2024 [Section No. 5.1.9.4 [Excluding any Sub-Sections]]	

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Public Input No. 167-NFPA 99-2024 [Section No. 5.1.3.3.1.3]

5.1.3.3.1.3

Any of the following central supply systems shall be permitted to be located together in the same room:

(1) Medical air central supply compressor supply sources *(see 5.1.3.6.3)*

(2) Medical–surgical vacuum central supply sources *(see 5.1.3.7)*

(3) Waste anesthetic gas disposal (WAGD) central supply sources *(see 5.1.3.8)*

(4) Instrument air compressor central supply sources (including their reserve headers if provided) *(see 5.1.13.3.7)*

(5) Any other compressor, vacuum pump, or electrically powered machinery

(6)* Compressors, dryers, and air receivers used to supply oxygen concentrators (*see 5.1.3.9*)

(7) Concentrator units with air and oxygen sides in an integral unit (*see 5.1.3.9*)

Statement of Problem and Substantiation for Public Input

5.1.3.3.1.4 allows instrument air standby headers to be in the same room as instrument air compressors, but implies that 5.1.3.3.1.2 and 5.1.3.3.1.3 still otherwise apply. The consequence is a conclusion that a separate room must be provided for these systems, since they are neither 5.1.3.3.1.2 OR 5.1.3.3.1.3. This is unnecessary from a safety viewpoint.
The proposal will clarify that they may be included with other systems under 5.1.3.3.1.3.

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Public Input No. 19-NFPA 99-2024 [Section No. 5.1.3.3.2.1]

5.1.3.3.2.1

Medical gas and vacuum systems shall be designed by one of the following:

(1) A ~~party technically competent and experienced in the field of medical gas and vacuum system design and meeting the~~ qualified person meeting the requirements of ASSE/IAPMO/ANSI 6060, *Professional Qualifications Standard for Medical Gas System Designers*

(2) A ~~party deemed technically competent through other qualification(s) deemed~~ qualified person deemed sufficient by the health care facility's governing body

Statement of Problem and Substantiation for Public Input

To improve clarity, vague text is replaced with the Chapter 3 defined term "qualified person" located at 3.3.162

3.3.162 Qualified Person.
A person who, by possession of a recognized degree, certificate, professional standing, or skill, and who, by knowledge, training, and experience, has demonstrated the ability to perform the work. (HYP)

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Public Input No. 159-NFPA 99-2024 [Section No. 5.1.3.3.2.3]

5.1.3.3.2.3

Locations for motor-driven central supply systems shall meet the following requirements:

(1) They shall be constructed with access to move equipment and so forth in and out of the location as necessary.

(2) They shall be provided with lockable doors or gates or otherwise able to be secured.

(3) They shall comply with *NFPA 70* for ordinary locations.

(4) The maximum allowable temperature of the room shall be in accordance with the manufacturer's recommendations.

(5) They shall be supplied with electrical power compliant with the requirements for essential electrical systems as described in Chapter 6.

(6) They shall be located indoors

Statement of Problem and Substantiation for Public Input

All of the category 1 motor driven machinery allowed within NFPA 99 is required to be located indoors (see 5.1.3.6.3.1 (1), 5.1.3.7.1 (1), 5.1.3.8.1.3 (2), 5.1.3.9.2 (1) & 5.1.13.3.7.2 (1)). Adding a requirement to locate motor driven machinery indoors under 5.1.3.3.2.3 would be appropriate and help clear up confusion about where these systems can be installed.

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Public Input No. 20-NFPA 99-2024 [Section No. 5.1.3.3.2.3]

5.1.3.3.2.3

Locations for motor-driven central supply systems shall meet the following requirements:

(1) ~~They shall be~~ Be constructed with access to move equipment and so forth in and out of the location as necessary.

(2) ~~They shall be~~ Be provided with lockable doors or gates or otherwise able to be secured.

(3) ~~They shall comply~~ Comply with *NFPA 70* for ordinary locations.

(4) The maximum allowable temperature of the room shall be in accordance with the manufacturer's recommendations.

(5) ~~They shall be~~ Be supplied with electrical power compliant with the requirements for essential electrical systems as described in Chapter 6.

Statement of Problem and Substantiation for Public Input

The proposed change removes redundant text for clarity

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Public Input No. 452-NFPA 99-2024 [Sections 5.1.3.3.2.5, 5.1.3.3.2.6]

Sections 5.1.3.3.2.5, 5.1.3.3.2.6

5.1.3.3.2.5*

The total quantity of medical gases connected ~~to or in storage for central~~ to central supply systems shall comply with Table 5.1.3.3.2.5 for each enclosure or room.

Table 5.1.3.3.2.5 ~~Storage~~ 5 Total Quantities for Medical Gas and Cryogenic Fluid Central Supply Systems in Health Care Facilities

		Maximum Allowable Quantity, Connected ~~and in Storage~~	
Gas	Outdoor Enclosures[a]	Indoor Nonsprinklered[b]	Indoor Sprinklered[c]
Oxygen and nitrous oxide[d]	No limit	283 m^3 (10,000 ft^3)	566 m^3 (20,000 ft^3)
Carbon dioxide, helium, medical air, and nitrogen	No limit		

[a]Outdoor enclosure constructed and ventilated in accordance with this code and NFPA 55.

[b]Indoor structure constructed in accordance with 5.1.3.3.2 and ventilated in accordance with 9.3.6.

[c]Indoor structure constructed in accordance with 5.1.3.3.2, ventilated in accordance with 9.3.6, and provided with an approved, automatic sprinkler system in accordance with NFPA 13.

[d]Sum of all oxidizing gases within a room.

5.1.3.3.2.6

Storage for medical gas cylinders and containers shall comply with NFPA 55.

5.1.3.3.2.7

Storage of portable patient care gas equipment shall comply with Chapter 11 .

Statement of Problem and Substantiation for Public Input

There is a direct conflict between NFPA 55 and NFPA 99 with regard to gas cylinder storage requirements. While NFPA 55 directs the reader to NFPA 99 for the "handling" and "use" of medical gas cylinders and containers, NFPA 55 has clearly retained the scope for "storage" of all gas cylinders, including medical gases. See 1.3.2 (3) of NFPA 55. This conflict has caused much confusion about the requirements for storing medical gas cylinders and containers in the health care setting. This proposal attempts to bring the two documents into harmony and is part of a set of PIs to achieve this goal throughout the NFPA 99 document. These updates change the requirements to only apply to "in use" cylinders and containers used with medical gas supply systems as intended in the document scopes.

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Committee:	HEA-PIP

Public Input No. 454-NFPA 99-2024 [Section No. 5.1.3.3.4]

5.1.3.3.4 Storage.

5.1.3.3.4.1 –

Full or empty medical gas cylinders, when not connected, shall be permitted to be stored in locations complying with both NFPA 99 and NFPA 55.

5.1.3.3. ~~2 through~~ ~~5.1.3.3.3~~ ~~and~~ 4.2

Full or empty medical gas cylinders, when not connected, shall be permitted to be in the same rooms or enclosures as their respective central supply systems.

5.1.3.3.4.3

Approved existing installations shall be permitted to be continued in service.

5.1.3.3.4.~~2~~ 4 *

Cylinders, whether full or empty, shall not be stored in enclosures containing motor-driven machinery, with the exception of cylinders intended for instrument air reserve headers complying with 5.1.13.3.7.6, which shall be permitted to be placed in the same location containing an instrument air compressor when it is the only motor-driven machinery located within the room. Only cylinders intended for instrument air reserve headers complying with 5.1.13.3.7.6 shall be permitted to be stored in enclosures containing instrument air compressors.

Statement of Problem and Substantiation for Public Input

There is a direct conflict between NFPA 55 and NFPA 99 with regard to gas cylinder storage requirements. While NFPA 55 directs the reader to NFPA 99 for the "handling" and "use" of medical gas cylinders and containers, NFPA 55 has clearly retained the scope for "storage" of all gas cylinders, including medical gases. See 1.3.2 (3) of NFPA 55. This conflict has caused much confusion about the requirements for storing medical gas cylinders and containers in the health care setting. This proposal attempts to bring the two documents into harmony and is part of a set of PIs to achieve this goal throughout the NFPA 99 document. These updates change the requirements to direct the reader to NFPA 55 for storage of cylinders and containers used with medical gas supply systems as intended in the document scopes.

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Submittal Date: Tue Jun 04 15:17:33 EDT 2024
Committee: HEA-PIP

Public Input No. 474-NFPA 99-2024 [Section No. 5.1.3.3.4]

5.1.3.3.4 Storage.

5.1.3.3.4.1

~~Full or empty~~ Oxidizing medical gas cylinders ~~, when not connected, shall be stored in locations complying with 5.1.3.3.2 through 5.1.3.3.3 and shall be permitted to be in the same rooms or enclosures as their respective central supply systems. Approved existing installations shall be permitted to be continued in service.~~

~~**5.1.3.3.4.2 ***~~ –

~~Cylinders, whether full or empty, shall not be stored in enclosures containing motor-driven machinery, with the exception of cylinders intended for instrument air reserve headers complying with 5.1.13.3.7.6 , which shall be permitted to be placed in the same location containing an instrument air compressor when it is the only motor-driven machinery located within the room. Only cylinders intended for instrument air reserve headers complying with 5.1.13.3.7.6 shall be permitted to be stored in enclosures containing instrument air compressors.~~ and containers in quanitities greater than the MAQ in NFPA 55, which is 1,500 cu ft. at STP, shall be stored in accordance with NFPA 55.

Add Extract material from NFPA 55, including Sections 6.4, 6.7, 6.8, 6.9, 6.12, 6.13, and 6.17 as applicable.

Statement of Problem and Substantiation for Public Input

There is a direct conflict between NFPA 55 and NFPA 99 with regard to gas cylinder storage requirements. While NFPA 55 directs the reader to NFPA 99 for the "handling" and "use" of medical gas cylinders and containers, NFPA 55 has clearly retained the scope for "storage" of all gas cylinders, including medical gases. See 1.3.2 (3) of NFPA 55. This conflict has caused much confusion about the requirements for storing medical gas cylinders and containers in the health care setting. This proposal attempts to bring the two documents into harmony and is part of a set of PIs to achieve this goal throughout the NFPA 99 document. These updates change the requirements to direct the reader to NFPA 55 for storage of cylinders and containers used with medical gas supply systems as intended in the document scopes. This includes bringing in the relevant extract material from NFPA 55 so the reader does not have to move to that document for the relevant requirements.

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Public Input No. 179-NFPA 99-2024 [Section No. 5.1.3.3.4.1]

5.1.3.3.4.1

Full or empty medical gas cylinders, when not connected, shall be stored in locations complying with 5.1.3.3.2 through 5.1.3.3.3 and shall be permitted to be in the same rooms or enclosures as their respective central supply systems. ~~Approved existing installations shall be permitted to be continued in service.~~

Statement of Problem and Substantiation for Public Input

Approval of existing installations is already covered in 1.3.2.3 and 5.1.1.3.

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Public Input No. 182-NFPA 99-2024 [Section No. 5.1.3.5.6.1]

5.1.3.5.6.1

All pressure relief valves shall meet the following requirements:

(1) They shall be of brass, bronze, or stainless steel construction.

(2) They shall be designed for the specific gas service.

(3) They shall have a relief pressure setting not higher than the maximum allowable working pressure (MAWP) of the component with the lowest working pressure rating in the portion of the system being protected.

(4) They shall 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. Relief valves vented in the room shall be provided with sound attenuation.

(5) They shall have a vent discharge line that is not smaller than the size of the relief valve outlet or 20 mm (NPS ¾), whichever is larger.

(6) Where two or more relief valves discharge into a common vent line, the internal cross-sectional area of the common line shall be not less than the aggregate cross-sectional area of all relief valve vent discharge lines served.

(7) They shall discharge to open air such that escaping gas does not impinge on personnel, equipment, or adjacent structures or enter into enclosed spaces.

(8) They shall have the discharge terminal turned down and screened to prevent the entry of rain, snow, or vermin.

(9) They shall be designed in accordance with ASME B31.3, *Process Piping.*

Statement of Problem and Substantiation for Public Input

In the event that these valves did discharge, the noise level would be extreme and probably unexpected. Some degree of protection for anyone in the room must be provided. The same is less critical when discharging to outside provided the other location rules are observed.

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Public Input No. 21-NFPA 99-2024 [Section No. 5.1.3.5.6.1]

5.1.3.5.6.1

All pressure relief valves shall meet the following requirements:

(1) ~~They shall be~~ Be of brass, bronze, or stainless steel construction.

(2) ~~They shall be~~ Be designed for the specific gas service.

(3) ~~They shall have~~ Have a relief pressure setting not higher than the maximum allowable working pressure (MAWP) of the component with the lowest working pressure rating in the portion of the system being protected.

(4) ~~They shall be~~ 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) ~~They shall have~~ Have a vent discharge line that is not smaller than the size of the relief valve outlet or 20 mm (NPS ¾), whichever is larger.

(6) Where two or more relief valves discharge into a common vent line, the internal cross-sectional area of the common line shall be not less than the aggregate cross-sectional area of all relief valve vent discharge lines served.

(7) ~~They shall discharge~~ Discharge to open air such that escaping gas does not impinge on personnel, equipment, or adjacent structures or enter into enclosed spaces.

(8) ~~They shall have~~ Have the discharge terminal turned down and screened to prevent the entry of rain, snow, or vermin.

(9) ~~They shall be~~ Be designed in accordance with ASME B31.3, *Process Piping.*

Statement of Problem and Substantiation for Public Input

The proposed change removes redundant text for clarity

Submitter Information Verification

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Submittal Date: Sat Jan 13 15:24:08 EST 2024
Committee: HEA-PIP

Public Input No. 169-NFPA 99-2024 [Section No. 5.1.3.5.9]

5.1.3.5.9* Headers.

In central supply systems using cylinders or containers containing either gas or liquid, each header shall include the following:

* ~~Cylinder connections~~
(1)* Cylinder or Container connection points in the number required for the header's application

~~Cylinder~~
(2) Pipe connection lead for each cylinder or container connection point constructed of materials complying with 5.1.3.5.4 and provided with end fittings permanently attached to the cylinder pipe connection lead complying with the mandatory requirements of CGA V-1, Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections (ANSI B57.1)

(3) Filter of a material complying with 5.1.3.5.4 to prevent the intrusion of debris into the manifold controls

(4) Header shutoff valve downstream of the nearest cylinder or container connection point , but upstream of the point at which the header connects to the central supply system

(5) Pressure indicator indicating the pressure of header contents

(6) Check valve to prevent backflow into the header and to allow service to the header

(7) If intended for gas cylinder service, a check valve at each connection for the cylinder lead pipe connection lead in 5.1.3.5.9(2) to prevent loss of gas in the event of damage to the cylinder lead pipe connection lead or operation of an individual cylinder relief valve

(8) If intended for gas cylinder service, a pressure regulator to reduce the cylinder pressure to an intermediate pressure to allow the proper operation of the primary and secondary headers

(9) If intended for service with cryogenic liquid containers, a pressure relief valve

(10) Vent valves, if fitted on a header, vented outside of the building per 5.1.3.5.6.1(5) through 5.1.3.5.6.1(9) and 5.1.3.5.6.3

Statement of Problem and Substantiation for Public Input

Although this clause is intended for headers using cylinders and headers using containers, the term cylinder has persisted even when the provision is applicable to both. The rewording corrects this.

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Submittal Date: Tue Apr 30 08:36:39 EDT 2024
Committee: HEA-PIP

Public Input No. 250-NFPA 99-2024 [New Section after 5.1.3.5.12]

New 5.1.3.5.11.10*

When considering the use of liquid container manifolds, the designer shall consider both maximum utilization and minimum utilization of the system to prevent undue wastage resulting from the normal evaporative rate of the containers. Venting of container contents can result in unsafe atmospheres in the manifold room and avoidable venting of gases with negative environmental impact (e.g. nitrous oxide and carbon dioxide).

Annex A-5.1.3.5.11.10

N2O is regarded as a greenhouse gas of concern and one that healthcare facilities are evaluating as part of their environmental impact. Nitrous oxide has a global warming potential (GWP) 279 times that of CO2 and persists in the atmosphere for 114 years. Once in common use for anesthesia, the demand for N2O as an adjunct for anesthesia has waned considerably with the advent of new anaesthetics and changes in practice.

Containers of nitrous oxide and carbon dioxide have a normal evaporative rate and the gas must be continuously used at a rate greater than that NER rate, or they will vent into the room. A facility which uses sufficient nitrous oxide to prevent this venting has been shown to be rare (see also A.5.1.2.2). Containers for nitrous oxide and CO2 should not be used without indisputable evidence that the usage is sufficient to prevent this wastage to prevent the resulting environmental damage. A facility with lower usage which uses these gases could supply these gases through a cylinder manifold, as cylinders do not have normal evaporative rates.

Statement of Problem and Substantiation for Public Input

See rationale for PI 249

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 249-NFPA 99-2024 [Section No. 5.1.2]	
Public Input No. 249-NFPA 99-2024 [Section No. 5.1.2]	

Submitter Information Verification

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Submittal Date: Mon May 27 09:25:06 EDT 2024
Committee: HEA-PIP

Public Input No. 46-NFPA 99-2024 [Sections 5.1.3.5.12.1, 5.1.3.5.12.2]

Sections 5.1.3.5.12.1, 5.1.3.5.12.2

5.1.3.5.12.1

EOSCs shall be located as follows:

(1) Located 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

(3) Minimum of 1m (3ft) of clearance around EOSC for connection of temporary auxiliary source

5.1.3.5.12.2

EOSCs shall consist of the following:

(1) Physical protection to prevent unauthorized tampering

(2) Female DN (NPS) inlet for connection of the emergency oxygen source that is sized for 100 percent of the system demand at the emergency source gas pressure

(3) Manual shutoff valve to isolate the EOSC when not in use

(4) Two check valves, one downstream of the EOSC and one downstream of the main line shutoff valve, with both upstream from the tee connection for the two pipelines

(5) Relief valve sized to protect the downstream piping system and related equipment from exposure to pressures in excess of 50 percent higher than normal line pressure

(6) Any valves and other components necessary to allow ~~connection~~ testing, maintenance, and connection of an emergency supply of oxygen and isolation of the piping to the normal source of supply

(7) ~~Minimum of 1 m (3 ft) of clearance around the EOSC for connection of temporary auxiliary source~~

(8)

(9)* Four alarm connection points installed to both master alarm panels to allow the temporary supply to be monitored while in use

(10 Labeled as "Emergency Oxygen Supply Connection".

Additional Proposed Changes

File Name	Description	Approved
PC_97_-_99_HEA_PIP.pdf	99_PC#97	

Statement of Problem and Substantiation for Public Input

This Public Input appeared as “Reject but Hold” in Public Comment No.97 of the (A2023) Second Draft Report for NFPA 99 and per the Regs. at 4.4.8.3.1 and needs to be reconsidered by the TC for the next edition of the
document.

During the Covid-19 Pandemic when surges in oxygen demand were at their highest levels, the Emergency Oxygen Supply Connections (EOSC) was the most depended upon Oxygen System

auxiliary connection to add vital supplemental oxygen. This critical auxiliary connection allows for supplemental oxygen supplies such as portable oxygen bulk tank system trailers, temporary skid mounted bulk oxygen tanks systems, temporary microbulk oxygen supplies systems, portable liquid container systems, high pressure cylinder systems, to be connected into the Medical Oxygen Piped Utility System and support and enhance the patient respiratory treatment needs of the Facility. The EOSC is a vital part of the Medical Oxygen Utility System and the design, location, testing and maintenance of this auxiliary supply connection are important parts of the EOSC.
Testing and maintenance conducted on the EOSC needs to be conducted to keep the EOSC operating as needed when used. With most industry design configurations of the EOSC units, testing and maintenance can be a challenge. It is recommended that the Facility works with their Bulk Gas Supplier when testing and conducting maintenance on the EOSC. Any newly installed EOSC should take into consideration a means to test and maintain the EOSC. This will require additional components and designs of te EOSC.

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Submittal Date: Wed Jan 17 14:18:07 EST 2024
Committee: HEA-PIP

Public Comment No. 97-NFPA 99-2022 [Sections 5.1.3.5.12.1, 5.1.3.5.12.2]

Sections 5.1.3.5.12.1, 5.1.3.5.12.2

5.1.3.5.12.1

EOSCs shall be located as follows:

(1) Located 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

(3) Minimum of 1 m (3 ft) of clearance around the EOSC for connection of temporary auxiliary source

5.1.3.5.12.

~~2~~

2

EOSCs shall consist of the following:

(1) Physical protection to prevent unauthorized tampering

(2) Female DN (NPS) inlet for connection of the emergency oxygen source that is sized for 100 percent of the system demand at the emergency source gas pressure

(3) Manual shutoff valve to isolate the EOSC when not in use

(4) Two check valves, one downstream of the EOSC and one downstream of the main line shutoff valve, with both upstream from the tee connection for the two pipelines

(5) Relief valve sized to protect the downstream piping system and related equipment from exposure to pressures in excess of 50 percent higher than normal line pressure

(6) Any valves and other components necessary to allow testing, maintenance, and connection of an emergency supply of oxygen and isolation of the piping to the normal source of supply

(7) ~~Minimum of 1 m (3 ft) of clearance around the EOSC for connection of temporary auxiliary source~~

(8) * Four alarm connection points installed to both master alarm panels to allow the temporary supply to be monitored while in use

(9) Labeled as “Emergency Oxygen Supply Connection”.

Statement of Problem and Substantiation for Public Comment

During the Covid-19 Pandemic when surges in oxygen demand were at their highest levels, the Emergency Oxygen Supply Connections (EOSC) was the most depended upon Oxygen System auxiliary connection to add vital supplemental oxygen. This critical auxiliary connection allows for supplemental oxygen supplies such as portable oxygen bulk tank system trailers, temporary skid mounted bulk oxygen tanks systems, temporary microbulk oxygen supplies systems, portable liquid container systems, high pressure cylinder systems, to be connected into the Medical Oxygen Piped Utility System and support and enhance the patient respiratory treatment needs of the Facility. The

EOSC is a vital part of the Medical Oxygen Utility System and the design, location, testing and maintenance of this auxiliary supply connection are important parts of the EOSC.
Testing and maintenance conducted on the EOSC needs to be conducted to keep the EOSC operating as needed when used. With most industry design configurations of the EOSC units, testing and maintenance can be a challenge. It is recommended that the Facility works with their Bulk Gas Supplier when testing and conducting maintenance on the EOSC. Any newly installed EOSC should take into consideration a means to test and maintain the EOSC. This will require additional components and designs of te EOSC.

Related Item

• EOSC Task group and 1st Revision 1044

Submitter Information Verification

Submitter Full Name: Keith Ferrari
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Submittal Date: Fri May 27 13:44:25 EDT 2022
Committee: HEA-PIP

Committee Statement

Committee Action: Rejected but held
Resolution: The proposed revision is considered new material and will be held for the next revision cycle.

Public Input No. 172-NFPA 99-2024 [Section No. 5.1.3.5.14]

5.1.3.5.14* Auxiliary Connections.

All medical gas and vacuum systems shall be provided with a point of access for connection of a temporary or supplemental source of supply complying with 5.1.3.5.14.1 through 5.1.3.5.14.5.

5.1.3.5.14.1

~~The auxiliary connection shall be located~~

Auxiliary connections for cryogenic fluid central supply systems shall be the same size as the main line, and located immediately on the patient side of the source valve.

5.1.3.5.14.2

Auxiliary connections for systems other than cryogenic fluid central supply systems shall be located in the main line, on the patient side of the source valve, as determined by the responsible facility authority.

5.1.3.5.14.~~2~~ 3

~~The auxiliary connection shall~~ Auxiliary connections for systems other than cryogenic fluid central supply systems shall be the same size as the main line but not required to be larger than DN50 (NPS 2 in.).

5.1.3.5.14.~~3~~ 4

The auxiliary connection shall consist of a tee, valve, and removable plugged or capped connection point.

5.1.3.5.14.~~4~~ 5

The valve and connection point shall be labeled in accordance with 5.1.11.

5.1.3.5.14.~~5~~ 6

The valve shall be secured in accordance with 5.1.4.1.2.

Delete 5.1.4.10

Statement of Problem and Substantiation for Public Input

5.1.4.10 becomes redundant, as all systems would be covered in 5.1.3.5.14

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Submittal Date: Tue Apr 30 09:07:05 EDT 2024
Committee: HEA-PIP

Public Input No. 282-NFPA 99-2024 [Section No. 5.1.3.5.14 [Excluding any Sub-Sections]]

All medical gas and vacuum systems, except CO2, N2O, N2, & Instrument Air, shall be provided with a point of access for connection of a temporary or supplemental source of supply complying with 5.1.3.5.14.1 through 5.1.3.5.14.5.

Statement of Problem and Substantiation for Public Input

The likelihood that the auxiliary Valve would be required for CO2, N2O, N2, and Instrument Air creates an additional undo cost for the facilities. COVID19 highlighted the need for this requirement for O2, Med Air, and Vacuum. Even during COVID, the need for an auxiliary valve for these gases was not necessary.

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Submittal Date: Thu May 30 09:15:14 EDT 2024
Committee: HEA-PIP

Public Input No. 22-NFPA 99-2024 [Section No. 5.1.3.6.1]

5.1.3.6.1* Quality of Medical Air.

Medical air shall be required to have the following characteristics:

(1) ~~It shall be~~ Be supplied from cylinders, bulk containers, or medical air compressor sources, or it shall be reconstituted from oxygen USP and oil-free, dry nitrogen NF.

(2) ~~It shall meet~~ Meet the requirements of medical air USP.

(3) ~~It shall have~~ Have no detectable liquid hydrocarbons.

(4) ~~It shall have~~ Have less than 25 ppm gaseous hydrocarbons.

(5) ~~It shall have~~ Have equal to or less than 1 mg/m^3 (6.85×10^{-7} lb/yd^3) of permanent particulates sized 1 micron or larger in the air at normal atmospheric pressure.

Statement of Problem and Substantiation for Public Input

The proposed change removes redundant text for clarity

Submitter Information Verification

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Submittal Date: Sat Jan 13 15:29:04 EST 2024
Committee: HEA-PIP

Public Input No. 23-NFPA 99-2024 [Section No. 5.1.3.6.3.6]

5.1.3.6.3.6 Medical Air Receivers.

Receivers for medical air shall meet the following requirements:

(1) ~~They shall be~~ Be made of corrosion-resistant materials or otherwise be made corrosion resistant.

(2) ~~They shall comply~~ Comply with Section VIII, “Unfired Pressure Vessels,” of the ASME *Boiler and Pressure Vessel Code.*

(3) ~~They shall be~~ Be equipped with a pressure relief valve, automatic drain, manual drain, sight glass, and pressure indicator.

(4) ~~They shall be~~ Be of a capacity sufficient to prevent the compressors from short-cycling.

Statement of Problem and Substantiation for Public Input

The proposed change removes redundant text for clarity

Submitter Information Verification

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Submittal Date: Sat Jan 13 15:32:30 EST 2024
Committee: HEA-PIP

Public Input No. 286-NFPA 99-2024 [Section No. 5.1.3.7.2]

5.1.3.7.2 Vacuum Pumps.

Medical-Surgical Vacuum systems shall be connected to the Medical-Surgical Vacuum gas distribution system only and shall be used only for Medical-Surgical Vacuum as a source of drainage, aspiration and suction in order to remove body fluids from patients, in the calibration of medical devices for respiratory application, and in simulation centers for the education, training and assessment of health care professionals in accordance with 5.1.3.7.2.

5. 1.3.7.2.1

Vacuum pumps shall be constructed of materials deemed suitable by the manufacturer.

5.1.3.7.2.2

Antivibration mountings shall be installed for vacuum pumps as required by equipment dynamics or location and in accordance with the manufacturer's recommendations.

5.1.3.7.2.3

Flexible connectors shall connect the vacuum pumps with their intake and outlet piping.

5.1.3.7.2.4

For liquid ring vacuum pumps, seal water shall be of a quality recommended by the vacuum pump manufacturer.

Statement of Problem and Substantiation for Public Input

This clarifies the allowable applications for medical vacuum and provides certifiers / verifiers with a clear irrefutable code statement available to be cited in their reports.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 288-NFPA 99-2024 [Section No. 5.1.3.8.2]	similar paragraph for WAGD
Public Input No. 288-NFPA 99-2024 [Section No. 5.1.3.8.2]	

Submitter Information Verification

Submitter Full Name: James Lucas
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Submittal Date: Thu May 30 14:11:16 EDT 2024
Committee: HEA-PIP

Public Input No. 24-NFPA 99-2024 [Section No. 5.1.3.7.3]

5.1.3.7.3 Vacuum Receivers.

Receivers for vacuum shall meet the following requirements:

(1) ~~They shall be~~ Be made of materials deemed suitable by the manufacturer.

(2) ~~They shall comply~~ Comply with Section VIII, “Unfired Pressure Vessels,” of the ASME *Boiler and Pressure Vessel Code.*

(3) ~~They shall be~~ Be capable of withstanding a gauge pressure of 415 kPa (60 psi) and 760 mm (30 in.) gauge HgV.

(4) ~~They shall be~~ Be equipped with a manual drain.

(5) ~~They shall be~~ Be of a capacity based on the technology of the pumps.

Statement of Problem and Substantiation for Public Input

The proposed change removes redundant text for clarity

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Submittal Date: Sat Jan 13 15:37:40 EST 2024
Committee: HEA-PIP

Public Input No. 458-NFPA 99-2024 [Section No. 5.1.3.8.1.2]

5.1.3.8.1.2

If WAGD is produced by the medical–surgical vacuum source, the following shall apply:

(1) The medical–surgical vacuum source shall comply with 5.1.3.7.

(2) The total concentration of oxygen shall be maintained below a miximum of 23.~~6 percent~~ 5 percent unless one of the following conditions is met:

(3) The vacuum pump complies with 5.1.3.8.2.1 .

(4) The combined medical–surgical vacuum/WAGD system is monitored for oxygen and an alarm will initiate at all master alarm panels if the oxygen concentration exceeds 23.

~~6 percent~~

(a) 5 percent .

(5) The medical–surgical vacuum source shall be sized to accommodate the additional volume.

Statement of Problem and Substantiation for Public Input

This change corrects the oxygen concentration reference to align with the definition of an oxygen enriched atmosphere, which is the basis for the requirement.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 460-NFPA 99-2024 [Section No. 5.1.9.2.4]	

Submitter Information Verification

Submitter Full Name: Jonathan Willard
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Submittal Date: Tue Jun 04 15:51:47 EDT 2024
Committee: HEA-PIP

Public Input No. 288-NFPA 99-2024 [Section No. 5.1.3.8.2]

5.1.3.8.2 WAGD Producers.

Waste Anesthetic Gas Disposal (WAGD) systems shall be connected to the medical gas distribution system only and shall be used only for Waste Anesthetic Gas Disposal (WAGD) in the process of capturing and carrying away gases vented from the patient breathing circuit during the normal operation of gas anesthesia or analgesic equipment, in the calibration of medical devices for respiratory application, and in simulation centers for the education, training and assessment of health care professionals in accordance with 5.1.3.8.2.

5. 1.3.8.2.1

Vacuum pumps dedicated for WAGD service shall be as follows:

(1) Compliant with 5.1.3.7.2

(2) Designed of materials and using lubricants and sealants that are inert in the presence of oxygen, nitrous oxide, and halogenated anesthetics

5.1.3.8.2.2

Vacuum producers (e.g., fans or blowers) designed for operation at vacuums below 130 mm (5 in.) HgV shall be as follows:

(1) Permitted to be made of any materials determined by the manufacturer as suitable for the service

(2) Provided with antivibration mountings as required by equipment dynamics or location and in accordance with the manufacturer's recommendation

(3) Connected with their intake and outlet piping through flexible connections

(4) Used only for WAGD service and not employed for other services

(5) Interconnected via piping, ductwork, and so forth, made of materials determined by the manufacturer as suitable to the service

Statement of Problem and Substantiation for Public Input

This clarifies the allowable applications for medical WAGD and provides certifiers / verifiers with a clear irrefutable code statement available to be cited in their reports.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 286-NFPA 99-2024 [Section No. 5.1.3.7.2]	similar paragraph content
Public Input No. 286-NFPA 99-2024 [Section No. 5.1.3.7.2]	

Submitter Information Verification

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Submittal Date:	Thu May 30 14:20:36 EDT 2024
Committee:	HEA-PIP

Public Input No. 166-NFPA 99-2024 [Section No. 5.1.3.8.2.1]

5.1.3.8.2.1

Vacuum pumps dedicated for WAGD service shall be as follows:

(1) Compliant with 5.1.3.7.2 and;

(2) Designed of materials and using lubricants and sealants that are inert in the presence of oxygen, nitrous oxide, and halogenated anesthetics in the concentrations to which they can be exposed.

Statement of Problem and Substantiation for Public Input

The addition of "concentrations to which they can be exposed" recognizes that if the test were made with pure oxygen, almost no pump could pass. But that was never the intention here. Safe for the service has always been the intent of this clause, and the manufacturer should evaluate any given machine in light of it's design to determine it's suitability and advise the designer accordingly.

Submitter Information Verification

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Submittal Date: Tue Apr 30 08:30:43 EDT 2024
Committee: HEA-PIP

Public Input No. 25-NFPA 99-2024 [Section No. 5.1.3.9.1.13]

5.1.3.9.1.13

The oxygen concentrator supply source shall be provided with an oxygen concentration monitor with the following characteristics:

(1) ~~The monitor shall be~~ Be capable of monitoring 99 percent oxygen concentration with 1 percent accuracy.

(2) ~~The monitor shall continuously~~ Continuously display the oxygen concentration and activate the local alarm and master alarms in accordance with 5.1.3.9.5 when a concentration lower than 91 percent is observed.

(3) ~~The monitor shall continuously~~ Continuously display the oxygen concentration.

(4) ~~The monitor shall be~~ Be permitted to be inserted into the pipeline without a demand check.

Statement of Problem and Substantiation for Public Input

The proposed change removes redundant text for clarity

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Submittal Date: Sat Jan 13 15:42:51 EST 2024
Committee: HEA-PIP

Public Input No. 409-NFPA 99-2024 [Section No. 5.1.3.9.3]

5.1.3.9.3 Arrangement and Redundancies.

An oxygen central supply system using a concentrator(s) shall be permitted to consist of two or three supply sources, as follows:

(1) If two or more supply sources are provided, the following shall apply:

(2) ~~One source shall be an oxygen concentrator supply source.~~

(3) ~~The second source shall be a cylinder header complying with 5.1.3.5.9 with sufficient cylinder connections for one average day's supply.~~

(4) ~~Containers shall not be used as a supply source.~~

(5) ~~If three supply sources are provided, the following shall apply:~~

(6) ~~Each source shall be capable of independently supplying the full system demand in the event of the unavailability of one or both of the other sources.~~

(7) ~~Each source shall be permitted to be either of the following:~~

(8) ~~An oxygen concentrator supply source complying with 5.1.3.9.1~~

(9) ~~A cylinder header complying with 5.1.3.5.9 with sufficient cylinder connections for one average day's supply~~

~~Containers shall not be used as a supply source.~~

(10)

i. ~~A Cryogenic Fluid Central Supply System that meet 5.1.3.5.11 or 5.1.3.10 requirements.~~

(11) Use of oxygen concentrator supply systems as all three sources shall only be permitted after a documented risk analysis by the governing authority of the health care facility indicates an understanding of the inherent risks and defines how those risks will be mitigated.

(12) An isolation valve and automatic check valve shall be provided to isolate each of the three sources from the others and from the pipeline. The valves in 5.1.3.5.9(4), 5.1.3.5.9(6), 5.1.3.9.1.11, and 5.1.3.9.1.12 shall be permitted to be used for this purpose.

(13) Each of the three supply sources shall be provided with a pressure relief valve complying with 5.1.3.5.6 on the source side of its respective isolating valve.

(14) The three supply sources shall join to the pipeline systems through control arrangements with at least the following characteristics:

(a) The control arrangements shall be able to maintain stable pressures within the limits of Table 5.1.11.

(b) The control arrangements shall be able to flow 100 percent of the peak calculated demand.

(c) The control arrangements shall be redundant, such that each component of the control mechanism can be isolated for service or replacement while maintaining normal operation.

(d) The cascade of sources shall comply with 5.1.3.9.4.

(e) The system shall be protected against overpressure *(see 5.1.3.5.6)*.

(15) A pressure relief valve shall be provided in the common line between the sources and the line pressure controls.

(16) A source valve in accordance with 5.1.4.2 shall be provided on the patient side of the line pressure controls.

(17) A gauge and switch or sensor shall be located between the three sources and the line pressure controls to monitor the pressure feeding the line pressure controls.

(18) An oxygen concentration monitor, sampling the gas on the patient side of the line pressure controls and on the source side of the source valve, shall be provided with the following characteristics:

(a) The monitor shall be capable of monitoring 99 percent oxygen concentration with ±1.0 percent accuracy.

(b) The monitor shall be attached to the pipeline through a demand check in accordance with 5.1.8.2.3.

(c) The monitor shall continuously display the oxygen concentration and activate the local alarm and master alarms when an oxygen concentration lower than 91 percent is observed.

(19) A DN8 (NPS ¼) valved sample port shall be provided on the patient side of the line pressure controls and source side of the source valve for sampling the oxygen.

(20) An auxiliary source connection complying with 5.1.4.10 shall be provided.

(21) Electrical installation and wiring shall conform to the requirements of *NFPA 70*.

(22) Emergency electrical service for all components of the oxygen supply system shall conform to the requirements of the essential electrical system as described in Chapter 6.

Statement of Problem and Substantiation for Public Input

Any Oxygen (or Nitrogen) Central Supply System as defined by 5.1.3.3.1.1 and 5.1.3.3.1.2 should be permitted to be used as an alternative source and deemed appropriate. Remote locations are especially vulnerable to these restrictions currently being enforced by this section which has a negative safety impact.

Submitter Information Verification

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Submittal Date: Mon Jun 03 18:18:11 EDT 2024
Committee: HEA-PIP

Public Input No. 440-NFPA 99-2024 [Section No. 5.1.3.10.1.1]

5.1.3.10.1.1*

~~The storage, use, and handling of cryogenic~~ Cryogenic fluid central supply systems that deliver compressed medical gases (CMGs) to health care facilities shall be in accordance with the requirements of this section. [**55:**17.1.1]

Statement of Problem and Substantiation for Public Input

This change has also been submitted to NFPA 55 committee. The NFPA 99/55 storage task group identified that this language needs to be changed. There is really no storage, use and handling of these bulk systems.

Submitter Information Verification

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Submittal Date: Tue Jun 04 13:36:02 EDT 2024
Committee: HEA-PIP

Public Input No. 442-NFPA 99-2024 [Section No. 5.1.3.10.1.2(A)]

~~(A)~~ –

~~The source valve shall be the line separating the applicability between NFPA 55 and this code.~~
[**~~55:~~** ~~17.1.2.1~~]

Statement of Problem and Substantiation for Public Input

Item (A) creates confusion with the intent of Item (B) which provides more clarity of the intent of the applicability and the point of demarcation where NFPA 55 jurisdiction ends.

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Committee: HEA-PIP

Public Input No. 299-NFPA 99-2024 [Section No. 5.1.3.10.3.4]

5.1.3.10.3.4

Bulk cryogenic liquid sources shall include automatic means to provide the following functions:

(1) When the ~~main~~ primary supply is supplying the system, the reserve supply shall be prevented from supplying the system until the ~~main supply~~ primary supply is reduced to a level at or below the reserve activation pressure.

(2) When the ~~main~~ primary 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~~ are two or more supply vessels interconnected and operating as one primary supply, the following shall apply:

(4) A reserve supply that automatically begins to supply the system, when the primary supply cannot supply the system.

(5) *Multiple vessels are manifolded together to operate as one primary supply system A.16.3.4(3)(b)

Vessels of different full level elevations may be manifolded together only after completing an engineering evaluation and implementing its results, including any engineering controls required.

(6) The full liquid level of each vessel is at the same elevation to prevent overfilling and relief valve malfunction

(7) Where there is one primary supply vessel, one secondary supply vessel, and one reserve supply, the system shall operate as follows for primary, secondary, and reserve operation:

~~If provided with two liquid container headers, one~~

(a) One cryogenic liquid ~~header~~

(b) vessel shall be the primary and the other shall be the secondary, with either being capable of either role.

(c) ~~If provided with one liquid container header and one gas cylinder header (i.e., a hybrid arrangement), the liquid container header shall be the primary and the gas cylinder header shall be the secondary.~~

(d) When the primary ~~header is~~ supply is supplying the system, the secondary ~~header~~ supply and reserve supply shall be prevented from supplying the system.

(e) When the primary ~~header~~ supply is depleted, the secondary ~~header~~ supply shall automatically begin to supply the system.

(f) The reserve supply shall automatically begin to supply the system when the primary supply and secondary supply cannot supply the system.

(g) 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, provided that an operating cascade (i.e., primary–secondary–reserve) is maintained at all times.

(8) 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.

[~~**55:** 17.3.4~~]

(1)

Statement of Problem and Substantiation for Public Input

Terms such as "Primary" instead of "Main" and "Supply" verses "Header" are changed to harmonizes with Chapter 5 language related to cryogenic systems.

Item 3 was added new to this section for clarity to allow an industry practice of joining to cryogenic vessels together to act as one supply. Existing sections did not seem to describe this type of installation.
Item 4 (d) was added for clarity to define the operation of the reserve supply for this section.

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Committee: HEA-PIP

Public Input No. 297-NFPA 99-2024 [New Section after 5.1.3.10.9]

TITLE OF NEW CONTENT

5.1.3.10.9.1 Final line pressure regulators complying with 5.1.3.5.5 Controls for Line Pressure

Statement of Problem and Substantiation for Public Input

The Cryogenic Fluid Central Supply System section does not point back to the final line pressure regulators section of the code. This lack of information has caused some designer of this system to assume that the controls are on the tanks or handled inside the facility. Drawings have shown bulk tanks, vaporizers with interconnecting piping going directly to the source valve without any line controls.

Under the Medical Air Proportioning Supply Sources section 5.1.3.6.3.14 C(10), this code section spells out that the final line pressure regulators must include and comply with section 5.1.3.5.5

"5.1.3.10.9.1 Final line pressure regulators complying with 5.1.3.5.5 Controls for Line Pressure"

Submitter Information Verification

Submitter Full Name: Keith Ferrari
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Submittal Date: Thu May 30 15:45:42 EDT 2024
Committee: HEA-PIP

Public Input No. 222-NFPA 99-2024 [Section No. 5.1.4.1.6]

5.1.4.1.6 Valve Types.

New or replacement valves shall be permitted to be of any type as long as they meet the following conditions:

(1) They have a minimum Cv factor in accordance with either Table 5.1.4.1.6(a) or Table 5.1.4.1.6(b).

(2) They use a quarter turn to off.

(3) They are constructed of materials suitable for the service.

(4) They are provided with

(5) copper tube extensions by the manufacturer for brazing or

~~with~~

(a)

(b) corrugated medical tubing (CMT) fittings or

(c) supplied with joints defined in section 5 . 1.10.3.1 sub paragraphs 1-4

(6) They indicate to the operator if the valve is open or closed.

(7) They permit in-line serviceability.

(8) They are cleaned for oxygen service by the manufacturer if used for any positive-pressure service.

(9) They have threaded purge ports on the patient side and the source side.

(10) They have a minimum working pressure equal to or greater than the relief valve protecting the piping system on which the valve is installed for any positive-pressure service.

(11) Seals necessary for the operation of the valve and prevention of leaks comply with 5.1.3.5.4 and are replaceable.

Table 5.1.4.1.6(a) Positive-Pressure Gases

Valve Size (in.)	Minimum Cv (full open)
½	17
¾	31
1	60
1¼	110
1½	169
2	357
2½	390
3	912
4	1837

Table 5.1.4.1.6(b) Vacuum and WAGD

Valve Size (in.)	Minimum Cv (full open)
½	17
¾	31
1	60
1¼	110

Valve Size (in.)	Minimum Cv (full open)
1½	169
2	357
2½	196
3	302
4	600
5	1022
6	1579
8	3136

Statement of Problem and Substantiation for Public Input

Adding in accepted technology (axial swaged) to valves for joint connection. Appears to be inadvertently not included in the past version.

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Committee: HEA-PIP

Public Input No. 26-NFPA 99-2024 [Section No. 5.1.4.1.6]

5.1.4.1.6 Valve Types.

New or replacement valves shall be permitted to be of any type as long as they meet the following conditions:

(1) ~~They have~~ Have a minimum Cv factor in accordance with either Table 5.1.4.1.6(a) or Table 5.1.4.1.6(b).

(2) ~~They use~~ Use a quarter turn to off.

(3) ~~They are~~ Are constructed of materials suitable for the service.

(4) ~~They are~~ Are provided with copper tube extensions by the manufacturer for brazing or with corrugated medical tubing (CMT) fittings.

(5) ~~They indicate~~ Indicate to the operator if the valve is open or closed.

(6) ~~They permit~~ Permit in-line serviceability.

(7) ~~They are~~ Are cleaned for oxygen service by the manufacturer if used for any positive-pressure service.

(8) ~~They have~~ Have threaded purge ports on the patient side and the source side.

(9) ~~They have~~ Have a minimum working pressure equal to or greater than the relief valve protecting the piping system on which the valve is installed for any positive-pressure service.

(10) Seals necessary for the operation of the valve and prevention of leaks comply with 5.1.3.5.4 and are replaceable.

Table 5.1.4.1.6(a) Positive-Pressure Gases

Valve Size (in.)	Minimum Cv (full open)
½	17
¾	31
1	60
1¼	110
1½	169
2	357
2½	390
3	912
4	1837

Table 5.1.4.1.6(b) Vacuum and WAGD

Valve Size (in.)	Minimum Cv (full open)
½	17
¾	31
1	60
1¼	110
1½	169
2	357
2½	196
3	302
4	600

Valve Size (in.)	Minimum Cv (full open)
5	1022
6	1579
8	3136

Statement of Problem and Substantiation for Public Input

The proposed change removes redundant text for clarity

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Committee: HEA-PIP

Public Input No. 170-NFPA 99-2024 [Section No. 5.1.4.6]

5.1.4.6 Zone Valves.

5.1.4.6.1

All station outlets/inlets , including those in gas delivery columns, hose reels, ceiling tracks, control panels, pendants, booms, or other special installations shall be supplied through a zone valve

, which shall be placed as follows: It is installed so that a wall

.

5.1.4.6.2 Each Category 1 patient care space and each Category 2 and 3 patient care space intended as an anesthetising location shall be provided with zone valves only controlling that patient care space.

5.1.4.6.3 Zone valves shall be located in a manner which will satisfy the following tests:

(1)* A physical separation intervenes between the valve and the outlets/inlets that it controls.

*

Physical separation may include any combination of:

(a) walls, provided they reach floor to ceiling or deck to deck;

(b) doors which can be closed, including fully or partially glass doors;

(c) non-operable windows

(d) glass enclosures, provided they reach floor to ceiling or deck to deck;

(2) It is readily operable from a standing position

;

*

(3) It is

installed where it is

visible

and accessible

at all times.

It is

and not installed where it can be hidden from plain view, such as behind normally open or normally closed doors

;

(4) It is accessible at all times and not installed in

a room with the station outlets/inlets that it controls.It is not installed in

rooms, areas, or closets that can be closed or locked

;

~~5.1.4.6.2 * –~~

~~A zone valve in each medical gas and vacuum line shall be provided for each Category 1 space and be located as follows:~~

(1) ~~In patient care spaces that are not anesthetizing locations, they shall be installed immediately outside the area or zone being controlled.~~

(2) ~~In anesthetizing locations, they shall be installed immediately outside each room.~~

(5) It is located near the egress to the controlled patient care space which will be used by the staff for evacuating patients in event of emergency (the primary egress). Where more than one such egress is available, any of them may be designated as the primary egress for this purpose.

(6) The primary egress is visible when in the normal position to operate that zone valve.

5.1.4.6.

~~3~~
4

Piping on the patient side of zone valves shall be arranged to provide the following:

(1) Shutting off the supply of medical gas or vacuum to one zone will not affect the supply of medical gas or vacuum to another zone or the rest of the system.

~~Service will only be to~~

(2) Zone valves only control outlets/inlets located on

~~that~~

the same

~~story.All gas delivery columns, hose reels, ceiling tracks, control panels, pendants, booms, or other special installations are located on the patient side of the zone~~

building story as the valve.

5.1.4.6.

~~4~~
5

(1) Zone valves shall be installed in valve boxes with removable covers large enough to allow manual operation and service of valves;

(2) Covers shall be rapidly removable or openable to access the valves in the event of emergency;

(3) When any valve in the zone valve box is in the closed position, the cover shall not close or be replaceable;

(4) A pressure/vacuum indicator shall be provided on the

~~station outlet/inlet~~

patient side of each zone valve ;

(5)* Where needed to prevent inappropriate access, zone valves shall be permitted to be secured and exempt from 5 . 1.4.6.5 (2) and (3) with the approval of the authority having jurisdiction.

5.1.4.6.6 Flammable Gases.

Valves for nonflammable medical gases shall not be installed with valves for flammable gases in the same zone valve box.

Additional Proposed Changes

File Name	Description	Approved

5.1.4.6.docx text to ensure readability

Statement of Problem and Substantiation for Public Input

(1) General: The zone valve section has become somewhat confused over the last few cycles. The proposal attempts to improve the overall flow and remove some redundancies.
(2) Proposed 5.1.4.6.2: With removal of the requirement that general anesthesia and deep sedation must be performed in Category 1 (NFPA 99 2021 5.1.1.2), it is necessary to allow for Category 2 and 3 anesthetizing locations
(3) Proposed 5.1.4.6.3 (1) : The location for zone valves has proven quite problematic in the field. Interpretations of the rules (some exceedingly creative) have obscured the basic concept. The proposal is an attempt to restore a degree of precision to the process based on the basic idea of simply separating people from the likely problem(s). New annex text is also proposed.
(4) Proposed 5.1.4.6.3 (5) & (6) : The current wording of 5.1.4.6.2 is vague and has produced disputes because of the lack of definition in the terms. The proposed language changes the approach from stating a requirement to providing tests which can be used to achieve the desired result and evaluate compliance.

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Submittal Date: Tue Apr 30 08:40:47 EDT 2024
Committee: HEA-PIP

Reword 5.1.4.6 to read:

5.1.4.6 Zone Valves

5.1.4.6.1 All station outlets/inlets, including those in gas delivery columns, hose reels, ceiling tracks, control panels, pendants, booms, or other special installations shall be supplied through a zone valve.

5.1.4.6.2 Each Category 1 patient care space and each Category 2 and 3 patient care space intended as an anesthetising location shall be provided with zone valves only controlling that patient care space.

5.1.4.6.3 Zone valves shall be located in a manner which will satisfy the following tests:

(1)* A physical separation intervenes between the valve and the outlets/inlets that it controls. Physical separation may include any combination of:
(a) walls, provided they reach floor to ceiling or deck to deck;
(b) doors which can be closed, including fully or partially glass doors;
(c) non-operable windows
(d) glass enclosures, provided they reach floor to ceiling or deck to deck;
(2) It is readily operable from a standing position;
(3) It is visible at all times. and not installed where it can be hidden from plain view, such as behind normally open or normally closed doors;
(4) It is accessible at all times and not installed in rooms, areas, or closets that can be closed or locked;
(5) It is located near the egress to the controlled patient care space which will be used by the staff for evacuating patients in event of emergency (the primary egress). Where more than one such egress is available, any of them may be designated as the primary egress for this purpose.
(6) The primary egress is visible when in the normal position to operate that zone valve.

5.1.4.6.4
Piping on the patient side of zone valves shall be arranged to provide the following:
(1) Shutting off the supply of medical gas or vacuum to one zone will not affect the

supply of medical gas or vacuum to another zone or the rest of the system.
(2) Zone valves only control outlets/inlets located on the same building story as the valve.

5.1.4.6.5
(1) Zone valves shall be installed in valve boxes with removable covers large enough to allow manual operation and service of valves;
(2) Covers shall be rapidly removable or openable to access the valves in the event of emergency;
(3) When any valve in the zone valve box is in the closed position, the cover shall not close or be replaceable;
(4) A pressure/vacuum indicator shall be provided on the patient side of each zone valve;
(5)* Where needed to prevent inappropriate access, zone valves shall be permitted to be secured and exempt from 5.1.4.6.5 (2) and (3) with the approval of the authority having jurisdiction.

5.1.4.6.6 Flammable Gases.
Valves for nonflammable medical gases shall not be installed with valves for flammable gases in the same zone valve box.

Public Input No. 27-NFPA 99-2024 [Section No. 5.1.4.6.1]

5.1.4.6.1

All station outlets/inlets shall be supplied through a zone valve, which shall be placed as follows:

(1) ~~It is installed~~ Installed so that a wall intervenes between the valve and the outlets/inlets that it controls.

(2)* ~~It is readil~~R eadily operable from a standing position.

(3)* ~~It is installed~~ Installed where it is visible and accessible at all times.

(4) ~~It is not~~ Not installed where it can be hidden from plain view, such as behind normally open or normally closed doors.

(5) ~~It is not~~ Not installed in a room with the station outlets/inlets that it controls.

(6) ~~It is not~~ Not installed in rooms, areas, or closets that can be closed or locked.

Statement of Problem and Substantiation for Public Input

The proposed change removes redundant text for clarity

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Submittal Date: Sat Jan 13 15:53:17 EST 2024
Committee: HEA-PIP

Public Input No. 177-NFPA 99-2024 [Section No. 5.1.4.6.2]

5.1.4.6.2*

A zone valve in each medical gas and vacuum line shall be provided for each Category 1 space and be ~~located as follows:In patient care spaces that are not anesthetizing locations, they shall be installed~~ located immediately outside the ~~area or zone~~ patient care space being controlled . ~~In anesthetizing locations, they shall be installed immediately outside each room.~~ (see 5.1.3).

Statement of Problem and Substantiation for Public Input

See proposal 176, to which this is tied.
We have traditionally alarmed and valved areas like intensive care as multiple patient areas, and anesthetising locations as single patient spaces. Experience demonstrates that this is been both effective and economical. In previous editions, this practice was supported by the interaction of the "anesthetising location" definition and the use of the term "critical care and vital life support" when referring to other areas where valves and alarms were wanted.
However, "critical care and vital life support" has been replaced by Category 1, which clearly encompasses both anesthetising locations and areas with highly dependent patients. We have therefore lost the underpinning that supported our traditional practice.
The definition of a patient care space uses "patients", so it does not explicitly support this practice, but neither does it prohibit it. Beyond this, there is nowhere in the standard where it is clear how to evaluate that definition in light of 5.1.4.6.2 and 5.1.9.4.
By including this method of defining the patient care space for the purposes of this chapter, both 5.1.4.6.2. and 5.1.9.4 can be simplified.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 176-NFPA 99-2024 [New Section after 5.1.3]	
Public Input No. 176-NFPA 99-2024 [New Section after 5.1.3]	
Public Input No. 178-NFPA 99-2024 [Section No. 5.1.9.4 [Excluding any Sub-Sections]]	

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Submittal Date: Tue Apr 30 09:30:52 EDT 2024
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Public Input No. 215-NFPA 99-2024 [Section No. 5.1.4.8.2]

5.1.4.8.2

Downstream piping shall be closed with a brazed cap with tubing allowance for cutting and rebrazing.

Downstream piping shall be closed with a cap defined in section 5.1.10.3.1 sub paragraphs 1-4.

Statement of Problem and Substantiation for Public Input

Adding in accepted technology (axial swaged) to valves for joint connection. Appears to be inadvertently not included in the past version.

Submitter Information Verification

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Submittal Date: Tue May 14 15:41:21 EDT 2024
Committee: HEA-PIP

Public Input No. 14-NFPA 99-2024 [Section No. 5.1.4.9]

5.1.4.9 In-Line Check Valves.

New or replacement check valves shall be as follows:

(1) ~~They shall be of brass~~ Brass or bronze construction.

(2) ~~They shall have~~ Have brazed extensions.

(3) ~~They shall have~~ Have in-line serviceability.

(4) ~~They shall~~ Shall not have threaded connections.

(5) ~~They shall have~~ Have threaded purge points of ⅛ in. NPT.

(6) ~~They shall be~~ Be sized to have a maximum velocity which does not exceed the manufacturer's recommendations.

Statement of Problem and Substantiation for Public Input

The proposed change removes redundant text for clarity

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Submittal Date: Fri Jan 12 16:30:25 EST 2024
Committee: HEA-PIP

Public Input No. 216-NFPA 99-2024 [Section No. 5.1.4.9]

5.1.4.9 In-Line Check Valves.

New or replacement check valves shall be as follows:

(1) They shall be of brass or bronze construction.

(2) They shall have either brazed extensions or be supplied with joints defined in section 5 .1.10.3.1 sub paragraphs 1-4

(3) They shall have in-line serviceability.

(4) They shall not have threaded connections.

(5) They shall have threaded purge points of ⅛ in. NPT.

(6) They shall be sized to have a maximum velocity which does not exceed the manufacturer's recommendations.

Statement of Problem and Substantiation for Public Input

Adding in accepted technology (axial swaged) to valves for joint connection. Appears to be inadvertently not included in the past version.

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Submittal Date: Tue May 14 15:43:43 EDT 2024
Committee: HEA-PIP

Public Input No. 126-NFPA 99-2024 [Section No. 5.1.4.10]

~~**5.1.4.10** – Auxiliary Source Connection.~~

~~All cryogenic fluid central supply systems shall be provided with an auxiliary source connection point of the same size as the main line, which shall be located immediately on the patient side of the source valve.~~

~~**5.1.4.10.1** –~~

~~The connection shall consist of a tee, a valve, and a removable plug or cap.~~

~~**5.1.4.10.2** –~~

~~The auxiliary source connection valve shall be normally closed and secured.~~

Statement of Problem and Substantiation for Public Input

The 5.1.4.10 Auxiliary Source Connection reference conflicts with 5.1.3.5.14 Auxiliary Connections reference. The material under 5.1.4.10 is also mostly redundant since the addition of 5.1.3.5.14 in the 2024 edition of NFPA 99. These two references are practically referring to the same thing.
Conflicts:

5.1.3.5.14 requires the connection be the same size as the main line but no larger than 2" NPS
5.1.4.10 requires the connection be the same size as the main line with no size limit

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Public Input No. 76-NFPA 99-2024 [New Section after 5.1.5.2]

Inlet requirements

5.1.5.2 . Unless specifically designed to accept the additional weight, station inlets shall support only regulators and incidental tubing.

5.1.5.2.1 Canisters or accessories shall be secured without adding weight or stress to the station inlet.

Additional Proposed Changes

File Name	Description	Approved
medvacinlet.pdf	Medical vacuum inlet overloaded	

Statement of Problem and Substantiation for Public Input

When devices are utilized to eliminate the torque placed upon the station inlets do not remain aligned with the wall, damage to the station inlet will result over time. This problem can be eliminated by requiring the manufacturers to either design and manufacture their devices to overcome these forces or alternatively by eliminating the possibility to place these forces on the station inlet.

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Committee: HEA-PIP

Public Input No. 15-NFPA 99-2024 [Section No. 5.1.5.15]

5.1.5.15

Station outlets in systems having nonstandard operating pressures shall meet the following additional requirements:

(1) ~~They shall be~~ Be gas-specific.

(2) ~~They shall be~~ Be pressure-specific where a single gas is piped at more than one operating pressure [e.g., a station outlet for oxygen at 550 kPa (80 psi) shall not accept an adapter for oxygen at 345 kPa (50 psi)].

(3) If operated at a pressure in excess of 550 kPa (80 psi), they shall be either D.I.S.S. connectors or comply with 5.1.5.15(4).

(4) If operated at a gauge pressure between 1380 kPa and 2070 kPa (200 psi and 300 psi), the station outlet shall be designed so as to prevent the removal of the adapter until the pressure has been relieved to prevent the adapter injuring the user or others when removed from the outlet.

Statement of Problem and Substantiation for Public Input

The proposed change removes redundant text for clarity

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Submittal Date: Fri Jan 12 16:34:59 EST 2024
Committee: HEA-PIP

Public Input No. 427-NFPA 99-2024 [Section No. 5.1.5.16 [Excluding any Sub-Sections]]

WAGD networks shall provide a WAGD inlet in all ~~locations~~ Anesthetizing Locations where nitrous oxide or halogenated anesthetic gas is intended to be administered for deep sedation or general anesthesia . Scavenging shall be allowed through Vacuum Inlets where minimal and moderate sedation are being provided.

Statement of Problem and Substantiation for Public Input

The current code does not take into consideration that a hospital (or other medical facility) has various types of treatment areas within the same facility. Nitrous oxide and oxygen are more and more commonly being used in procedural areas for pain management and minimal sedation. This includes the emergency department, radiology, oncology, burn unit, labor and delivery, and various pediatric applications. The benefits to the facility and patients that have access to nitrous oxide and oxygen for minimal sedation / pain management are very impactful and allow for an appropriate level of sedation (versus using more sedation than needed).

A WAGD inlet is typically exclusive to areas of the facility that are performing surgeries and/or invasive procedures that require deep sedation / general anesthesia. Standard patient rooms do not have WAGD inlets. Scavenging should be allowed through a Vacuum inlet. The WAGD and VAC inlets both tie together and go through the same pipeline to the same vacuum source - and exhaust the same exact way out of the facility. The only parameter is that the vacuum itself is compliant for oxygen and nitrous oxide. That is covered in the Vacuum section of NFPA 99.

If Scavenging through a Vacuum inlet is not safe - why is it allowed in Dental? The same allowance should apply in a medical facility and can be explained through the definition of Scavenging.

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Committee: HEA-PIP

Public Input No. 16-NFPA 99-2024 [Section No. 5.1.5.16.1]

5.1.5.16.1

Station inlets for WAGD service shall have the following additional characteristics:

(1) ~~They shall not~~ Not be interchangeable with any other systems, including medical–surgical vacuum.

(2) Components necessary for the maintenance of WAGD specificity shall be legibly marked to identify them as components of a WAGD inlet.

(3) ~~They shall be~~ Be of a type appropriate for the flow and vacuum level required by the facility's gas anesthetic machines.

(4) ~~They shall be~~ Be located to avoid physical damage to the inlet.

Statement of Problem and Substantiation for Public Input

The proposed change removes redundant text for clarity

Submitter Information Verification

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Submittal Date: Fri Jan 12 16:37:19 EST 2024
Committee: HEA-PIP

Public Input No. 397-NFPA 99-2024 [Section No. 5.1.6.3]

5.1.6.3

The leakage from a completed manufactured assembly shall not exceed 0.~~006 cm~~ 06 cm ^{3}/sec (0.~~00037 in~~ 0037 in $.^3$/sec) when tested at 20 percent above operating pressure for pressure pipelines and shall not exceed 0.~~002 cm~~ 02 cm ^{3}/sec (0.~~00012 in~~ 0012 in $.^3$/sec) for vacuum and WAGD systems when started at 635 mm (25 in.) HgV.

Statement of Problem and Substantiation for Public Input

Summary

It seems that the intent of this code section is to specifically provide a means for headwall manufacturers to efficiently test and ensure that their product is leak free. However, an effective pass/fail criteria is apparently elusive as evidenced by the many changes to the specific values provided in this code section in the recent code cycles. This proposed wording change attempts provide a leak rate that currently available commercial leak testing equipment is capable of detecting.

Why change is needed.

Upon investigation, it is understood that the current pass/fail criteria is achievable for small and fixed volume component parts such as medical gas outlet primary and secondary valves which are manufactured in controlled environments but unachievable for larger and variable volume items such as “manufactured assemblies” which are fabricated in shop environments that are less temperature stable. This is evidenced by the fact that four leading leak testing equipment companies were all tasked with providing an accurate and repeatable leak tester device which achieves the leak rates currently specified and all were unsuccessful.

Details of the Proposed Change

The proposed leak rate is intended to align with the capabilities of commercially available leak testing equipment intended for this use in the environment in which the “manufactured assemblies” are produced.
As additional justification, it is our experience that the assemblies do not leak near the threshold values. The volume of the medical gas manifolds being tested is small enough that any leak at all is readily detectable with a relatively short duration test. So, leaks in the completed assembly are quite easily detected. However, demonstrating that the 0.006 cm3/sec requirement has not been exceeded is not possible using currently available commercial leak testing equipment.
Furthermore, because the volume of the “manufactured assembly” is so small in relation to the zone being tested on site, even the smallest leak that could be detected in the zone would be a very large and immediately noticeable leak when testing the “manufactured assembly” independently. So, the current pass/fail criteria is likely unnecessarily sensitive.

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Submittal Date:	Mon Jun 03 11:59:47 EDT 2024
Committee:	HEA-PIP

Public Input No. 168-NFPA 99-2024 [Section No. 5.1.6.7]

5.1.6.7

Components of manufactured assemblies shall ~~have a flame spread index of not greater than 200 when tested in accordance with ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials* , or UL 723, *Test for Surface Burning Characteristics of Building Materials* , or shall comply with the requirements for heat release in accordance with NFPA 286 as described in Section 10.2 of NFPA *101*~~ be limited combustible or noncombustible per 4.4.2 .

Statement of Problem and Substantiation for Public Input

The standard already includes a full description of materials suitable for this service. We should use the existing description.

Submitter Information Verification

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Submittal Date: Tue Apr 30 08:35:19 EDT 2024
Committee: HEA-PIP

Public Input No. 220-NFPA 99-2024 [Section No. 5.1.7.8]

5.1.7.8

MGR assemblies shall connect to the pipeline through fittings that are brazed or joints defined in section 5.1.10.3.1 sub paragraphs 1-4 to the pipeline.

Statement of Problem and Substantiation for Public Input

Adding in accepted technology (axial swaged) to valves for joint connection. Appears to be inadvertently not included in the past version.

Submitter Information Verification

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Submittal Date: Tue May 14 15:56:25 EDT 2024
Committee: HEA-PIP

Public Input No. 410-NFPA 99-2024 [Section No. 5.1.9.1]

5.1.9.1 General.

All master, area, and local alarm systems used for medical gas and vacuum systems shall include the following:

(1) Separate visual indicators for each condition monitored, except as permitted in 5.1.9.2.4(10) for local alarms that are displayed on master alarm panels

(2) Visual indicators that remain in alarm until the situation that has caused the alarm is resolved

(3) Cancelable audible indication of each alarm condition that produces a sound with a minimum level of 80 dBA at 0.92 m (3 ft)

(4) Means to indicate a lamp or LED failure and audible failure

(5) Visual and audible indication that the communication with an alarm-initiating device is disconnected

(6) Labeling of each indicator, indicating the condition monitored

(7) Labeling of each alarm panel for its area of surveillance

(8) Reinitiating of the audible signal if another alarm condition occurs while the audible alarm is silenced

(9) Power for master alarms, area alarms, sensors, and switches from the life safety branch of the essential electrical system as described in Chapter 6

(10) Power for local alarms, dew point sensors, and carbon monoxide sensors permitted to be from the same essential electrical branch as is used to power the air compressor system

(11) Where used for communications, wiring from switches or sensors that is either supervised or protected as required by 517.~~30~~ 31 (C)(3) of *NFPA 70* for life safety and critical branches circuits in which protection is any of the following types:

(12) Nonflexible metal raceways - Conduit

(13) ~~Free air~~

(14) ~~Wire~~

(15) ~~Cable tray~~

(16) ~~Raceways~~

(a) Schedule 40 encased in concrete

(17) Communication devices that do not use electrical wiring for signal transmission and are supervised such that failure of communication initiates an alarm

(18) Assurance by the responsible authority of the facility that the labeling of alarms, where room numbers or designations are used, is accurate and up-to-date

(19) Provisions for automatic restart after a power loss of 10 seconds (e.g., during generator start-up) without giving false signals or requiring manual reset

(20) Alarm switches/sensors installed so as to be removable and accessible for service and testing

Statement of Problem and Substantiation for Public Input

The code as written references the wrong code section from NFPA 70. Note: Mechanical Protection of the Essential Electrical system can be found in section 517.31(C)(3) of NFPA 70 not 517.30 referenced. The code also seems to be contradicting itself by stating open wiring, cable tray etc. is protected.
It is my understanding that the intent is to either have the wiring supervised or protected (where requirements for protection can be found in NEC 70 517.31(C)(3). I recommend that the list of acceptable protection method either be deleted or mimic what can be found in NEC 70 517.31(C)(3). Note: as written the intent is not clear.

Submitter Information Verification

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Submittal Date:	Mon Jun 03 19:21:56 EDT 2024
Committee:	HEA-PIP

Public Input No. 408-NFPA 99-2024 [Section No. 5.1.9.2.4]

5.1.9.2.4

Master alarm panels for medical gas and vacuum systems shall each include the following signals:

(1) Alarm indication when or just before changeover occurs in a medical gas system that is supplied by a manifold or other alternating-type bulk system that has, as a part of its normal operation, a changeover from one portion of the operating supply to another

(2) Alarm indication for a cryogenic fluid central supply system when the main supply reaches one average day's supply, indicating low contents

(3) Alarm indication when or just before changeover to the reserve supply occurs in a medical gas system that consists of one or more units that continuously supply the piping system while another unit remains as the reserve supply and operates only in an emergency

(4) Alarm indication for cylinder reserve pressure low when the content of a cylinder reserve header is reduced below one average day's supply

(5) For cryogenic fluid central supply systems, alarm indication when or at a predetermined set point before the reserve supply contents fall to one average day's supply, indicating low reserve

(6) Where a cryogenic liquid storage unit is used as a reserve for a cryogenic fluid central supply system, alarm indication when the gas pressure available in the reserve unit is below that required for the medical gas system to function

(7) Alarm indication when the pressure in the main line of each separate medical gas system increases 20 percent from the normal operating pressure

(8) Alarm indication when the pressure in the main line of each separate medical gas system decreases 20 percent from the normal operating pressure

(9) Alarm indication when the medical–surgical vacuum pressure in the main line of each vacuum system drops to or below 300 mm (12 in.) gauge HgV

(10) Single alarm indication from the local alarm panel(s) as described in 5.1.3.6.3.12 and 5.1.9.5.3 to indicate when one or more of the conditions being monitored at a site is in alarm

(11) Medical air dew point high alarm from each compressor site to indicate when the line pressure dew point is greater than +2°C (+35°F)

(12) WAGD low alarm when the WAGD vacuum level or flow is below effective operating limits

(13) Instrument air dew point high alarm from each compressor site to indicate when the line pressure dew point is greater than −30°C (−22°F)

(14) Alarm indication if the primary or reserve production stops on a proportioning system

(15) When oxygen is supplied from an oxygen central supply system using concentrators *(see 5.1.3.9)*, the following signals:

(16) For each concentrator supply source used in the oxygen central supply system, an alarm indication that oxygen concentration from that oxygen concentrator supply source is below 91 percent

~~For each oxygen concentrator supply source used in the oxygen central supply system, alarm indication that the isolating valve for that oxygen concentrator supply source is closed and the supply source is isolated~~

(a) ~~and cannot be achieved in a 1 hour period after initial start up from standby use.~~

(b)

(c) ~~For each cylinder header used as a source, alarm indication that the header is in use~~

(d) ~~For each cylinder header used as a source, alarm indication that the cylinder contents are below one average day's supply~~

(e) ~~If the supply source in use changes because of a failure to appropriately supply the system, alarm indication that an unexpected oxygen supply change has occurred~~

(f) ~~Alarm indication that the pressure in the common line on the source side of the line pressure controls is low~~

(g) ~~Alarm indication that the oxygen concentration from the central supply system is below 91 percent~~ ~~, which shall be monitored as described in 5.1.9.2.5.~~

(17) For combined medical-surgical vacuum/WAGD systems that are monitored for oxygen concentration, an alarm indication when the concentration of oxygen exceeds 23.6 percent

Statement of Problem and Substantiation for Public Input

(a) An Oxygen concentrator that has satisfied pressure requirements or an Oxygen Concentrator packages is intended to alternate multiple oxygen concentrators often are designed to go into standby or sleep mode. When this occurs and returns to "in use", the system often needs an opportunity to achieve USP purity before actively supplying the system again. As long as this low purity is not yet feeding the system, a lower purity master alarm should not activate.
(b) Isolating valves for each concentrator or each concentrator source package should not be monitored by the Master Alarm and should be treated the same as all other "mechanical pump" Category 1 central supply systems. If the board disagrees and it should be monitored, than all other category 1 central supply systems should be monitored in the same way.
(g) This will add patient safety to situations that Oxygen Concentrators are used at the auxiliary valve or the EOSC locations.

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Committee: HEA-PIP

Public Input No. 460-NFPA 99-2024 [Section No. 5.1.9.2.4]

5.1.9.2.4

Master alarm panels for medical gas and vacuum systems shall each include the following signals:

(1) Alarm indication when or just before changeover occurs in a medical gas system that is supplied by a manifold or other alternating-type bulk system that has, as a part of its normal operation, a changeover from one portion of the operating supply to another

(2) Alarm indication for a cryogenic fluid central supply system when the main supply reaches one average day's supply, indicating low contents

(3) Alarm indication when or just before changeover to the reserve supply occurs in a medical gas system that consists of one or more units that continuously supply the piping system while another unit remains as the reserve supply and operates only in an emergency

(4) Alarm indication for cylinder reserve pressure low when the content of a cylinder reserve header is reduced below one average day's supply

(5) For cryogenic fluid central supply systems, alarm indication when or at a predetermined set point before the reserve supply contents fall to one average day's supply, indicating low reserve

(6) Where a cryogenic liquid storage unit is used as a reserve for a cryogenic fluid central supply system, alarm indication when the gas pressure available in the reserve unit is below that required for the medical gas system to function

(7) Alarm indication when the pressure in the main line of each separate medical gas system increases 20 percent from the normal operating pressure

(8) Alarm indication when the pressure in the main line of each separate medical gas system decreases 20 percent from the normal operating pressure

(9) Alarm indication when the medical–surgical vacuum pressure in the main line of each vacuum system drops to or below 300 mm (12 in.) gauge HgV

(10) Single alarm indication from the local alarm panel(s) as described in 5.1.3.6.3.12 and 5.1.9.5.3 to indicate when one or more of the conditions being monitored at a site is in alarm

(11) Medical air dew point high alarm from each compressor site to indicate when the line pressure dew point is greater than +2°C (+35°F)

(12) WAGD low alarm when the WAGD vacuum level or flow is below effective operating limits

(13) Instrument air dew point high alarm from each compressor site to indicate when the line pressure dew point is greater than −30°C (−22°F)

(14) Alarm indication if the primary or reserve production stops on a proportioning system

(15) When oxygen is supplied from an oxygen central supply system using concentrators *(see 5.1.3.9)*, the following signals:

(16) For each concentrator supply source used in the oxygen central supply system, alarm indication that oxygen concentration from that oxygen concentrator supply source is below 91 percent

(17) For each oxygen concentrator supply source used in the oxygen central supply system, alarm indication that the isolating valve for that oxygen concentrator supply source is closed and the supply source is isolated

(18) For each cylinder header used as a source, alarm indication that the header is in use

(19) For each cylinder header used as a source, alarm indication that the cylinder contents are below one average day's supply

(20) If the supply source in use changes because of a failure to appropriately supply the system, alarm indication that an unexpected oxygen supply change has occurred

(21) Alarm indication that the pressure in the common line on the source side of the line pressure controls is low

(22) Alarm indication that the oxygen concentration from the central supply system is

below 91 percent

(23) For combined medical-surgical vacuum/WAGD systems that are monitored for oxygen concentration, an alarm indication when the concentration of oxygen exceeds 23.~~6 percent~~ 5 percent

Statement of Problem and Substantiation for Public Input

This change corrects the oxygen concentration reference to align with the definition of an oxygen enriched atmosphere, which is the basis for the requirement.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 458-NFPA 99-2024 [Section No. 5.1.3.8.1.2]	

Submitter Information Verification

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Submittal Date: Tue Jun 04 15:58:34 EDT 2024
Committee: HEA-PIP

Public Input No. 164-NFPA 99-2024 [Section No. 5.1.9.4 [Excluding any Sub-Sections]]

Area alarm panels shall be provided to monitor all medical gas, medical–surgical vacuum, and piped WAGD systems supplying the following:

(1) Anesthetizing locations

(2) * Category 1 spaces

Revise to read:

Area alarm panels shall be provided to monitor all medical gas, medical–surgical vacuum, and piped WAGD systems supplying Category 1 Spaces.

Statement of Problem and Substantiation for Public Input

This proposal eliminates an antique provision based on an assumption which is not always valid in current medical practice. That assumption was that all anesthesia in O.R.s was conducted using a gas machine, and that on that machine was both an alarm and backup gas supply. Under that assumption it was true that no additional medical gas alarm was needed in an O.R., as they already had one.

The code allowed for the “grouping” of Operating rooms and provision of a single alarm (probably located where the O.R. Supervisor would stand) based on this assumption.

With the advent of injectable anesthesia, where no gas machine may be connected or even present in the room, this assumption is no longer valid. This change in practice also appears to becoming more common.

Therefore, it now makes sense to simply have an alarm in every Category 1 location.

This does leave a loophole - since it is now possible to do general anesthesia in Category 2 or even Category 3 rooms, these rooms could exist with no alarm. However, the risk analysis inherent in arriving at Category 2 or 3 should preclude this. (see Annex A.5.1.1.1)

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 165-NFPA 99-2024 [Section No. 5.1.9.4.4]	
Public Input No. 165-NFPA 99-2024 [Section No. 5.1.9.4.4]	

Submitter Information Verification

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Submittal Date: Tue Apr 30 08:21:35 EDT 2024
Committee: HEA-PIP

Public Input No. 178-NFPA 99-2024 [Section No. 5.1.9.4 [Excluding any Sub-Sections]]

Area alarm panels shall be provided to monitor all medical gas, medical–surgical vacuum, and piped WAGD systems ~~supplying the following:~~

- ~~Anesthetizing locations~~

* supplying Category 1 patient care spaces (see 5.1.3)

Statement of Problem and Substantiation for Public Input

See proposal 176 to which this is tied
We have traditionally alarmed and valved areas like intensive care as multiple patient areas, and anesthetising locations as single patient spaces. Experience demonstrates that this is been both effective and economical. In previous editions, this practice was supported by the interaction of the "anesthetising location" definition and the use of the term "critical care and vital life support" when referring to other areas where valves and alarms were wanted.
However, "critical care and vital life support" has been replaced by Category 1, which clearly encompasses both anesthetising locations and areas with highly dependent patients. We have therefore lost the underpinning that supported our traditional practice.
The definition of a patient care space uses "patients", so it does not explicitly support this practice, but neither does it prohibit it. Beyond this, there is nowhere in the standard where it is clear how to evaluate that definition in light of 5.1.4.6.2 and 5.1.9.4.
By including this method of defining the patient care space for the purposes of this chapter, both 5.1.4.6.2. and 5.1.9.4 can be simplified.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 176-NFPA 99-2024 [New Section after 5.1.3]	
Public Input No. 177-NFPA 99-2024 [Section No. 5.1.4.6.2]	
Public Input No. 176-NFPA 99-2024 [New Section after 5.1.3]	

Submitter Information Verification

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Committee: HEA-PIP

Public Input No. 165-NFPA 99-2024 [Section No. 5.1.9.4.4]

5.1.9.4.4*

Revise to read:

Alarm sensors for area alarms shall be located

~~as follows*~~ ~~Category 1 spaces, other than anesthetizing locations addressed in 5.1.9.4.4 (2), shall have the alarm sensors installed~~
on the patient or use side of each of the individual zone valves.

~~* Anesthetizing locations, including those that are part of a group of anesthetizing locations, shall have the sensors installed in either of the following locations:~~

(1) ~~On the source side of each group of anesthetizing location zone valves on the same branch line~~

(2) ~~On the patient or use side of each of the individual zone valves~~

Statement of Problem and Substantiation for Public Input

This proposal eliminates an antique provision based on an assumption which is not always valid in current medical practice. That assumption was that all anesthesia in O.R.s was conducted using a gas machine, and that on that machine was both an alarm and backup gas supply. Under that assumption it was true that no additional medical gas alarm was needed in an O.R., as they already had one.

The code allowed for the “grouping” of Operating rooms and provision of a single alarm (probably located where the O.R. Supervisor would stand) based on this assumption.

With the advent of injectable anesthesia, where no gas machine may be connected or even present in the room, this assumption is no longer valid.

Therefore, it now makes sense to simply have an alarm in every Category 1 location.

This does leave a loophole - since it is now possible to do general anesthesia in Category 2 or even Category 3 rooms, these rooms could exist with no alarm. However, the risk analysis inherent in arriving at Category 2 or 3 should preclude this. (see Annex A.5.1.1.1)

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 164-NFPA 99-2024 [Section No. 5.1.9.4 [Excluding any Sub-Sections]]	
Public Input No. 164-NFPA 99-2024 [Section No. 5.1.9.4 [Excluding any Sub-Sections]]	

Submitter Information Verification

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Submittal Date: Tue Apr 30 08:26:46 EDT 2024
Committee: HEA-PIP

Public Input No. 446-NFPA 99-2024 [New Section after 5.1.10.1.3]

5.1.10.1.4

Tubes, fittings, valves, and other components shall be visually examined internally to confirm that they have not become contaminated for oxygen service and that they are free of obstructions, debris, residue, and contamination.

5.1.10.1.4.1

Tubes, fittings, valves, and other components that are not free of obstructions, debris, residue, and contamination shall not be used in medical gas systems.

5.1.10.1.5

The installer shall furnish documentation certifying that all piping materials comply with the requirements of 5.1.10.1.1 thru 5.1.10.1.4.

Re Number Remaining sections

Statement of Problem and Substantiation for Public Input

Over the last several years there looks to be an increase in contaminated piping systems that have been placed into service or nearly placed into service. The contamination has manifested itself by way of an objectionable odor. Some of the systems the odor has been caught at the time of the initial systems verification, but in others it has not been detected until after the system has been placed into service and an additional verification or annual test has been performed. During the last code cycle there was a proposal to look at the verifiers piping purity test, but there was not a good data set of what to change available at the time of the proposal. To that end MGPHO (Medical Gas Professional Healthcare Organization) formed a working group to look at the piping purity test. Working with various piping manufacturers it was determined that any residual cleaning agents that those manufactures used, should be picked up by the existing piping purity tests. However, it was unknown what all other non-participating manufactures were using or doing for cleaning to the B819 standard.
Meanwhile as time went on during the working groups project, we continued to get report after report of systems where a strong chemical smell was present and/or a white film inside of tubing that was subsequently removed. Almost all these reports came at the time of, or after, the medical gas verification. Because of the scale of correcting the problems (typically full replacement) and the large associated cost, it has been very difficult to get actual data and samples of what has happened.
For that reason, we are adding clarifying inspection and documentation requirements for the medical gas piping, fittings, and components received by the installing contractor. The requirements are not a new requirement but instead a consolidation of requirements that are spread in different sections of the code.
The proposal also adds the odor test as part of the installer performed tests in an effort to identify the problem at an earlier stage in the installation. Also, the requirement to coordinate with the RFA on additional testing or documentation in the event an odor is detected.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 447-NFPA 99-2024 [Section No. 5.1.10.1.8]	
Public Input No. 448-NFPA 99-2024 [New Section after 5.1.12.2.2]	
Public Input No. 449-NFPA 99-2024 [New Section after 5.1.12.2.5.2]	
Public Input No. 450-NFPA 99-2024 [New Section after 5.1.12.4.6.4]	

Submitter Information Verification

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Submittal Date:	Tue Jun 04 14:46:17 EDT 2024
Committee:	HEA-PIP

Public Input No. 269-NFPA 99-2024 [New Section after 5.1.10.1.4]

5.1.10.1.4.1

Hard-drawn seamless copper in accordance with ASTM B819, *Standard Specification for Seamless Copper Tube for Medical Gas Systems*, medical gas tube, Type L, and Type K shall be a minimum H58 (Drawn General Purpose) temper. Type your content here ...

Statement of Problem and Substantiation for Public Input

In 2019 the B819 standard was updated and now includes a H55 “semi-hard” copper. With B819 now including two different types of tube the proposal would clearly identify which one is allowed for piped medical gas systems. This proposal adds in the minimum standard for hardness or temper to maintain what has been in the code as “hard drawn” or H58 Drawn General purpose copper.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 270-NFPA 99-2024 [New Section after 5.1.10.2.1]	

Submitter Information Verification

Submitter Full Name: Mathis Carlson
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Submittal Date: Wed May 29 12:14:38 EDT 2024
Committee: HEA-PIP

Public Input No. 445-NFPA 99-2024 [New Section after 5.1.10.1.4]

5.1.10.1.4

Upon receipt, an appropriate sample of the tubes, fittings, valves, and other components shall be inpected and visually examined internally to validate that they have not become contaminated for oxygen service and that they are free of obstructions, debris, residue, and contamination.

5.1.10.1.5

Tubes, fittings, valves, and other components that are not free of obstructions, debris, residue, and contamination shall not be used in medical gas systems

Statement of Problem and Substantiation for Public Input

There have been many recent cases of contaminated tubing being introduced into the installation "pipeline" for medical gas projects. In some cases the piping is being installed and the contamination issues are only observed after the installation has been completed causing not only significant and costly delays, but also serious safety concerns if these systems were ever to be placed in service and used by patients. The contamination issue is only exacerbated by the intense heat required for the installation brazing procedures. The experience has been that if these contamination issues are found after installation, the only safe way to deal with them is to replace the systems. These additional requirements are meant to direct the installer to check for possible contamination at the time they are receiving the materials.

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Committee: HEA-PIP

Public Input No. 268-NFPA 99-2024 [Sections 5.1.10.1.4, 5.1.10.1.5, 5.1.10.1.6]

Sections 5.1.10.1.4, 5.1.10.1.5, 5.1.10.1.6

5.1.10.1.4*

Tubes shall be one of the following: ~~CMT shall have~~

(1) Hard-drawn seamless copper in accordance with ASTM B819, *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 (3⅛ in. O.D.)].

(2)* Listed corrugated medical tubing (CMT) That meets all of the following requirements:

(3) Be tested and listed to the requirements of UL 1365, *UL LLC Outline of Investigation for Corrugated Medical Tubing (CMT) Systems.*

(4) Be fabricated from copper alloy No.

~~51000~~

(a) 51000 strip, meeting ASTM B103/B103M, Standard Specification for Phosphor Bronze Plate, Sheet, Strip, and Rolled Bar

~~, with a design margin of 3.5,~~

(a) .

(b) Have a maximum operating pressure of no less than 185 Psi

(c) Have a minimum rated safety factor of 3.5 times the maximum operating pressure.

(d) Be externally coated with a nonmetallic sheath marked with the manufacturer's marking.

~~The listing shall include testing~~

(a)

(b) Testing to demonstrate that the CMT

~~systems~~

(a) system can be consistently gas-purged with results equivalent to comparable medical gas copper tubing.

~~5.1.10.1.5~~ –

~~CMT shall be~~

(1)

(a) Have a flame spread index of 25 or less and a smoke developed index of 50 or less as determined by ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials* .

~~5.1.10.1.6~~ –

(1)

(a) Be identified by the manufacturer as suitable for oxygen service at a minimum of every 0.

~~92 m~~

(1)

(a) 92 m (

~~3 ft~~

(1)

(a) 3 ft).

Additional Proposed Changes

File Name	Description	Approved
PI_268_Mathis_Carlson.docx	Mathis Carlson- PI 268 Layout	

Statement of Problem and Substantiation for Public Input

This proposal consolidates all the CMT tube requirements into a list format for clarity rather than having multiple requirements in one paragraph followed by other requirements in separate sections in compliance with the NFPA manual of style. Additionally, the proposal adds the listing standard of UL 1365. When CMT was added into the 2018 code, the requirement was for CMT to be listed, but there was no reference or standard included in the term “listed”. The addition of UL 1365 sets a baseline standard for performance of CMT systems. The proposal also incorporates a maximum operating pressure of no less than185 Psi.

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Submittal Date: Wed May 29 12:03:22 EDT 2024
Committee: HEA-PIP

5.1.10.1.4*

Tubes shall be one of the following:

(1) Hard-drawn seamless copper in accordance with ASTM B819, 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.)].

(2)* Listed corrugated medical tubing (CMT) that meets all of the following requirements:

a. Be tested and listed to the requirements of UL 1365, *UL LLC Outline of Investigation for Corrugated Medical Tubing (CMT) Systems*.
b. Be fabricated from copper alloy No. 51000 strip, meeting ASTM B103/B103M, Standard Specification for Phosphor Bronze Plate, Sheet, Strip, and Rolled Bar.
c. Have a maximum operating pressure of no less than 185 Psi
d. Have a minimum rated safety factor of 3.5 times the maximum operating pressure.
e. Be externally coated with a nonmetallic sheath marked with the manufacturer's marking.
f. Testing to demonstrate that the CMT system can be consistently gas-purged with results equivalent to comparable medical gas copper tubing.
g. Have a flame spread index of 25 or less and a smoke developed index of 50 or less as determined by ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*.
h. Be identified by the manufacturer as suitable for oxygen service at a minimum of every 0.92 m (3 ft).

This proposal consolidates all the CMT tube requirements into a list format for clarity rather than having multiple requirements in one paragraph followed by other requirements in separate sections in compliance with the NFPA manual of style. Additionally, the proposal adds the listing standard of UL 1365. When CMT was added into the 2018 code, the requirement was for CMT to be listed, but there was no reference or standard included in the term "listed". The addition of UL 1365 sets a baseline standard for performance of CMT systems. The proposal also incorporates a maximum operating pressure of no less than185 Psi.

**Add UL 1365 to referenced Standards*

Public Input No. 447-NFPA 99-2024 [Section No. 5.1.10.1.8]

~~5.1.10.1.8~~ –

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

Statement of Problem and Substantiation for Public Input

Over the last several years there looks to be an increase in contaminated piping systems that have been placed into service or nearly placed into service. The contamination has manifested itself by way of an objectionable odor. Some of the systems the odor has been caught at the time of the initial systems verification, but in others it has not been detected until after the system has been placed into service and an additional verification or annual test has been performed. During the last code cycle there was a proposal to look at the verifiers piping purity test, but there was not a good data set of what to change available at the time of the proposal. To that end MGPHO (Medical Gas Professional Healthcare Organization) formed a working group to look at the piping purity test. Working with various piping manufacturers it was determined that any residual cleaning agents that those manufactures used, should be picked up by the existing piping purity tests. However, it was unknown what all other non-participating manufactures were using or doing for cleaning to the B819 standard.
Meanwhile as time went on during the working groups project, we continued to get report after report of systems where a strong chemical smell was present and/or a white film inside of tubing that was subsequently removed. Almost all these reports came at the time of, or after, the medical gas verification. Because of the scale of correcting the problems (typically full replacement) and the large associated cost, it has been very difficult to get actual data and samples of what has happened.
For that reason, we are adding clarifying inspection and documentation requirements for the medical gas piping, fittings, and components received by the installing contractor. The requirements are not a new requirement but instead a consolidation of requirements that are spread in different sections of the code.
The proposal also adds the odor test as part of the installer performed tests in an effort to identify the problem at an earlier stage in the installation. Also, the requirement to coordinate with the RFA on additional testing or documentation in the event an odor is detected.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 446-NFPA 99-2024 [New Section after 5.1.10.1.3]	Deleates duplicated requirement that is proposed in 446

Submitter Information Verification

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Committee: HEA-PIP

Public Input No. 270-NFPA 99-2024 [New Section after 5.1.10.2.1]

5.1.10.2.1.1

Hard-drawn seamless copper in accordance with ASTM B88, *Standard Specification for Seamless Copper Water Tube*, copper tube (Type K, Type L, or Type M); ASTM B280, *Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service*, copper ACR tube; or ASTM B819, *Standard Specification for Seamless Copper Tube for Medical Gas Systems*, copper medical gas tubing (Type K or Type L); shall be a minimum H58 (Drawn General Purpose) temper.

Statement of Problem and Substantiation for Public Input

In 2019 the B819 standard was updated and now includes a H55 “semi-hard” copper. With B819 now including two different types of tube the proposal would clearly identify which one is allowed for piped medical gas systems. This proposal adds in the minimum standard for hardness or temper to maintain what has been in the code as “hard drawn” or H58 Drawn General purpose copper.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 269-NFPA 99-2024 [New Section after 5.1.10.1.4]	Same requirement placed in both applicable sections

Submitter Information Verification

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Submittal Date: Wed May 29 12:18:23 EDT 2024
Committee: HEA-PIP

Public Input No. 273-NFPA 99-2024 [Section No. 5.1.10.3.1]

5.1.10.3.1*

Positive pressure patient gas systems, medical support gas systems, vacuum systems, and WAGD systems constructed of hard-drawn seamless copper or stainless steel tubing 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 fittings, as described in 5.1.10.7
~~Threaded~~

(5) CMT fittings , as described in 5.1.10.8

(6) Threaded, as described in 5.1.10.9

Statement of Problem and Substantiation for Public Input

This proposal incorporates the new CMT fitting proposal

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 271-NFPA 99-2024 [New Section after 5.1.10.7.2]	Incorporates new fitting proposed section number

Submitter Information Verification

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Submittal Date: Wed May 29 12:25:17 EDT 2024
Committee: HEA-PIP

Public Input No. 272-NFPA 99-2024 [Section No. 5.1.10.3.2]

5.1.10.3.2

Positive pressure patient gas systems, medical support gas systems, vacuum systems, and WAGD systems constructed of CMT shall have turns, offsets, and other changes in direction made by bending the tubing up to the manufactures minimum bend radius or by fittings in accordance with 5.1.10.3.1 or 5 . 1.10.8 .

Statement of Problem and Substantiation for Public Input

This proposal incorporates the new CMT fitting proposal as well as some clarifying language. The clarification adding manufactures minimum establishes that each manufacture will have to establish their bend radius.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 271-NFPA 99-2024 [New Section after 5.1.10.7.2]	Incorporates proposed new section number

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Committee: HEA-PIP

Public Input No. 400-NFPA 99-2024 [Section No. 5.1.10.4.1.1]

5.1.10.4.1.1

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

Statement of Problem and Substantiation for Public Input

Explanation: NFPA 99-24 does not allow for soldering within said code book as soldering does not meet or exceed 449℃ (840℉), ipso facto, this code should be modified to only include the aforementioned brazing portion.

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Submittal Date: Mon Jun 03 13:40:45 EDT 2024
Committee: HEA-PIP

Public Input No. 401-NFPA 99-2024 [Section No. 5.1.10.4.1.3]

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~~ 593°C (~~1000°F~~ 1100°F) to retain the integrity of the piping system in the event of fire exposure.

Statement of Problem and Substantiation for Public Input

Explanation: There are not currently any manufactured brazing rods that fit the requirements of AWS A5.8M/A5.8 that are under the 1,001 degrees Fahrenheit (liquidus) for medical gas installation (ASSE 6010).

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Submittal Date: Mon Jun 03 13:47:43 EDT 2024
Committee: HEA-PIP

Public Input No. 217-NFPA 99-2024 [Section No. 5.1.10.4.1.10]

5.1.10.4.1.10

Braze joints shall be continuously purged with nitrogen NF.

NOTE: Axial swaged and memory metal fittings do not require nitrogen purging.

Statement of Problem and Substantiation for Public Input

Adding in accepted technology (axial swaged) to valves for joint connection. Appears to be inadvertently not included in the past version.

Submitter Information Verification

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Committee: HEA-PIP

Public Input No. 218-NFPA 99-2024 [Section No. 5.1.10.4.5.7]

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.

NOTE: Axial swaged and memory metal fittings eliminate the need for a discharge opening beause nitrogen purge is not required since there is neither nitrogen nor heat being applied

Statement of Problem and Substantiation for Public Input

Adding in accepted technology (axial swaged) to valves for joint connection. Appears to be inadvertently not included in the past version.

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Committee: HEA-PIP

Public Input No. 219-NFPA 99-2024 [Section No. 5.1.10.4.5.10]

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.

NOTE: Axial swaged and memory metal fittings eliminate the need for a 'dirty' joint sine there is neither nitrogen nor heat being applied.

Statement of Problem and Substantiation for Public Input

Adding in accepted technology (axial swaged) to valves for joint connection. Appears to be inadvertently not included in the past version.

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Public Input No. 402-NFPA 99-2024 [Section No. 5.1.10.4.6.3]

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~~ fit-up shall be heated to manual torch brazing working temperature, taking care not to overheat the joint.

Statement of Problem and Substantiation for Public Input

<Current> 5.1.10.4.6.3 After flux is liquified, 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.

<Proposed> 5.1.10.4.6.3 After flux is liquified, or where flux is not permitted to be used, the fit-up shall be heated to manual torch brazing working temperature, taking care not to overheat the joint.

Explanation: This code is misleading and, if followed, will lead to poor craftsmanship in application of manual torch brazing (TB). To heat any copper quickly is bad advice. When bringing metal to temperature quickly leads to voids within the binding of the filler material. Furthermore, heating metal to temperature quickly advocates for installers to skip full and complete coverage throughout the brazing material(s) made to adhere (bond). This could lead to poor brazement and crack propagation.

An installer (craftsman) should bring the base metal and the marrying metal to working temperatures so that an even brazement may be made throughout the intended area to be brazed. The intended areas being between the faying surfaces as well as the face of the fitting and around (no more than) the width of a rectangular brazing rod (@ 1/8") from the fitting's face.

The probability of a craftsman being able to execute a brazement at the pace with the equally distribution of thermal equipoise around a fit-up is not applicable to warrant the mention of “quickly” or “slowly” in the application of heat to a relative manual torch brazing process within the confines of the applicable code(s) of the NFPA 99 books.

“Quickly” or “slowly” usually refers to the heating of a fit-up that is stationary and brazed in the furnace (FB) and or other like brazing methods, where the heat (thermal application) can be altered by a single varying degree (up or down). “Slowly bringing a fit-up to working temperature can lead to the filler material (alloy) to liquate. Manual torch brazing does not give to a liquate state, it is rare that a manual torch brazer can work within the plastique state (of the filler material). When I am manually torch brazing within the plastique state the lack of skulling or having the alloy (brazing rod) modulate between solidus and liquidus because of the craftsmanship and the intentional movement of the torch which does not allow for the alloy to liquate.

Summarize: The NFPA 99 guidelines/code should not mention “slowly” or “quickly” when manual torch brazing. Slowly and quickly is irrelevant and therefore should not be recommended for the manual torch brazing (TB) process without further explanation. Further explanation would take away from the direct nature of code within said books.

5.1.10.4.6.3 should be deleted and let 5.1.10.4.6.4 take its place. Even though the CDA's description of how to manually torch braze is not full and complete, that is, according to best practice. Manual torch brazing should be performed with a leading angle (approximately 10°) in the direction of travel and approximately 10° at the shoulder of the fit-ups cup. When manually torch brazing copper tubing

and fitting the torch tip should not be applied at a right angle as the CDA's Copper Tube Handbook (CDA Publication A4015-14/16: Copper Tube Handbook, pg 39, "Applying Heat and Brazing", © 2016 Copper Development Association Inc., 260 Madison Avenue, New York, NY 10016,) recommends.

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Committee: HEA-PIP

Public Input No. 403-NFPA 99-2024 [Section No. 5.1.10.4.6.3]

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.

Statement of Problem and Substantiation for Public Input

5.1.10.4.6.3 should be deleted and let 5.1.10.4.6.4 take its place. Even though the CDA's description of how to manually torch braze is not full and complete, that is, according to best practice. Manual torch brazing should be performed with a leading angle (approximately 10°) in the direction of travel and approximately 10° at the shoulder of the fit-ups cup. When manually torch brazing copper tubing and fitting the torch tip should not be applied at a right angle as the CDA's Copper Tube Handbook (CDA Publication A4015-14/16: Copper Tube Handbook, pg 39, "Applying Heat and Brazing", © 2016 Copper Development Association Inc., 260 Madison Avenue, New York, NY 10016,) recommends.

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Committee: HEA-PIP

Public Input No. 404-NFPA 99-2024 [Section No. 5.1.10.4.6.4]

5.1.10.4.6.4

Techniques for heating the ~~joint~~ fit-up , applying the brazing filler metal, and making horizontal, vertical, and large-diameter ~~joints shall~~ fit-up 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*.

Statement of Problem and Substantiation for Public Input

<Current> 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.

<Proposed> 5.1.10.4.6.4 Techniques for heating the fit-up, applying the brazing filler metal, and making horizontal, vertical, and large-diameter fit-ups 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.

Explanation: A “joint” may be interpreted as a fit-up with a change in direction. Where “fit-up” should be interpreted as a fitting to be brazed or affixed with a portion of copper tubing. An 8” piece of copper tubing coming from an outlet/inlet that is fit-up (ASSE 6010) installed to be manually torch brazed within a system by way of a coupling does not constitute in a change of direction nor should it therefore be considered a “joint”. A “fit-up” is comprised of the tube (base metal) and the fitting.

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Submittal Date: Mon Jun 03 14:02:10 EDT 2024
Committee: HEA-PIP

Public Input No. 271-NFPA 99-2024 [New Section after 5.1.10.7.2]

5.1.10.8 Corrugated Medical Tube (CMT) Fittings

5.1.10.8.1

Listed Corrugated Medical Tube (CMT) fittings shall meet all of the following requirements:

(1) Be tested and listed to the requirements of UL 1365, *UL LLC Outline of Investigation for Corrugated Medical Tubing (CMT) Systems.*

(2) Provide a metal-to-metal seal.

(3) Have a maximum operating pressure of no less than 185 Psi.

(4) Have a minimum rated safety factor of 3.5 times the maximum operating pressure.

(5) Be able to withstand a temperature of 538°C (1000°F).

(6) When complete must be permanent, non-separable and non-removable, or so designed as to render the tube, fitting, or both unusable when removed.

5.1.10.8.2

Listed Corrugated Medical Tube (CMT) fittings shall be installed by ASSE 6010–qualified installers, who have completed the CMT manufactures authorized training course, and following the CMT manufacturer's instructions.

5.1.10.8.3

Listed Corrugated Medical Tube (CMT) shall be terminated or transitioned using only the CMT fittings supplied by the tubing manufacturer.

Re-Number remaining sections

Statement of Problem and Substantiation for Public Input

While CMT fittings currently fit under the requirements of axially swaged fittings, CMT is a complete piping system comprised of both tubing and fittings that are intended to work together as a listed system. This proposed section separates out CMT fittings from traditional axial swaged fittings and allows differentiation between the two. The focus of this proposal is to ensure CMT fittings are listed for use with a specific manufactures tubing and meet the performance-based requirements of UL 1365

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 272-NFPA 99-2024 [Section No. 5.1.10.3.2]	
Public Input No. 273-NFPA 99-2024 [Section No. 5.1.10.3.1]	

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Committee:	HEA-PIP

Public Input No. 328-NFPA 99-2024 [Section No. 5.1.10.11.1.1]

5.1.10.11.1.1

The system designer shall size the piping such that calculated pressure or vacuum losses do not exceed these limits.

5.1.10.11.1.1.1

Size positive pressure piping such that the calculated pressure losses across the piping as designed do not exceed ~~10 percent~~ 10 percent of the intended operating pressure ~~or vacuum~~ at the source valve.

5.1.10.11.1.1.2

Size vacuum piping such that the calculated vacuum losses across the piping as designed do not exceed 4 inches Hg from the inlet to the source valve.

Statement of Problem and Substantiation for Public Input

The current pipe sizing limitation imposes an unusually strict limitation for vacuum piping that does not coordinate with industry standards and significantly increases pipe sizing for no technical benefit. Vacuum system are typically designed for 3 (or 4 inch) Hg pressure loss across the system. For a system operating with a source pressure of 20 in HgV, a 4 in Hg loss would equal a 20% loss exceeding the current code limitation but well within convention. Adhering to the strict language in the current code would require upsizing 1 or 2 pipe sizes for no net benefit.

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Submittal Date: Fri May 31 16:01:39 EDT 2024
Committee: HEA-PIP

Public Input No. 274-NFPA 99-2024 [New Section after 5.1.10.11.1.2]

5.1.10.11.1.3

When using a system with Corrugated Medical Tube (CMT), pressure drop calculations should be in accordance with the CMT manufactures published flow and capacity tables.

Re-Number Remaining Sections

Statement of Problem and Substantiation for Public Input

Because CMT has a different pressure loss calculation than traditional copper and each CMT manufacture will have a slightly different calculation this adds the requirement that piping systems using CMT be appropriately sized and engineered to deliver the required flows and pressures.

Submitter Information Verification

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Submittal Date: Wed May 29 12:26:59 EDT 2024
Committee: HEA-PIP

Public Input No. 296-NFPA 99-2024 [Section No. 5.1.10.11.1.3]

5.1.10.11.1.3

The design and installation of piping shall meet the following requirements:

(1) Mains and branches supplying medical gas to more than a single terminal shall not be smaller than DN15 (NPS ½) (⅝ in. O.D.) size.

(2) Mains and branches supplying medical vacuum or WAGD to more than a single terminal shall not be smaller than DN20 (NPS ¾) (⅞ in. O.D.) size.

(3) Mains and branches supplying ~~WAGD or~~ support gases to more than a single terminal shall not be smaller than DN15 (NPS ½) (⅝ in O.D.) size.

(4) Drops to individual terminals shall not be smaller than DN15 (NPS ½) (⅝ in. O.D.) size.

(5) Runouts to pressure sensing devices shall be permitted to be DN8 (NPS ¼) (⅜ in. O.D.) size.

Statement of Problem and Substantiation for Public Input

WAGD appears to have been listed in the wrong grouping. It is a vacuum system similar in pressure to Medical Surgical Vacuum and is also critical for patient care and therefore should have the same design criteria as Medical Surgical Vacuum. It makes sense for the support gases to have a less restrictive minimum based on their usage.

Submitter Information Verification

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Committee: HEA-PIP

Public Input No. 236-NFPA 99-2024 [Section No. 5.1.10.11.5.8]

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 and include the following:

(1) Name of the gas or vacuum system or the chemical symbol in accordance with Table 5 . 1.11

(2) Gas or vacuum system color code in accordance with Table 5.1.11

Statement of Problem and Substantiation for Public Input

This change will bring the underground piping marking tape labeling requirements in line with the other labeling requirements within NFPA 99 for medical gas pipelines.

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Submittal Date: Thu May 23 16:02:51 EDT 2024
Committee: HEA-PIP

Public Input No. 223-NFPA 99-2024 [Section No. 5.1.10.11.6.4]

5.1.10.11.6.4

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

(1) For 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) or above and able to withstand temperatures of 538°C (1000°F)

(4) Provided with brazing extensions to allow brazing into the pipeline in accordance with 5.1.10.4 or be supplied with joints defined in section 5.1.10.3.1 sub paragraphs 1-4 as supplied by the manufacturer

(5) Supported with pipe hangers and supports as required for their additional weight

Statement of Problem and Substantiation for Public Input

Adding in accepted technology (axial swaged) to valves for joint connection. Appears to be inadvertently not included in the past version.

Submitter Information Verification

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Committee: HEA-PIP

Public Input No. 181-NFPA 99-2024 [Section No. 5.1.10.11.7.2]

5.1.10.11.7.2

Medical gas and vacuum systems with the same contents shall be permitted to be interconnected with an in-line valve installed between the systems. The valve shall be optional when the two central supply systems are in the same enclosure

Statement of Problem and Substantiation for Public Input

When two separate central supply systems are colocated in one enclosure, they will not require this valve in the same sense they would if they were separated since one unit can be shut off or isolated at it's source valve while the other is under observation.

Submitter Information Verification

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Submittal Date: Tue Apr 30 12:19:28 EDT 2024
Committee: HEA-PIP

Public Input No. 53-NFPA 99-2024 [Section No. 5.1.10.11.10]

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~~ persons who are experienced in performing such installations, including all personnel who actually install the piping system.

5.1.10.11.10.2

Installers of medical gas and vacuum piped distribution systems, all appurtenant piping supporting pump and compressor source systems, and appurtenant piping supporting source gas manifold systems not including permanently installed bulk source systems shall be certified in accordance with ASSE/IAPMO/ANSI 6010, *Professional Qualifications Standard for Medical Gas Systems Installers*.

5.1.10.11.10.3

CMT systems shall be installed by ASSE 6010–qualified installers using the CMT manufacturer's instructions.

5.1.10.11.10.4

Installers of medical gas and vacuum systems shall not use their certification to oversee installation by noncertified personnel.

5.1.10.11.10.5

Brazing shall be performed by ~~individuals who are~~ qualified persons in accordance with the provisions of 5.1.10.11.11.

5.1.10.11.10.6

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 required by 5.1.10.11.11.

5.1.10.11.10.7

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.

Statement of Problem and Substantiation for Public Input

To improve clarity, vague text is replaced with the Chapter 3 defined term "qualified person"

3.3.162 Qualified Person.
A person who, by possession of a recognized degree, certificate, professional standing, or skill, and who, by knowledge, training, and experience, has demonstrated the ability to perform the work. (HYP)

Submitter Information Verification

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Submittal Date:	Wed Jan 17 16:49:55 EST 2024
Committee:	HEA-PIP

Public Input No. 54-NFPA 99-2024 [Section No. 5.1.10.11.10.1]

5.1.10.11.10.1

The installation of medical gas and vacuum systems shall be made by qualified ~~, competent technicians who~~ persons who are experienced in performing such installations, including all personnel who actually install the piping system.

Statement of Problem and Substantiation for Public Input

To improve clarity, vague text is replaced with the Chapter 3 defined term "qualified person"

3.3.162 Qualified Person.
A person who, by possession of a recognized degree, certificate, professional standing, or skill, and who, by knowledge, training, and experience, has demonstrated the ability to perform the work. (HYP)

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Committee: HEA-PIP

Public Input No. 189-NFPA 99-2024 [New Section after 5.1.10.11.10.7]

Qualification of Installers

Personnel qualified in accordance with CGA M-1, Standard For medical Gas Supply Systems at Health Care Facilities, or ASSE/IAMPO/ASSE 6015 Professional Qualification Standard for Bulk Medical Gas /Cryogenic Fluid Central Supply system Installers shall be permitted to install source gas manifold systems and oxygen concentrator supply units.

Statement of Problem and Substantiation for Public Input

Personnel who are qualified in accordance with CGA M-1 or ASSE 6015 have the education, training, and experience to install source gas manifold systems as well as oxygen concentrator supply units and should be permitted to install these manifolds and gas concentrator units and the piping up to but not including the source valve. Not permitting qualified personnel to install these systems would be a restraint of trade.

Submitter Information Verification

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Submittal Date: Wed May 01 10:44:49 EDT 2024
Committee: HEA-PIP

Public Input No. 190-NFPA 99-2024 [Section No. 5.1.10.11.11.4]

5.1.10.11.11.4

The brazing procedure qualification record and the brazer performance qualification record shall document filler metal used, base metals, cleaning, joint clearance, overlap, internal purge gas and flow rate during brazing of coupon,~~- and absence of internal oxidation in the completed coupon.~~

Statement of Problem and Substantiation for Public Input

While there is a need to use nitrogen NF to prevent oxidation when brazing the pipe during installation, there is no need or benefit to requiring documentation showing an absence of oxidation in a brazing performance qualification record (BPQR). The BPQR is recording the skill and the ability of the brazer to satisfactorily braze a joint. This requirement prevents an individual who is a qualified brazer from having their BPQR's accepted if it does not show a lack of oxidation in a braze coupon.

Submitter Information Verification

Submitter Full Name: Robert Sutter
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Submittal Date: Wed May 01 11:18:08 EDT 2024
Committee: HEA-PIP

Public Input No. 289-NFPA 99-2024 [Section No. 5.1.11]

5.1.11* Labeling, Identification, and Operating Pressure.

Color and pressure requirements shall be in accordance with Table 5.1.11.

Table 5.1.11 Standard Designation Colors and Operating Pressures for Gas and Vacuum Systems

Gas Service	Abbreviated Name	Colors (Background/Text)	Standard Gauge Pressure kPa	Standard Gauge Pressure psi
Medical air	Med air	Yellow/black	345–380	50–55
Carbon dioxide	CO_2	Gray/black or gray/white	~~345–380~~ 345–621	50-90 ~~50–55~~
Helium	He	Brown/white	345–380	50–55
Nitrogen	N_2	Black/white	0–2070	0–300
Nitrous oxide	N_2O	Blue/white	345–380	50–55
Oxygen	O_2	Green/white or white/green	345–380	50–55
Oxygen/carbon dioxide mixtures	$O_2/CO_2n\%$ (n = % of CO_2)	Green/white	345–380	50–55
Medical–surgical vacuum	Med vac	White/black	380 mm to 760 mm (15 in. to 30 in.) HgV	
Waste anesthetic gas disposal	WAGD	Violet/white	Varies with system type	
Medical–surgical vacuum/WAGD combination	Med–surg/ WAGD	White/black and violet/white	380 mm to 760 mm (15 in. to 30 in.) HgV	
Other mixtures	Gas A%/Gas B%	Colors as above	None	
		-	-	Major gas for background/minor gas for text
Nonmedical air and dental air	—	Yellow and white diagonal stripe/black	None	
Nonmedical vacuum and dental vacuum	—	White and black diagonal stripe/black boxed	None	
Laboratory air	—	Yellow and white checkerboard/black	None	
Laboratory vacuum	—	White and black checkerboard/black boxed	None	
Instrument air	—	Red/white	0–2070	0–300

5.1.11.1 Pipe Labeling.

5.1.11.1.1

Piping shall be labeled by stenciling or adhesive markers that identify the patient medical gas, the medical support gas, or the vacuum system and include the following:

(1) Name of the gas or vacuum system or the chemical symbol per Table 5.1.11

(2) Gas or vacuum system color code per Table 5.1.11

5.1.11.1.2

Where positive-pressure gas piping systems operate at pressures other than the standard gauge pressure in Table 5.1.11, the operating pressure in addition to the name of the gas shall be labeled.

5.1.11.1.3

Where vacuum systems are used to serve WAGD systems in accordance with 5.1.10.2.3.1, piping in the immediate area of the WAGD system shall be labeled to indicate both systems.

5.1.11.1.4

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 traversed by risers

5.1.11.1.5

Medical gas piping shall not be painted.

5.1.11.1.6

Labeling of piping for compressor intakes, vacuum exhausts, and relief valve vent lines shall meet the requirements of 5.1.11.1.1 and state the specific function to distinguish them from the patient supply piping.

5.1.11.2 Shutoff Valves.

5.1.11.2.1

Shutoff valves shall be identified with the following:

(1) Name or chemical symbol for the specific medical gas or vacuum system

(2) Gas or vacuum system color code in accordance with Table 5.1.11

(3) Room or areas served

(4) Caution to not close or open the valve except in emergency

5.1.11.2.2

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 or instrument air, the valve identification shall also include the nonstandard operating pressure.

5.1.11.2.3*

Where vacuum systems are used to serve WAGD systems in accordance with 5.1.10.2.3.1, valves that are on the source side of the connection to the WAGD system shall be labeled to indicate both systems.

5.1.11.2.4

Source valves shall be labeled in substance as follows:

SOURCE VALVE FOR THE (GAS/VACUUM NAME) SERVING (NAME OF THE AREA/ BUILDING SERVED BY THE SOURCE VALVE).

5.1.11.2.5

Main line valves shall be labeled in substance as follows:

MAIN LINE VALVE FOR THE (GAS/VACUUM NAME)

SERVING (NAME OF THE BUILDING).

5.1.11.2.6

The riser valve(s) shall be labeled in substance as follows:

RISER FOR THE (GAS/VACUUM NAME) SERVING

(NAME OF THE AREA/BUILDING SERVED BY THE

PARTICULAR RISER).

5.1.11.2.7

The service valve(s) shall be labeled in substance as follows:

SERVICE VALVE FOR THE (GAS/VACUUM NAME)

SERVING (NAME OF THE AREA/BUILDING

SERVED BY THE PARTICULAR VALVE).

5.1.11.2.8*

Zone valve box assemblies shall be labeled with the rooms, areas, or spaces that they control as follows:

ZONE VALVES FOR THE (GAS/VACUUM NAME)

SERVING (NAME OF ROOMS OR SPACES SERVED

BY THE PARTICULAR VALVE).

Labeling shall either be visible from outside the zone valve box assembly through the cover or be replicated on the outside, but not affixed to the removable cover.

5.1.11.3 Station Outlets and Inlets.

5.1.11.3.1

Station outlets and inlets shall be identified as to the name or chemical symbol for the specific medical gas or vacuum provided and shall include the following:

(1) Name of the gas or vacuum system or the chemical symbol in accordance with Table 5.1.11

(2) Gas or vacuum system color code in accordance with Table 5.1.11

5.1.11.3.1.1

In sleep labs, where the outlet is downstream of a flow control device, the station outlet identification shall include a warning not to use the outlet for ventilating patients.

5.1.11.3.2

Where medical gas 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 outlet identification shall include the nonstandard operating pressure in addition to the name of the gas.

5.1.11.4 Alarm Panels.

5.1.11.4.1

Labeling of alarm panels for each indicator shall indicate the condition monitored and its area of surveillance.

5.1.11.4.2*

Area alarm panels shall be identified with the following:

(1) Name or chemical symbol of the specific medical gas or vacuum system being monitored

(2) Gas or vacuum system color code, in accordance with Table 5.1.11, of the specific medical gas or vacuum system being monitored

(3) Area(s) monitored by the alarm panel

5.1.11.4.3

Where medical gas 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 or instrument air, the area alarm panel identification shall include the nonstandard operating pressure in addition to the name of the gas.

5.1.11.4.4

Where vacuum systems are used to serve WAGD systems per 5.1.10.2.3.1, an area alarm panel(s) monitoring the area in which the WAGD system is used shall be labeled to indicate both systems.

5.1.11.5 Source Equipment.

5.1.11.5.1

Source equipment shall be labeled or tagged to identify the patient medical gas, the medical support gas, or the vacuum system and include the following information:

(1) Name of the gas or vacuum system

(2) Gas or vacuum system color code

(3) Rooms, areas, or buildings served

(4) Emergency contact information for the department or individual responsible for maintaining the equipment

5.1.11.5.2

Where vacuum systems are used to serve WAGD systems in accordance with 5.1.10.2.3.1, labeling for the medical–surgical vacuum source shall indicate that it serves both systems.

Statement of Problem and Substantiation for Public Input

There are insufflating (laparoscopy, endoscopy, arthroscopy) and cryotherapy and laser applications which require CO2 system pressure up to 90 psi.

Submitter Information Verification

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Submittal Date: Thu May 30 14:26:36 EDT 2024
Committee: HEA-PIP

Public Input No. 290-NFPA 99-2024 [Section No. 5.1.11]

5.1.11* Labeling, Identification, and Operating Pressure.

Color and pressure requirements shall be in accordance with Table 5.1.11.

Table 5.1.11 Standard Designation Colors and Operating Pressures for Gas and Vacuum Systems

Gas Service	Abbreviated Name	Colors (Background/Text)	Standard Gauge Pressure kPa	Standard Gauge Pressure psi
Medical air	Med air	Yellow/black	345–380	50–55
Carbon dioxide	CO_2	Gray/black or gray/white	345–380	50–55
Helium	He	Brown/white	345–380	50–55
Nitrogen	N_2	Black/white	0–2070	0–300
Nitrous oxide	N_2O	Blue/white	~~345–380~~	~~50–55~~ 310-345 45-50
Oxygen	O_2	Green/white or white/green	345–380	50–55
Oxygen/carbon dioxide mixtures	$O_2/CO_2n\%$ (n = % of CO_2)	Green/white	345–380	50–55
Medical–surgical vacuum	Med vac	White/black	380 mm to 760 mm (15 in. to 30 in.) HgV	
Waste anesthetic gas disposal	WAGD	Violet/white	Varies with system type	
Medical–surgical vacuum/WAGD combination	Med–surg/ WAGD	White/black and violet/white	380 mm to 760 mm (15 in. to 30 in.) HgV	
Other mixtures	Gas A%/Gas B%	Colors as above	None	
		-	-	Major gas for background/minor gas for text -
Nonmedical air and dental air	—	Yellow and white diagonal stripe/black	None	
Nonmedical vacuum and dental vacuum	—	White and black diagonal stripe/black boxed	None	
Laboratory air	—	Yellow and white checkerboard/black	None	
Laboratory vacuum	—	White and black checkerboard/black boxed	None	
Instrument air	—	Red/white	0–2070	0–300

5.1.11.1 Pipe Labeling.

5.1.11.1.1

Piping shall be labeled by stenciling or adhesive markers that identify the patient medical gas, the medical support gas, or the vacuum system and include the following:

(1) Name of the gas or vacuum system or the chemical symbol per Table 5.1.11

(2) Gas or vacuum system color code per Table 5.1.11

5.1.11.1.2

Where positive-pressure gas piping systems operate at pressures other than the standard gauge pressure in Table 5.1.11, the operating pressure in addition to the name of the gas shall be labeled.

5.1.11.1.3

Where vacuum systems are used to serve WAGD systems in accordance with 5.1.10.2.3.1, piping in the immediate area of the WAGD system shall be labeled to indicate both systems.

5.1.11.1.4

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 traversed by risers

5.1.11.1.5

Medical gas piping shall not be painted.

5.1.11.1.6

Labeling of piping for compressor intakes, vacuum exhausts, and relief valve vent lines shall meet the requirements of 5.1.11.1.1 and state the specific function to distinguish them from the patient supply piping.

5.1.11.2 Shutoff Valves.

5.1.11.2.1

Shutoff valves shall be identified with the following:

(1) Name or chemical symbol for the specific medical gas or vacuum system

(2) Gas or vacuum system color code in accordance with Table 5.1.11

(3) Room or areas served

(4) Caution to not close or open the valve except in emergency

5.1.11.2.2

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 or instrument air, the valve identification shall also include the nonstandard operating pressure.

5.1.11.2.3*

Where vacuum systems are used to serve WAGD systems in accordance with 5.1.10.2.3.1, valves that are on the source side of the connection to the WAGD system shall be labeled to indicate both systems.

5.1.11.2.4

Source valves shall be labeled in substance as follows:

SOURCE VALVE FOR THE (GAS/VACUUM NAME) SERVING (NAME OF THE AREA/ BUILDING SERVED BY THE SOURCE VALVE).

5.1.11.2.5

Main line valves shall be labeled in substance as follows:

MAIN LINE VALVE FOR THE (GAS/VACUUM NAME)

SERVING (NAME OF THE BUILDING).

5.1.11.2.6

The riser valve(s) shall be labeled in substance as follows:

RISER FOR THE (GAS/VACUUM NAME) SERVING

(NAME OF THE AREA/BUILDING SERVED BY THE

PARTICULAR RISER).

5.1.11.2.7

The service valve(s) shall be labeled in substance as follows:

SERVICE VALVE FOR THE (GAS/VACUUM NAME)

SERVING (NAME OF THE AREA/BUILDING

SERVED BY THE PARTICULAR VALVE).

5.1.11.2.8*

Zone valve box assemblies shall be labeled with the rooms, areas, or spaces that they control as follows:

ZONE VALVES FOR THE (GAS/VACUUM NAME)

SERVING (NAME OF ROOMS OR SPACES SERVED

BY THE PARTICULAR VALVE).

Labeling shall either be visible from outside the zone valve box assembly through the cover or be replicated on the outside, but not affixed to the removable cover.

5.1.11.3 Station Outlets and Inlets.

5.1.11.3.1

Station outlets and inlets shall be identified as to the name or chemical symbol for the specific medical gas or vacuum provided and shall include the following:

(1) Name of the gas or vacuum system or the chemical symbol in accordance with Table 5.1.11

(2) Gas or vacuum system color code in accordance with Table 5.1.11

5.1.11.3.1.1

In sleep labs, where the outlet is downstream of a flow control device, the station outlet identification shall include a warning not to use the outlet for ventilating patients.

5.1.11.3.2

Where medical gas 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 outlet identification shall include the nonstandard operating pressure in addition to the name of the gas.

5.1.11.4 Alarm Panels.

5.1.11.4.1

Labeling of alarm panels for each indicator shall indicate the condition monitored and its area of surveillance.

5.1.11.4.2*

Area alarm panels shall be identified with the following:

(1) Name or chemical symbol of the specific medical gas or vacuum system being monitored

(2) Gas or vacuum system color code, in accordance with Table 5.1.11, of the specific medical gas or vacuum system being monitored

(3) Area(s) monitored by the alarm panel

5.1.11.4.3

Where medical gas 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 or instrument air, the area alarm panel identification shall include the nonstandard operating pressure in addition to the name of the gas.

5.1.11.4.4

Where vacuum systems are used to serve WAGD systems per 5.1.10.2.3.1, an area alarm panel(s) monitoring the area in which the WAGD system is used shall be labeled to indicate both systems.

5.1.11.5 Source Equipment.

5.1.11.5.1

Source equipment shall be labeled or tagged to identify the patient medical gas, the medical support gas, or the vacuum system and include the following information:

(1) Name of the gas or vacuum system

(2) Gas or vacuum system color code

(3) Rooms, areas, or buildings served

(4) Emergency contact information for the department or individual responsible for maintaining the equipment

5.1.11.5.2

Where vacuum systems are used to serve WAGD systems in accordance with 5.1.10.2.3.1, labeling for the medical–surgical vacuum source shall indicate that it serves both systems.

Statement of Problem and Substantiation for Public Input

This change has been proposed and voted down in prior code cycles. I and others believe this would be a safety improvement. There are no negative application effects to having N2O at 45-50 psi (5 psi lower than O2 and Medical Air) but there are positive safety benefits from setting the N2O lower than the O2 and Medical Air. It would be easier for testing cross-connections and there would be less of a chance of back-feeding N2O into either an O2 or a Medical Air system if they were mistakenly cross-connected. This would also be in agreement with the recommendations by ASSE 6000.

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Committee: HEA-PIP

Public Input No. 117-NFPA 99-2024 [Section No. 5.1.11 [Excluding any Sub-Sections]]

Color and pressure requirements shall be in accordance with Table 5.1.11.

Table 5.1.11 Standard Designation Colors and Operating Pressures for Gas and Vacuum Systems

Gas Service	Abbreviated Name	Colors (Background/Text)	Standard Gauge Pressure kPa	Standard Gauge Pressure psi
Medical air	Med air	Yellow/black	345–380	50–55
Carbon dioxide	CO_2	Gray/black or gray/white	345–380	50–55
Helium	He	Brown/white	345–380	50–55
Nitrogen	N_2	Black/white	0–2070	0–300
Nitrous oxide	N_2O	Blue/white	~~345–380~~ 310–380	~~50–55~~ 45–55
Oxygen	O_2	Green/white or white/green	345–380	50–55
Oxygen/carbon dioxide mixtures	$O_2/CO_2n\%$ (n = % of CO_2)	Green/white	345–380	50–55
Medical–surgical vacuum	Med vac	White/black	380 mm to 760 mm (15 in. to 30 in.) HgV	
Waste anesthetic gas disposal	WAGD	Violet/white	Varies with system type	
Medical–surgical vacuum/WAGD combination	Med–surg/ WAGD	White/black and violet/ white	380 mm to 760 mm (15 in. to 30 in.) HgV	
Other mixtures	Gas A%/Gas B%	Colors as above	None	
		-	-	Major gas for background/minor gas for text
Nonmedical air and dental air	—	Yellow and white diagonal stripe/black	None	
Nonmedical vacuum and dental vacuum	—	White and black diagonal stripe/black boxed	None	
Laboratory air	—	Yellow and white checkerboard/black	None	
Laboratory vacuum	—	White and black checkerboard/black boxed	None	
Instrument air	—	Red/white	0–2070	0–300

Statement of Problem and Substantiation for Public Input

The associated annex material (A5.1.11) recommends that a facility keep their nitrous oxide operating pressure at least 5 psig below the normal operating pressures of oxygen and medical air. To accomplish this within the current standard operating pressure ranges for these gases (all listed at 50-55 psig) a facility needs to run oxygen and medical air at the very top end of that range (55 psig) and to run nitrous oxide at the very bottom end of that range (50 psig). It is common practice for a facility to run nitrous oxide at pressures lower than 50 psig, somewhere between 45-50 psig, to guard against the cross connection of gases within the anesthesia machine gas circuits.

The issue arises with an AO (Accrediting Organization) cites a facility for running their nitrous oxide operating pressure outside of the standard range set forth within NFPA 99. Within the current code editions, if a facility takes the steps suggested in A5.1.11 they would need to relabel their entire nitrous oxide system (manifold, valves, pipeline, alarms, and all outlets) with the non-standard operating pressure. This is unnecessary and overburdensome.

If the Standard Gauge Pressure range for nitrous oxide is changed to 45-55 psig, a facility could take advantage of the added safety measures of running nitrous oxide at a lower pressure, without having to incur a major operational expense of relabeling all of the components within the system.

Submitter Information Verification

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Submittal Date: Tue Apr 16 12:58:03 EDT 2024
Committee: HEA-PIP

Public Input No. 343-NFPA 99-2024 [Section No. 5.1.11 [Excluding any Sub-Sections]]

Color and pressure requirements shall be in accordance with Table 5.1.11.

Table 5.1.11 Standard Designation Colors and Operating Pressures for Gas and Vacuum Systems

Gas Service	Abbreviated Name	Colors (Background/Text)	Standard Gauge Pressure kPa	Standard Gauge Pressure psi
Medical air	Med air	Yellow/black	345–380	50–55
Carbon dioxide	CO_2	Gray/black or gray/white	345–380	50–55
Helium	He	Brown/white	345–380	50–55
Nitrogen	N_2	Black/white	0–2070	0–300
Nitrous oxide	N_2O	Blue/white	345–380	50–55
Oxygen	O_2	Green/white or white/green	345–380	50–55
Oxygen/carbon dioxide mixtures	$O_2/CO_2n\%$ (n = % of CO_2)	Green/white	345–380	50–55
Medical–surgical vacuum	Med vac	White/black	~~380 mm~~ 50 to ~~760 mm~~ 100 kPaV (15 in. to 30 in. HgV) ~~HgV~~	
Waste anesthetic gas disposal	WAGD	Violet/white	Varies with system type	
Medical–surgical vacuum/WAGD combination	Med–surg/ WAGD	White/black and violet/ white	~~380 mm~~ 50 to ~~760 mm~~ 100 kPaV (15 in. to 30 in. HgV) ~~HgV~~	
Other mixtures	Gas A%/Gas B%	Colors as above	None	
		-	-	Major gas for background/minor gas for text -
Nonmedical air and dental air	—	Yellow and white diagonal stripe/black	None	
Nonmedical vacuum and dental vacuum	—	White and black diagonal stripe/black boxed	None	
Laboratory air	—	Yellow and white checkerboard/black	None	
Laboratory vacuum	—	White and black checkerboard/black boxed	None	
Instrument air	—	Red/white	0–2070	0–300

Statement of Problem and Substantiation for Public Input

The change in metric units for vacuum is proposed to better align with other international codes including CSA Z7396.1, DIN EN ISO 7396-1 and UK HTM 02-01. If accepted, this change to kPaV should be applied across the code.

Submitter Information Verification

Submitter Full Name: David Braidich
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Submittal Date: Sat Jun 01 10:39:42 EDT 2024
Committee: HEA-PIP

Public Input No. 212-NFPA 99-2024 [Section No. 5.1.11.2.2]

5.1.11.2.2

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~~ 0 psi to ~~185 psi~~ 300 psi) for nitrogen or instrument air, the valve identification shall also include the nonstandard operating pressure.

Statement of Problem and Substantiation for Public Input

This change will bring this section into agreement with the standard operating pressure for nitrogen and instrument air listed within table 5.1.11.

Submitter Information Verification

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Zip:
Submittal Date: Wed May 08 13:27:10 EDT 2024
Committee: HEA-PIP

Public Input No. 77-NFPA 99-2024 [Section No. 5.1.11.2.2]

5.1.11.2.2

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~~ 0psi- 300psi) for nitrogen or instrument air, the valve identification shall also include the nonstandard operating pressure.

Statement of Problem and Substantiation for Public Input

Change the pressures to reflect a matching pressure to table 5.1.11

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 78-NFPA 99-2024 [Section No. 5.1.12.4.10.3]	
Public Input No. 79-NFPA 99-2024 [Section No. 5.1.11.3.2]	

Submitter Information Verification

Submitter Full Name: Douglas Miller
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Committee: HEA-PIP

Public Input No. 79-NFPA 99-2024 [Section No. 5.1.11.3.2]

5.1.11.3.2

Where medical gas 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~~ 0 psi - 300 psi) for nitrogen, the station outlet identification shall include the nonstandard operating pressure in addition to the name of the gas.

Statement of Problem and Substantiation for Public Input

Need to revise to match table 5.1.11

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 77-NFPA 99-2024 [Section No. 5.1.11.2.2]	Match pressure to table 5.1.11

Submitter Information Verification

Submitter Full Name: Douglas Miller
Organization: Local 190
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City:
State:
Zip:
Submittal Date: Sun Mar 03 20:18:44 EST 2024
Committee: HEA-PIP

Public Input No. 277-NFPA 99-2024 [New Section after 5.1.12.1.11]

5.1.12.1.11.1

Following the initial pressure test, the initial standing pressure test, the system inspection, and prior to the introduction of the system gas, a nitrogen atmosphere shall be maintained in the piping system as follows:

1) For new systems connected to an existing system, the nitrogen pressure in the new piping system shall not exceed 10 psi lower than the operating pressure of the existing system.

2) For new systems NOT connected to an existing system, the nitrogen pressure in the new piping system shall not exceed 10 psi higher than the standard operating pressures listed in table 5.1.11 for each gas.

3) For Medical-Surgical Vacuum systems and WAGD Systems, the nitrogen pressure shall not exceed 60 psi.

Statement of Problem and Substantiation for Public Input

It is not uncommon that following the installers initial pressure tests for systems to be left under pressure between 150 psi and 277.5 Psi for weeks, months or even years between the initial pressure tests and the final pressure tests. Leaving the systems at these elevated pressures poses not only a safety risk but also risks permanent damage to some system components, in particular the o-rings in outlets and the alarm pressure transducers. While the outlets are rated to deal with the higher pressures, what is very common is that while under 150psi for an extended period of time the secondary valve assemblies can imprint or deform some of the sealing gaskets and o-rings. Once the primary valve assemblies are installed and the system is now running at its lower standard operating pressure those gaskets and o-rings don't return to their original form and we have a series of leaks. In a best-case scenario, the leaks are found (after a lot of additional time testing) and repaired. However oftentimes these small leaks are overlooked and result in long term leaks in the facilities.
By setting a lower but accepted pressure of nitrogen atmosphere in the proposal we are protecting the integrity of system components that could be damaged by elevated pressures for a long duration of time.

Submitter Information Verification

Submitter Full Name: Mathis Carlson
Organization: Meditrac
Street Address:
City:
State:
Zip:
Submittal Date: Wed May 29 12:37:50 EDT 2024
Committee: HEA-PIP

Public Input No. 448-NFPA 99-2024 [New Section after 5.1.12.2.2]

5.1.12.2.2.1

No pronounced or objectionable odor shall be discernible from any blowdown discharge point of from the purge gas.

5.1.12.2.2.1.1

If a pronounced or objectionable odor is detected, additional testing or investigation shall be conducted and documented in cooperation with the responsible facility authority and the health care facility's governing body to determine the proper course of action.

Statement of Problem and Substantiation for Public Input

Over the last several years there looks to be an increase in contaminated piping systems that have been placed into service or nearly placed into service. The contamination has manifested itself by way of an objectionable odor. Some of the systems the odor has been caught at the time of the initial systems verification, but in others it has not been detected until after the system has been placed into service and an additional verification or annual test has been performed. During the last code cycle there was a proposal to look at the verifiers piping purity test, but there was not a good data set of what to change available at the time of the proposal. To that end MGPHO (Medical Gas Professional Healthcare Organization) formed a working group to look at the piping purity test. Working with various piping manufacturers it was determined that any residual cleaning agents that those manufactures used, should be picked up by the existing piping purity tests. However, it was unknown what all other non-participating manufactures were using or doing for cleaning to the B819 standard.
Meanwhile as time went on during the working groups project, we continued to get report after report of systems where a strong chemical smell was present and/or a white film inside of tubing that was subsequently removed. Almost all these reports came at the time of, or after, the medical gas verification. Because of the scale of correcting the problems (typically full replacement) and the large associated cost, it has been very difficult to get actual data and samples of what has happened.
For that reason, we are adding clarifying inspection and documentation requirements for the medical gas piping, fittings, and components received by the installing contractor. The requirements are not a new requirement but instead a consolidation of requirements that are spread in different sections of the code.
The proposal also adds the odor test as part of the installer performed tests in an effort to identify the problem at an earlier stage in the installation. Also, the requirement to coordinate with the RFA on additional testing or documentation in the event an odor is detected.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 446-NFPA 99-2024 [New Section after 5.1.10.1.3]	Adds odor test that is tied to the additional inspection of material, and direction in the event of a failure

Submitter Information Verification

Submitter Full Name:	Mathis Carlson
Organization:	Meditrac
Affiliation:	MGPHO (Medical Gas Professional Healthcare Organization)

Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Tue Jun 04 14:51:36 EDT 2024
Committee:	HEA-PIP

Public Input No. 41-NFPA 99-2024 [Sections 5.1.12.2.3.3, 5.1.12.2.3.4]

Sections 5.1.12.2.3.3, 5.1.12.2.3.4

5.1.12.2.3.3

~~The source shutoff valve shall remain closed during the tests specified~~ When the test pressures reach the levels identified in 5.1.12.2.3 .4, the test gas suppling the piped distribution areas being tested, shall be valved off and remained closed for the duration of the initial pressure test.

5.1.12.2.3.4

The test pressure for pressure gases and vacuum systems shall be 1.5 times the system operating pressure but not less than a gauge pressure of 1035 kPa (150 psi).

Additional Proposed Changes

File Name	Description	Approved
PC_92_-_99_HEA_PIP.pdf	99_PC#92	

Statement of Problem and Substantiation for Public Input

This Public Input appeared as “Reject but Hold” in Public Comment No 92 of the (A2023) Second Draft Report or NFPA 99 and per the Regs. at 4.4.8.3.1 and needs to be reconsidered by the TC for the next edition of the document.

The word “SOURCE” is used throughout the Installer and Verifier testing sections of 5.1.12.2 and 5.1.12.4. But the meaning of this term is not the same for these sections. First you have the defined source supply such as the Bulk Oxygen Central Supply, MA Compressor Central Supply, and MV Pump Central Supply and each of these supply systems also has a defined “Source Valve” located at the Central Supply location. Next you have the test gas used to supply the pressures needed for conducting the tests. This test gas can be either the Nitrogen NF, or in some cases the gas from the central supply systems. But in both case of the test gas used (ether the test gas N2 NF or the gas from the central supply system), the source valve for the test gas is not referring to the NFPA 99 defined source valve near the central supply systems (refer to note 1), the valve to be closed is the valve for the test gas supply for the area(s) being tested and not the entire MGVS. This shutoff valve will either be the valve for the test gas N2 NF supplied to the testing zone, or the isolation valve (inline valve or zone valve) for the central supply system gas supplied to the testing zone. The word “source” in these sections is being misapplied, in some cases, for these tests. Over the years and editions of NFPA 99 (56F, 565,…), the term “source” was used throughout the standard/code and when the term “source valve” was defined in NFPA 99, a check of the various locations this term was used was not conducted. This is the cause of some confusion over this term in the sections listed.
NOTE (1): With one exception -- If the testing is conducted on an entire new facility and the testing requires the entire MGVS supplies shut off.

Also, move section and numbers for 5.1.12.2.3.4 above 5.1.12.2.3.3 section for better sequence of events order. Pressure the system, then shut of test supply.

Submitter Information Verification

Submitter Full Name:
Organization: Holds
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City:	
State:	
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Submittal Date:	Tue Jan 16 15:13:57 EST 2024
Committee:	HEA-PIP

Public Comment No. 92-NFPA 99-2022 [Sections 5.1.12.2.3.3, 5.1.12.2.3.4]

Sections 5.1.12.2.3.3, 5.1.12.2.3.4

5.1.12.2.3.3

~~The~~ ~~source~~ ~~shutoff valve shall remain closed during the tests specified in~~ ~~5.1.12.2.3~~ ~~.~~ When the test pressures reach the levels identified in 5.1.12.2.3.4, the test gas suppling the piped distribution areas being tested, shall be valved off and remained closed for the duration of the initial pressure test.

5.1.12.2.3.4

The test pressure for pressure gases and vacuum systems shall be 1.5 times the system operating pressure but not less than a gauge pressure of

~~1035 kPa~~

1035 kPa (

~~150 psi~~

150 psi).

Statement of Problem and Substantiation for Public Comment

The word “SOURCE” is used throughout the Installer and Verifier testing sections of 5.1.12.2 and 5.1.12.4. But the meaning of this term is not the same for these sections. First you have the defined source supply such as the Bulk Oxygen Central Supply, MA Compressor Central Supply, and MV Pump Central Supply and each of these supply systems also has a defined “Source Valve” located at the Central Supply location. Next you have the test gas used to supply the pressures needed for conducting the tests. This test gas can be either the Nitrogen NF, or in some cases the gas from the central supply systems. But in both case of the test gas used (ether the test gas N2 NF or the gas from the central supply system), the source valve for the test gas is not referring to the NFPA 99 defined source valve near the central supply systems (refer to note 1), the valve to be closed is the valve for the test gas supply for the area(s) being tested and not the entire MGVS. This shutoff valve will either be the valve for the test gas N2 NF supplied to the testing zone, or the isolation valve (inline valve or zone valve) for the central supply system gas supplied to the testing zone. The word “source” in these sections is being misapplied, in some cases, for these tests. Over the years and editions of NFPA 99 (56F, 565,…), the term “source” was used throughout the standard/code and when the term “source valve” was defined in NFPA 99, a check of the various locations this term was used was not conducted. This is the cause of some confusion over this term in the sections listed.
NOTE (1): With one exception -- If the testing is conducted on an entire new facility and the testing requires the entire MGVS supplies shut off.

Also, move section and numbers for 5.1.12.2.3.4 above 5.1.12.2.3.3 section for better sequence of events order. Pressure the system, then shut of test supply.

Related Item

• 1st Revision 1058 & 1102

Submitter Information Verification

Submitter Full Name: Keith Ferrari

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City:	
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Submittal Date:	Fri May 27 13:07:21 EDT 2022
Committee:	HEA-PIP

Committee Statement

Committee Action:	Rejected but held
Resolution:	The proposed revision is considered new material and will be held for the next revision cycle.

Public Input No. 451-NFPA 99-2024 [Section No. 5.1.12.2.3.4]

5.1.12.2.3.4

The test pressure for pressure gases and vacuum systems shall ~~be 1.5 times the system operating pressure but not~~ be not less than a gauge pressure of 1035 kPa (150 psi).

Statement of Problem and Substantiation for Public Input

All systems are required to be tested at this minimum test pressure. Since there is no added value to the 1.5 times operating pressure requirement and it can be confusing to the installer and inspectors, this just standardizes the test pressure.

Submitter Information Verification

Submitter Full Name: Jonathan Willard
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City:
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Submittal Date: Tue Jun 04 15:01:02 EDT 2024
Committee: HEA-PIP

Public Input No. 275-NFPA 99-2024 [New Section after 5.1.12.2.3.6]

5.1.12.2.4 Initial Standing Pressure Test

5.1.12.2.4.1

The initial standing pressure test shall be performed prior to concealing piping distribution systems in walls, ceilings, chases, trenches, underground, or otherwise hidden from view.

5.1.12.2.4.2

Following the tests required in 5.1.12.2.3, Piping systems shall be subjected to a 10-minute standing pressure test for pressure gases and vacuum systems. The test pressure shall not exceed 10 psi higher than the standard operating pressures listed in table 5.1.11 for each gas, or 60 psi for medical-surgical vacuum and WAGD systems using the following procedure:

(1) After the system is filled with nitrogen NF, the source valve shall be closed, and the source of the test gas shall be disconnected from the system.

(2) The piping system shall show no decrease in pressure after 10 minutes.

(3) Gauges used for testing shall be compliant with 5.1.12.1.14

(4) Leaks, if any, shall be located, repaired (if permitted) or replaced (if required), and retested.

5.1.12.2.4.3

The test required in 5.1.12.2.4 shall be witnessed as part of the System inspection required in 5.1.12.3

Re-Number Remaining Sections

Statement of Problem and Substantiation for Public Input

The initial pressure test currently is only required until all joints/fittings have been checked for leakage using an approved leak detectant. In the event of a small leak there is a high likelihood that in the few seconds that the installer is there in front of the fitting, the leak detectant does not show an active leak. This last 10-minute standing pressure test requires that they perform one more set time minimum standing pressure test prior to checking off the test as complete. This is largely already a standard industry practice, but the proposal adds a set minimum requirement that will then be documented and recorded.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 276-NFPA 99-2024 [Section No. 5.1.12.3.2.1]	

Submitter Information Verification

Submitter Full Name: Mathis Carlson
Organization: Meditrac
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City:
State:

Zip:	
Submittal Date:	Wed May 29 12:29:24 EDT 2024
Committee:	HEA-PIP

Public Input No. 449-NFPA 99-2024 [New Section after 5.1.12.2.5.2]

5.1.12.2.5.3

No pronounced or objectionable odor shall be discernible from any positive pressure outlet.

5.1.12.2.5.3.1

If a pronounced or objectionable odor is detected, additional testing or investigation shall be conducted and documented in cooperation with the responsible facility authority and the health care facility's governing body to determine the proper course of action.

Statement of Problem and Substantiation for Public Input

Over the last several years there looks to be an increase in contaminated piping systems that have been placed into service or nearly placed into service. The contamination has manifested itself by way of an objectionable odor. Some of the systems the odor has been caught at the time of the initial systems verification, but in others it has not been detected until after the system has been placed into service and an additional verification or annual test has been performed. During the last code cycle there was a proposal to look at the verifiers piping purity test, but there was not a good data set of what to change available at the time of the proposal. To that end MGPHO (Medical Gas Professional Healthcare Organization) formed a working group to look at the piping purity test. Working with various piping manufacturers it was determined that any residual cleaning agents that those manufactures used, should be picked up by the existing piping purity tests. However, it was unknown what all other non-participating manufactures were using or doing for cleaning to the B819 standard.
Meanwhile as time went on during the working groups project, we continued to get report after report of systems where a strong chemical smell was present and/or a white film inside of tubing that was subsequently removed. Almost all these reports came at the time of, or after, the medical gas verification. Because of the scale of correcting the problems (typically full replacement) and the large associated cost, it has been very difficult to get actual data and samples of what has happened.
For that reason, we are adding clarifying inspection and documentation requirements for the medical gas piping, fittings, and components received by the installing contractor. The requirements are not a new requirement but instead a consolidation of requirements that are spread in different sections of the code.
The proposal also adds the odor test as part of the installer performed tests in an effort to identify the problem at an earlier stage in the installation. Also, the requirement to coordinate with the RFA on additional testing or documentation in the event an odor is detected.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 446-NFPA 99-2024 [New Section after 5.1.10.1.3]	Adds odor test that is tied to the additional inspection of material, and direction in the event of a failure

Submitter Information Verification

Submitter Full Name:	Mathis Carlson
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Zip:	
Submittal Date:	Tue Jun 04 14:54:28 EDT 2024
Committee:	HEA-PIP

Public Input No. 42-NFPA 99-2024 [Section No. 5.1.12.2.6]

5.1.12.2.6 Standing Pressure Test for Positive Pressure Medical Gas Piping.

After successful completion of the initial pressure tests under 5.1.12.2.3, medical gas distribution piping shall be subject to a standing pressure test.

5.1.12.2.6.1*

Tests shall be conducted after the final installation of station outlet valve bodies, faceplates, and all other distribution system components.

5.1.12.2.6.2

~~The source valve shall be closed during this test.~~ When the test pressures reach the levels identified in 5.1.12.2.6.4, the test gas supplying the piped distribution areas being tested, shall be valved off and remained closed for the duration of the 24-hour standing pressure test.

5.1.12.2.6.3

The piping systems shall be subjected to a 24-hour standing pressure test using oil-free, dry nitrogen NF.

5.1.12.2.6.4

Test pressures shall be 20 percent above the normal system operating line pressure.

5.1.12.2.6.5*

The leakage over the 24-hour test shall not exceed 0.5 percent of the starting pressure [e.g., 2 kPa (0.3 psi) starting at 415 kPa (60 psig)], except that attributed to specific changes in ambient temperature.

5.1.12.2.6.6

Leaks, if any, shall be located, repaired (if permitted) or replaced (if required), and retested.

5.1.12.2.6.7

The 24-hour standing pressure test of the positive-pressure system shall be witnessed by an ASSE 6020 inspector, an ASSE 6030 verifier, or the authority having jurisdiction or its designee. A form indicating that this test has been performed and witnessed shall be provided to the verifier at the start of the tests required in 5.1.12.4.

Additional Proposed Changes

File Name	Description	Approved
PC_93_-_99_HEA_PIP.pdf	99_PC93	

Statement of Problem and Substantiation for Public Input

This Public Input appeared as “Reject but Hold” in Public Comment No.93 of the (A2023) Second Draft Report for NFPA 99 and per the Regs. at 4.4.8.3.1 and needs to be reconsidered by the TC for the next edition of the document.

The word “SOURCE” is used throughout the Installer and Verifier testing sections of 5.1.12.2 and 5.1.12.4. But the meaning of this term is not the same for these sections. First you have the defined source supply such as the Bulk Oxygen Central Supply, MA Compressor Central Supply, and MV Pump Central Supply and each of these supply systems also has a defined “Source Valve” located at the Central Supply location. Next you have the test gas used to supply the pressures needed for conducting the tests. This test gas can be either the Nitrogen NF, or in some cases the gas from the

central supply systems. But in both case of the test gas used (ether the test gas N2 NF or the gas from the central supply system), the source valve for the test gas is not referring to the NFPA 99 defined source valve near the central supply systems (refer to note 1), the valve to be closed is the valve for the test gas supply for the area(s) being tested and not the entire MGVS. This shutoff valve will either be the valve for the test gas N2 NF supplied to the testing zone, or the isolation valve (inline valve or zone valve) for the central supply system gas supplied to the testing zone. The word “source” in these sections is being misapplied, in some cases, for these tests. Over the years and editions of NFPA 99 (56F, 565,…), the term “source” was used throughout the standard/code and when the term “source valve” was defined in NFPA 99, a check of the various locations this term was used was not conducted. This is the cause of some confusion over this term in the sections listed.
NOTE (1): With one exception -- If the testing is conducted on an entire new facility and the testing requires the entire MGVS supplies shut off.

Also, move section and numbers for 5.1.12.2.6.2, 5.1.12.2.6.3, 5.1.12.2.6.4 section for better sequence of events order. Pressure the system, shut if test supply, run 24 hrs. (5.1.12.2.6.4, then 5.1.12.2.6.2, then 5.1.12.2.6.3)

Submitter Information Verification

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City:
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Zip:
Submittal Date: Tue Jan 16 15:19:48 EST 2024
Committee: HEA-PIP

Public Comment No. 93-NFPA 99-2022 [Sections 5.1.12.2.6.2, 5.1.12.2.6.3, 5.1.12.2.6.4]

Sections 5.1.12.2.6.2, 5.1.12.2.6.3, 5.1.12.2.6.4

5.1.12.2.6 Standing Pressure Test for Positive Pressure Medical Gas Piping .

~~2~~

5.1.12.2.6.2 ~~The~~ ~~source~~ ~~valve shall be closed during this test.~~ When the test pressures reach the levels identified in 5.1.12.2.6.4, the test gas supplying the piped distribution areas being tested, shall be valved off and remained closed for the duration of the 24-hour standing pressure test.

5.1.12.2.6.3

The piping systems shall be subjected to a 24-hour standing pressure test using oil-free, dry nitrogen NF.

5.1.12.2.6.4

Test pressures shall be

~~20 percent~~

20 percent above the normal system operating line pressure.

Statement of Problem and Substantiation for Public Comment

The word “SOURCE” is used throughout the Installer and Verifier testing sections of 5.1.12.2 and 5.1.12.4. But the meaning of this term is not the same for these sections. First you have the defined source supply such as the Bulk Oxygen Central Supply, MA Compressor Central Supply, and MV Pump Central Supply and each of these supply systems also has a defined “Source Valve” located at the Central Supply location. Next you have the test gas used to supply the pressures needed for conducting the tests. This test gas can be either the Nitrogen NF, or in some cases the gas from the central supply systems. But in both case of the test gas used (ether the test gas N2 NF or the gas from the central supply system), the source valve for the test gas is not referring to the NFPA 99 defined source valve near the central supply systems (refer to note 1), the valve to be closed is the valve for the test gas supply for the area(s) being tested and not the entire MGVS. This shutoff valve will either be the valve for the test gas N2 NF supplied to the testing zone, or the isolation valve (inline valve or zone valve) for the central supply system gas supplied to the testing zone. The word “source” in these sections is being misapplied, in some cases, for these tests. Over the years and editions of NFPA 99 (56F, 565,…), the term “source” was used throughout the standard/code and when the term “source valve” was defined in NFPA 99, a check of the various locations this term was used was not conducted. This is the cause of some confusion over this term in the sections listed.
NOTE (1): With one exception -- If the testing is conducted on an entire new facility and the testing requires the entire MGVS supplies shut off.

Also, move section and numbers for 5.1.12.2.6.2, 5.1.12.2.6.3, 5.1.12.2.6.4 section for better sequence of events order. Pressure the system, shut if test supply, run 24 hrs. (5.1.12.2.6.4, then 5.1.12.2.6.2, then 5.1.12.2.6.3)

Related Item

• 1st Revision 1058 & 1102

Submitter Information Verification

Submitter Full Name: Keith Ferrari
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Street Address:
City:
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Zip:
Submittal Date: Fri May 27 13:12:11 EDT 2022
Committee: HEA-PIP

Committee Statement

Committee Action: Rejected but held
Resolution: The proposed revision is considered new material and will be held for the next revision cycle.

Public Input No. 161-NFPA 99-2024 [Section No. 5.1.12.2.6.7]

5.1.12.2.6.7

Reword 5.1.12.2.6.7

The 24-hour standing pressure test of

~~the~~
positive-pressure

~~system~~
piping shall be witnessed by

~~an ASSE 6020 inspector, an ASSE 6030 verifier, or~~
the authority having jurisdiction

~~or its designee. A form indicating that this test has been performed and witnessed shall be provided to the verifier at the start of the tests required in 5.1.12.4 .~~
, it's designee or where the AHJ does not perform this service, the Inspector.

Statement of Problem and Substantiation for Public Input

1. The current requirement in 5.1.12.3.2.1 essentially requires the AHJ, inspector or verifier to follow the installer, climb up and down ladders, through crawlspaces, etc, etc, to physically witness the bubble testing of each joint, which is work they are unlikely to be willing to undertake. Therefore, it is not performed or performed perfunctorily. However, this work should be unnecessary provided the later 24 hour test is faithfully performed. In the proposal, this requirement is removed and the requirement for the 24 hour test is reinforced.
2. The Inspector is notionally most qualified to investigate the labelling and tagging as they hold a 6000 series qualification, which may not be true of the AHJ. However, the AHJ is the ideal person to witness the pressure tests (and is often required to do so by local regulation). Both activities are necessary, so this rewording clarifies the roles.
3. The restructure pulls all the requirements together to clearly define the responsibilities of each participant and their responsibility to confirm completion of their tasks in writing.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 162-NFPA 99-2024 [Section No. 5.1.12.2.7.6]	
Public Input No. 163-NFPA 99-2024 [Section No. 5.1.12.3.2.1]	
Public Input No. 162-NFPA 99-2024 [Section No. 5.1.12.2.7.6]	
Public Input No. 163-NFPA 99-2024 [Section No. 5.1.12.3.2.1]	

Submitter Information Verification

Submitter Full Name: Mark Allen
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City:
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Submittal Date: Tue Apr 30 08:10:56 EDT 2024

Committee: HEA-PIP

Public Input No. 158-NFPA 99-2024 [Section No. 5.1.12.2.7.6]

5.1.12.2.7.6

The 24-hour standing pressure test of the vacuum system shall be witnessed by an ASSE 6020 inspector, an ASSE 6030 verifier, or the authority having jurisdiction or its designee. A form indicating that this test has been performed and witnessed shall be provided to the verifier at the start of the tests required in 5.1.12.4.

Statement of Problem and Substantiation for Public Input

This change will align the witness requirements for the installer performed 24 hour standing vacuum test (5.1.12.2.7.6) with the installer performed 24 hour standing pressure test (5.1.12.2.6.7).

Submitter Information Verification

Submitter Full Name: Cary Darden
Organization: Environmental and Medical Gas Services
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City:
State:
Zip:
Submittal Date: Mon Apr 29 10:47:03 EDT 2024
Committee: HEA-PIP

Public Input No. 162-NFPA 99-2024 [Section No. 5.1.12.2.7.6]

5.1.12.2.7.6

The 24-hour standing pressure test of the vacuum system shall be witnessed by the authority having jurisdiction or its designee. A form indicating that this test has been performed and witnessed shall be provided to the verifier at the start of the tests required in 5.1.12.4.

Reword to read:

The 24-hour standing pressure test of vacuum piping shall be witnessed by the authority having jurisdiction, it's designee or where the AHJ does not perform this service, the Inspector.

Statement of Problem and Substantiation for Public Input

1. The current requirement in 5.1.12.3.2.1 essentially requires the AHJ, inspector or verifier to follow the installer, climb up and down ladders, through crawlspaces, etc, etc, to physically witness the bubble testing of each joint, which is work they are unlikely to be willing to undertake. Therefore, it is not performed or performed perfunctorily. However, this work should be unnecessary provided the later 24 hour test is faithfully performed. In the proposal, this requirement is removed and the requirement for the 24 hour test is reinforced.
2. The Inspector is notionally most qualified to investigate the labelling and tagging as they hold a 6000 series qualification, which may not be true of the AHJ. However, the AHJ is the ideal person to witness the pressure tests (and is often required to do so by local regulation). Both activities are necessary, so this rewording clarifies the roles.
3. The restructure pulls all the requirements together to clearly define the responsibilities of each participant and their responsibility to confirm completion of their tasks in writing.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 161-NFPA 99-2024 [Section No. 5.1.12.2.6.7]	
Public Input No. 163-NFPA 99-2024 [Section No. 5.1.12.3.2.1]	
Public Input No. 161-NFPA 99-2024 [Section No. 5.1.12.2.6.7]	
Public Input No. 163-NFPA 99-2024 [Section No. 5.1.12.3.2.1]	

Submitter Information Verification

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Submittal Date: Tue Apr 30 08:14:31 EDT 2024
Committee: HEA-PIP

Public Input No. 55-NFPA 99-2024 [Section No. 5.1.12.3.1]

5.1.12.3.1 General.

5.1.12.3.1.1

System inspections shall be performed prior to concealing piping distribution systems in walls, ceilings, chases, trenches, underground, or otherwise hidden from view.

5.1.12.3.1.2

The test gas shall be nitrogen NF.

5.1.12.3.1.3

Inspections shall be conducted by ~~a party technically competent and experienced~~ a qualified person experienced in the field of medical gas and vacuum pipeline inspections and testing and meeting the requirements of ASSE/IAPMO/ANSI 6020, *Professional Qualifications Standard for Medical Gas Systems Inspectors*, or ASSE/IAPMO/ANSI 6030, *Professional Qualifications Standard for Medical Gas Systems Verifiers*.

5.1.12.3.1.4

Inspections shall be performed by a party other than the installing contractor.

5.1.12.3.1.5

Where systems have not been installed by in-house personnel, inspections shall be permitted by personnel of the organization who meet the requirements of 5.1.12.3.1.3.

Statement of Problem and Substantiation for Public Input

To improve clarity, vague text is replaced with the Chapter 3 defined term "qualified person"

3.3.162 Qualified Person.
A person who, by possession of a recognized degree, certificate, professional standing, or skill, and who, by knowledge, training, and experience, has demonstrated the ability to perform the work. (HYP)

Submitter Information Verification

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Submittal Date: Thu Jan 18 08:44:51 EST 2024
Committee: HEA-PIP

Public Input No. 163-NFPA 99-2024 [Section No. 5.1.12.3.2.1]

5.1.12.3.2.1

The initial pressure tests performed by the installing contractor shall be witnessed by an ASSE 6020 inspector, an ASSE 6030 verifier, or the authority having jurisdiction or its designee. A form indicating that this test has been performed and witnessed shall be provided to the verifier at the start of the tests required in 5.1.12.4.

Reword to read:

5.1.12.3.2.1 Attestation

Written attestation shall be provided to the verifier prior to start of the tests, that:

(a) The installing contractor shall provide confirmation that all tests as required in 5.1.12.2 have been perfomed and satisfactorily passed.

(b) The authority having jurisdiction, it's designee or where the AHJ does not perform this service, the Inspector shall provide written confirmation that they have witnessed the 24 hour leak test required in 5.1.12.2.7 and that the test was completed satisfactorily.

(c) The Inspector shall provide written confirmation that they have examined the labeling and valve tagging and that these were at time of inspection as required by this code.

These attestations shall be included in the Verifier's final report.

Statement of Problem and Substantiation for Public Input

1. The current requirement in 5.1.12.3.2.1 essentially requires the AHJ, inspector or verifier to follow the installer, climb up and down ladders, through crawlspaces, etc, etc, to physically witness the bubble testing of each joint, which is work they are unlikely to be willing to undertake. Therefore, it is not performed or performed perfunctorily. However, this work should be unnecessary provided the later 24 hour test is faithfully performed. In the proposal, this requirement is removed and the requirement for the 24 hour test is reinforced.
2. The Inspector is notionally most qualified to investigate the labelling and tagging as they hold a 6000 series qualification, which may not be true of the AHJ. However, the AHJ is the ideal person to witness the pressure tests (and is often required to do so by local regulation). Both activities are necessary, so this rewording clarifies the roles.
3. The restructure pulls all the requirements together to clearly define the responsibilities of each participant and their responsibility to confirm completion of their tasks in writing.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 162-NFPA 99-2024 [Section No. 5.1.12.2.7.6]	
Public Input No. 161-NFPA 99-2024 [Section No. 5.1.12.2.6.7]	
Public Input No. 161-NFPA 99-2024 [Section No. 5.1.12.2.6.7]	
Public Input No. 162-NFPA 99-2024 [Section No. 5.1.12.2.7.6]	

Submitter Information Verification

Submitter Full Name: Mark Allen
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Street Address:

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State:	
Zip:	
Submittal Date:	Tue Apr 30 08:17:15 EDT 2024
Committee:	HEA-PIP

Public Input No. 276-NFPA 99-2024 [Section No. 5.1.12.3.2.1]

5.1.12.3.2.1

The initial ~~pressure tests~~ standing pressure test(s) and the System inspection pressure test shall be performed by the installing contractor and shall be witnessed by an ~~ASSE 6020 inspector, an ASSE 6030 verifier, or~~ individual meeting the requirements of 5.1.12.3.1.3 and 5.1.12.3.1.4 , or by the authority having jurisdiction or its designee.

~~A form indicating that this test has been performed and witnessed shall be provided to the verifier at the start of the tests required in~~

5.1.12.3.2.1.1 System Inspection Pressure Test

Piping systems shall be subjected to a 10-minute standing pressure test for pressure gases and vacuum systems. The test pressure shall not exceed 10 psi higher than the standard operating pressures listed in table 5.1.11 for each gas or 60 psi for medical-surgical vacuum and WAGD systems, using the following procedure:

(1) After the system is filled with nitrogen, the source valve shall be closed, and the source of the test gas shall be disconnected from the system.

(2) The piping system shall show no decrease in pressure after 10 minutes.

(3) Gauges used for testing shall be compliant with 5.1.12. 1.14

(4) Leaks, if any, shall be located, repaired (if permitted) or replaced (if required), and retested .

Statement of Problem and Substantiation for Public Input

Following the adoption of the System inspections in the 2018 edition we have seen that the requirement for the 6020/6030 to witness the entirety of the initial pressure test done by the installing contractor to be overly burdensome. In most practices this initial pressure test that consists of individually inspecting each fitting with a leak detection is done daily at the end of the workday. So, the requirement of a third party to witness this test would essentially require a full-time representative on site for all projects. Not only is this very expensive to the end user, but it also becomes slightly impractical.
The proposal still requires a third-party inspection to be done prior to concealing the piping but modifies the pressure test requirement to a set minimum amount of time as well as the current set minimum pressures.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 275-NFPA 99-2024 [New Section after 5.1.12.2.3.6]	The test in PI 275 will be witnessed as part of the test in this proposal

Submitter Information Verification

Submitter Full Name: Mathis Carlson
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City:
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Submittal Date: Wed May 29 12:35:31 EDT 2024
Committee: HEA-PIP

Public Input No. 56-NFPA 99-2024 [Sections 5.1.12.4.1.3, 5.1.12.4.1.4]

Sections 5.1.12.4.1.3, 5.1.12.4.1.4

5.1.12.4.1.3

Testing shall be conducted by a ~~party technically competent and experienced~~ qualified person experienced in the field of medical gas and vacuum pipeline testing and meeting the requirements of ASSE/IAPMO/ANSI 6030, *Professional Qualifications Standard for Medical Gas Systems Verifiers*, except as required by 5.1.12.4.1.4.

5.1.12.4.1.4

Testing of the cryogenic fluid central supply system shall be conducted by a ~~party technically competent and experienced~~ qualified person experienced in the field of cryogenic fluid systems and meeting the requirements of ASSE/IAPMO/ANSI 6035, *Professional Qualifications Standard for Bulk Medical Gas/Cryogenic Fluid Central Supply Systems Verifiers*, in accordance with the mandatory requirements in CGA M-1, *Standard for Medical Gas Supply Systems at Health Care Facilities*.

Statement of Problem and Substantiation for Public Input

To improve clarity, vague text is replaced with the Chapter 3 defined term "qualified person"

3.3.162 Qualified Person.
A person who, by possession of a recognized degree, certificate, professional standing, or skill, and who, by knowledge, training, and experience, has demonstrated the ability to perform the work. (HYP)

Submitter Information Verification

Submitter Full Name: Vincent Della Croce
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Submittal Date: Thu Jan 18 08:50:33 EST 2024
Committee: HEA-PIP

Public Input No. 43-NFPA 99-2024 [Section No. 5.1.12.4.2]

5.1.12.4.2* Standing Pressure Test.

Piping systems shall be subjected to a 10-minute standing pressure test at operating line pressure using the following procedure:

(1) ~~After the system is filled with nitrogen or source gas, the source valve~~ When the test pressures reach the levels identified in 5.1.12.4.2, the test gas supplying the piped distribution areas being tested shall be valved off, and all zone valves ~~shall be closed~~ in the are closed, and all valves remain closed for the duration of the 10-min standing pressure test .

(2) The piping system shall show no decrease in pressure after 10 minutes.

(3) Any leaks found shall be located, repaired, and retested per 5.1.12.2.6.

Additional Proposed Changes

File Name	Description	Approved
PC_94_-_99_HEA_PIP.pdf	99_PC#94	

Statement of Problem and Substantiation for Public Input

This Public Input appeared as “Reject but Hold” in Public Comment No.94 of the (A2023) Second Draft Report for NFPA 99 and per the Regs. at 4.4.8.3.1 and needs to be reconsidered by the TC for the next edition of the document.

The word “SOURCE” is used throughout the Installer and Verifier testing sections of 5.1.12.2 and 5.1.12.4. But the meaning of this term is not the same for these sections. First you have the defined source supply such as the Bulk Oxygen Central Supply, MA Compressor Central Supply, and MV Pump Central Supply and each of these supply systems also has a defined “Source Valve” located at the Central Supply location. Next you have the test gas used to supply the pressures needed for conducting the tests. This test gas can be either the Nitrogen NF, or in some cases the gas from the central supply systems. But in both case of the test gas used (ether the test gas N2 NF or the gas from the central supply system), the source valve for the test gas is not referring to the NFPA 99 defined source valve near the central supply systems (refer to note 1), the valve to be closed is the valve for the test gas supply for the area(s) being tested and not the entire MGVS. This shutoff valve will either be the valve for the test gas N2 NF supplied to the testing zone, or the isolation valve (inline valve or zone valve) for the central supply system gas supplied to the testing zone. The word “source” in these sections is being misapplied, in some cases, for these tests. Over the years and editions of NFPA 99 (56F, 565,…), the term “source” was used throughout the standard/code and when the term “source valve” was defined in NFPA 99, a check of the various locations this term was used was not conducted. This is the cause of some confusion over this term in the sections listed.
NOTE (1): With one exception -- If the testing is conducted on an entire new facility and the testing requires the entire MGVS supplies shut off.

Submitter Information Verification

Submitter Full Name:
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Submittal Date:	Tue Jan 16 15:25:44 EST 2024
Committee:	HEA-PIP

Public Comment No. 94-NFPA 99-2022 [Section No. 5.1.12.4.2]

5.1.12.4.2* Standing Pressure Test.

Piping systems shall be subjected to a 10-minute standing pressure test at operating line pressure using the following procedure:
(1) ~~After the system is filled with nitrogen or~~ ~~source~~ ~~gas, the~~ ~~source~~ ~~valve and all zone valves shall be closed.~~ When the test pressures reach the levels identified in 5.1.12.4.2, the test gas supplying the piped distribution areas being tested shall be valved off, and all zone valves in the area closed, and all valves remain closed for the duration of the 10-min standing pressure test.

(1) The piping system shall show no decrease in pressure after 10 minutes.

(2) Any leaks found shall be located, repaired, and retested per 5.1.12.2.6.

Statement of Problem and Substantiation for Public Comment

The word “SOURCE” is used throughout the Installer and Verifier testing sections of 5.1.12.2 and 5.1.12.4. But the meaning of this term is not the same for these sections. First you have the defined source supply such as the Bulk Oxygen Central Supply, MA Compressor Central Supply, and MV Pump Central Supply and each of these supply systems also has a defined “Source Valve” located at the Central Supply location. Next you have the test gas used to supply the pressures needed for conducting the tests. This test gas can be either the Nitrogen NF, or in some cases the gas from the central supply systems. But in both case of the test gas used (ether the test gas N2 NF or the gas from the central supply system), the source valve for the test gas is not referring to the NFPA 99 defined source valve near the central supply systems (refer to note 1), the valve to be closed is the valve for the test gas supply for the area(s) being tested and not the entire MGVS. This shutoff valve will either be the valve for the test gas N2 NF supplied to the testing zone, or the isolation valve (inline valve or zone valve) for the central supply system gas supplied to the testing zone. The word “source” in these sections is being misapplied, in some cases, for these tests. Over the years and editions of NFPA 99 (56F, 565,…), the term “source” was used throughout the standard/code and when the term “source valve” was defined in NFPA 99, a check of the various locations this term was used was not conducted. This is the cause of some confusion over this term in the sections listed.
NOTE (1): With one exception -- If the testing is conducted on an entire new facility and the testing requires the entire MGVS supplies shut off.

Related Item

• 1st Revision 1058 & 1102

Submitter Information Verification

Submitter Full Name: Keith Ferrari
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Submittal Date: Fri May 27 13:27:40 EDT 2022
Committee: HEA-PIP

Committee Statement

Committee Action:	Rejected but held
Resolution:	The proposed revision is considered new material and will be held for the next revision cycle.

Public Input No. 44-NFPA 99-2024 [Section No. 5.1.12.4.3.1]

5.1.12.4.3.1 Individual Pressurization Method.

(A)

All medical gas and vacuum piping ~~systems~~ areas being tested shall be reduced to atmospheric pressure.

(

~~B~~

C) _

~~All sources of test gas from all of the medical gas and vacuum systems, with the exception of the one system to be checked, shall be disconnected.~~

~~(C)~~ _

~~The system~~

The individual medical gas being checked shall be pressurized with the test gas to a gauge pressure of 345 kPa (50 psi).

(X) The medical vacuum system being checked shall be pressurized with medical vacuum to a gauge pressure of 510 mm (20 in. HgV or greater).

(X) The WAGD being checked shall be pressurized with WAGD vacuum to a gauge pressure

~~of 345 kPa (50 psi).~~

meeting the designed WAGD mm (HgV) levels.

(D) _

With adapters matching outlet labels, each individual station outlet/inlet of all medical gas and vacuum systems installed shall be checked to determine that test gas is being dispensed only from the outlets/inlets of the piping system being tested.

(E) _

The source of test gas shall be disconnected, and the system tested reduced to atmospheric pressure.

(F) _

Proceed to test each additional piping system

~~until all medical~~

until the cross-connection test for all medical gas and vacuum piping systems

~~are free of cross-connections~~

is completed .

Additional Proposed Changes

File Name	Description	Approved
PC_95_-_99_HEA_PIP.pdf	99_PC#95	

Statement of Problem and Substantiation for Public Input

This Public Input appeared as “Reject but Hold” in Public Comment No.95 of the (A2025) Second Draft Report for NFPA 99 and per the Regs. at 4.4.8.3.1 and needs to be reconsidered by the TC for the next edition of the
document.

The word “SOURCE” is used throughout the Installer and Verifier testing sections of 5.1.12.2 and 5.1.12.4. But the meaning of this term is not the same for these sections. First you have the defined source supply such as the Bulk Oxygen Central Supply, MA Compressor Central Supply, and MV Pump Central Supply and each of these supply systems also has a defined “Source Valve” located at the Central Supply location. Next you have the test gas used to supply the pressures needed for conducting the tests. This test gas can be either the Nitrogen NF, or in some cases the gas from the central supply systems. But in both case of the test gas used (ether the test gas N2 NF or the gas from the central supply system), the source valve for the test gas is not referring to the NFPA 99 defined source valve near the central supply systems (refer to note 1), the valve to be closed is the valve for the test gas supply for the area(s) being tested and not the entire MGVS. This shutoff valve will either be the valve for the test gas N2 NF supplied to the testing zone, or the isolation valve (inline valve or zone valve) for the central supply system gas supplied to the testing zone. The word “source” in these sections is being misapplied, in some cases, for these tests. Over the years and editions of NFPA 99 (56F, 565,…), the term “source” was used throughout the standard/code and when the term “source valve” was defined in NFPA 99, a check of the various locations this term was used was not conducted. This is the cause of some confusion over this term in the sections listed.
NOTE (1): With one exception -- If the testing is conducted on an entire new facility and the testing requires the entire MGVS supplies shut off.

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Submittal Date: Tue Jan 16 15:48:31 EST 2024
Committee: HEA-PIP

Public Comment No. 95-NFPA 99-2022 [Section No. 5.1.12.4.3.1]

5.1.12.4.3.1 Individual Pressurization Method.

(A)

All medical gas and vacuum piping

~~systems~~

system ~~s~~ areas being tested shall be reduced to atmospheric pressure.

~~(B)~~

~~All sources of test gas from all of the medical gas and vacuum systems, with the exception of the one system to be checked, shall be disconnected.~~

(C)

~~The~~

The individual medical gas system being checked shall be pressurized with the test gas to a gauge pressure of 345 kPa (50 psi).

(X) The medical vacuum system being checked shall be pressurized with medical vacuum to a gauge pressure of

~~345 kPa (50 psi~~

510 mm (20 in. HgV or greater).

(X) The WAGD being checked shall be pressurized with WAGD vacuum to a gauge pressure meeting the designed WAGD mm (HgV) levels.

(D)

With adapters matching outlet labels, each individual station outlet/inlet of all medical gas and vacuum systems installed shall be checked to determine that test gas is being dispensed only from the outlets/inlets of the piping system being tested.

(E)

The source of test gas shall be disconnected, and the system tested reduced to atmospheric pressure.

(F)

Proceed to test each additional piping system until the cross-connection test for all medical gas and vacuum piping systems is completed . ~~are free of cross~~

~~connections~~ .

Statement of Problem and Substantiation for Public Comment

The word “SOURCE” is used throughout the Installer and Verifier testing sections of 5.1.12.2 and 5.1.12.4. But the meaning of this term is not the same for these sections. First you have the defined

source supply such as the Bulk Oxygen Central Supply, MA Compressor Central Supply, and MV Pump Central Supply and each of these supply systems also has a defined “Source Valve” located at the Central Supply location. Next you have the test gas used to supply the pressures needed for conducting the tests. This test gas can be either the Nitrogen NF, or in some cases the gas from the central supply systems. But in both case of the test gas used (ether the test gas N2 NF or the gas from the central supply system), the source valve for the test gas is not referring to the NFPA 99 defined source valve near the central supply systems (refer to note 1), the valve to be closed is the valve for the test gas supply for the area(s) being tested and not the entire MGVS. This shutoff valve will either be the valve for the test gas N2 NF supplied to the testing zone, or the isolation valve (inline valve or zone valve) for the central supply system gas supplied to the testing zone. The word “source” in these sections is being misapplied, in some cases, for these tests. Over the years and editions of NFPA 99 (56F, 565,…), the term “source” was used throughout the standard/code and when the term “source valve” was defined in NFPA 99, a check of the various locations this term was used was not conducted. This is the cause of some confusion over this term in the sections listed.
NOTE (1): With one exception -- If the testing is conducted on an entire new facility and the testing requires the entire MGVS supplies shut off.

Related Item

• 1st Revision 108 & 1102

Submitter Information Verification

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Submittal Date: Fri May 27 13:31:11 EDT 2022
Committee: HEA-PIP

Committee Statement

Committee Action: Rejected but held

Resolution: The proposed revision is considered new material and will be held for the next revision cycle.

Public Input No. 450-NFPA 99-2024 [New Section after 5.1.12.4.6.4]

5.1.12.4.6.4.1

If a pronounced or objectionable odor is detected, additional testing or investigation shall be conducted and documented in cooperation with the responsible facility authority and the health care facility's governing body to determine the proper course of action.

Statement of Problem and Substantiation for Public Input

Over the last several years there looks to be an increase in contaminated piping systems that have been placed into service or nearly placed into service. The contamination has manifested itself by way of an objectionable odor. Some of the systems the odor has been caught at the time of the initial systems verification, but in others it has not been detected until after the system has been placed into service and an additional verification or annual test has been performed. During the last code cycle there was a proposal to look at the verifiers piping purity test, but there was not a good data set of what to change available at the time of the proposal. To that end MGPHO (Medical Gas Professional Healthcare Organization) formed a working group to look at the piping purity test. Working with various piping manufacturers it was determined that any residual cleaning agents that those manufactures used, should be picked up by the existing piping purity tests. However, it was unknown what all other non-participating manufactures were using or doing for cleaning to the B819 standard.
Meanwhile as time went on during the working groups project, we continued to get report after report of systems where a strong chemical smell was present and/or a white film inside of tubing that was subsequently removed. Almost all these reports came at the time of, or after, the medical gas verification. Because of the scale of correcting the problems (typically full replacement) and the large associated cost, it has been very difficult to get actual data and samples of what has happened.
For that reason, we are adding clarifying inspection and documentation requirements for the medical gas piping, fittings, and components received by the installing contractor. The requirements are not a new requirement but instead a consolidation of requirements that are spread in different sections of the code.
The proposal also adds the odor test as part of the installer performed tests in an effort to identify the problem at an earlier stage in the installation. Also, the requirement to coordinate with the RFA on additional testing or documentation in the event an odor is detected.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 446-NFPA 99-2024 [New Section after 5.1.10.1.3]	Adds odor test that is tied to the additional inspection of material, and direction in the event of a failure

Submitter Information Verification

Submitter Full Name:	Mathis Carlson
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Submittal Date: Tue Jun 04 14:56:22 EDT 2024
Committee: HEA-PIP

Public Input No. 45-NFPA 99-2024 [Section No. 5.1.12.4.8]

5.1.12.4.8* Verifier Piping Purity Test.

For each medical gas system, the purity of the piping system shall be verified in accordance with 5.1.12.4.8.

5.1.12.4.8.1

These tests shall be performed with oil-free, dry nitrogen NF or the system gas.

5.1.12.4.8.2

~~The outlet most remote from the source shall be tested~~

A comparison test for total nonmethane hydrocarbons and halogenated hydrocarbons

~~and compared to the source gas.~~

shall be conducted between the test gas source supply and the outlet, in the testing area, most remote from the test gas supply.

5.1.12.4.8.3

If the central supply, system gas is used as the ~~source gas, it shall~~ test gas, the system gas shall be tested at the central supply source ~~equipment~~ location .

5.1.12.4.8.4

If a test cylinder/container of oil-free, dry nitrogen NF is used as the test gas, the Nitrogen NF gas shall be tested at the portable cylinder/container supply location.

The difference between the two tests shall in no case exceed 5 ppm of total non-methane hydrocarbons.

5.1.12.4.8.5

The difference between the two tests shall in no case exceed 5 ppm halogenated hydrocarbons.

5.1.12.4.8.6

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).

Additional Proposed Changes

File Name	Description	Approved
PC_96_-_99_HEA_PIP.pdf	99_PC96	

Statement of Problem and Substantiation for Public Input

This Public Input appeared as “Reject but Hold” in Public Comment No 96. of the (A2023) Second Draft Report for NFPA 99 and per the Regs. at 4.4.8.3.1 and needs to be reconsidered by the TC for the next edition of the document.

The word “SOURCE” is used throughout the Installer and Verifier testing sections of 5.1.12.2 and 5.1.12.4. But the meaning of this term is not the same for these sections. First you have the defined source supply such as the Bulk Oxygen Central Supply, MA Compressor Central Supply, and MV Pump Central Supply and each of these supply systems also has a defined “Source Valve” located at the Central Supply location. Next you have the test gas used to supply the pressures needed for conducting the tests. This test gas can be either the Nitrogen NF, or in some cases the gas from the

central supply systems. But in both case of the test gas used (ether the test gas N2 NF or the gas from the central supply system), the source valve for the test gas is not referring to the NFPA 99 defined source valve near the central supply systems (refer to note 1), the valve to be closed is the valve for the test gas supply for the area(s) being tested and not the entire MGVS. This shutoff valve will either be the valve for the test gas N2 NF supplied to the testing zone, or the isolation valve (inline valve or zone valve) for the central supply system gas supplied to the testing zone. The word “source” in these sections is being misapplied, in some cases, for these tests. Over the years and editions of NFPA 99 (56F, 565,…), the term “source” was used throughout the standard/code and when the term “source valve” was defined in NFPA 99, a check of the various locations this term was used was not conducted. This is the cause of some confusion over this term in the sections listed.
NOTE (1): With one exception -- If the testing is conducted on an entire new facility and the testing requires the entire MGVS supplies shut off.
Confirmation request: Is the moisture test a comparison test or not between the test gas source supply and remote outlet? As listed in the code today it is NOT a comparison test, so I did not adjust any of the wording or section 5.1.12.4.8.6.

Submitter Information Verification

Submitter Full Name:
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Street Address:
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Submittal Date: Wed Jan 17 14:07:22 EST 2024
Committee: HEA-PIP

Public Comment No. 96-NFPA 99-2022 [Section No. 5.1.12.4.8]

5.1.12.4.8* Verifier Piping Purity Test.

For each medical gas system, the purity of the piping system shall be verified in accordance with 5.1.12.4.8.

5.1.12.4.8.1

These tests shall be performed with oil-free, dry nitrogen NF or the system gas.

5.1.12.4.8.2

~~The outlet most remote from the~~ source ~~shall be tested for total nonmethane hydrocarbons and halogenated hydrocarbons and compared to the~~ source ~~gas.~~

A comparison test for total nonmethane hydrocarbons and halogenated hydrocarbons shall be conducted between the test gas source supply and the outlet, in the testing area, most remote from the test gas supply.

5.1.12.4.8.3

If the central supply system gas is used as the ~~source~~ test gas, ~~it~~ the system gas shall be tested at the central supply source location. ~~equipment~~ .

5.1.12.4.8.

~~4~~

X If a test cylinder/container of oil-free, dry nitrogen NF is used as the test gas, the Nitrogen NF gas shall be tested at the portable cylinder/container supply location.

5.1.12.4.8.4 The difference between the two tests shall in no case exceed 5 ppm of total non-methane hydrocarbons.

5.1.12.4.8.5

The difference between the two tests shall in no case exceed 5 ppm halogenated hydrocarbons.

5.1.12.4.8.6

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~~

345 kPa (

~~50 psi~~

50 psi).

Statement of Problem and Substantiation for Public Comment

The word “SOURCE” is used throughout the Installer and Verifier testing sections of 5.1.12.2 and 5.1.12.4. But the meaning of this term is not the same for these sections. First you have the defined source supply such as the Bulk Oxygen Central Supply, MA Compressor Central Supply, and MV Pump Central Supply and each of these supply systems also has a defined “Source Valve” located at the Central Supply location. Next you have the test gas used to supply the pressures needed for conducting the tests. This test gas can be either the Nitrogen NF, or in some cases the gas from the central supply systems. But in both case of the test gas used (ether the test gas N2 NF or the gas from the central supply system), the source valve for the test gas is not referring to the NFPA 99 defined source valve near the central supply systems (refer to note 1), the valve to be closed is the valve for the test gas supply for the area(s) being tested and not the entire MGVS. This shutoff valve will either be the valve for the test gas N2 NF supplied to the testing zone, or the isolation valve (inline valve or zone valve) for the central supply system gas supplied to the testing zone. The word “source” in these sections is being misapplied, in some cases, for these tests. Over the years and editions of NFPA 99 (56F, 565,…), the term “source” was used throughout the standard/code and when the term “source valve” was defined in NFPA 99, a check of the various locations this term was used was not conducted. This is the cause of some confusion over this term in the sections listed.
NOTE (1): With one exception -- If the testing is conducted on an entire new facility and the testing requires the entire MGVS supplies shut off.
Confirmation request: Is the moisture test a comparison test or not between the test gas source supply and remote outlet? As listed in the code today it is NOT a comparison test, so I did not adjust any of the wording or section 5.1.12.4.8.6.

Related Item

• 1st Revision 1058 & 1102

Submitter Information Verification

Submitter Full Name: Keith Ferrari
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Submittal Date: Fri May 27 13:36:04 EDT 2022
Committee: HEA-PIP

Committee Statement

Committee Action: Rejected but held
Resolution: The proposed revision is considered new material and will be held for the next revision cycle.

Public Input No. 407-NFPA 99-2024 [Section No. 5.1.12.4.10]

5.1.12.4.10 Operational Flow Pressure Drop Test.

Operational flow pressure drop tests shall be performed at each station outlet/inlet or terminal where the user makes connections and disconnections.

5.1.12.4.10.1

Tests shall be performed with the gas of system designation or the operating vacuum.

5.1.12.4.10.2

All gas outlets with a gauge pressure of 345 kPa (50 psi), including, but not limited to, oxygen, nitrous oxide, medical air, and carbon dioxide, shall deliver 100 SLPM (3.5 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).

5.1.12.4.10.3

Medical support gas outlets shall deliver 140 SLPM (5.0 SCFM) with a pressure drop of not more than 35 kPa (5 psi) gauge and static pressure of 1100 kPa to 1275 kPa (160 psi to 185 psi) gauge.

5.1.12.4.10.4

Medical–surgical vacuum inlets shall draw 85 Nl/min (3 SCFM) without reducing the vacuum pressure below 300 mm (12 in.) gauge HgV at any adjacent station inlet.

5.1.12.4.10.5

Waste anesthetic gas disposal inlets shall draw 50 lpm (1.8 SCFM) without reducing the vacuum pressure below 300 mm (12 in.) gauge HgV at any adjacent station inlet.

5.1.12.4.10.6

Oxygen and medical air outlets serving Category 1 spaces shall allow a transient flow rate of 170 SLPM (6 SCFM) for 3 seconds and a pressure drop of not more than 70 kPa (10 psi) gauge.

5.1.12.4.10.6 7 *

Where outlets are being fed with non-standard line pressure, volume, or gas content, for clinical reasons, they shall be labeled in accordance with 5.1.11.

Statement of Problem and Substantiation for Public Input

There is currently no operational flow test requirement for WAGD. Operational flow test validate that the piping system has not been compromised during construction. This is a critical verification test for WAGD as any other system.

Submitter Information Verification

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Submittal Date:	Mon Jun 03 15:48:21 EDT 2024
Committee:	HEA-PIP

Public Input No. 295-NFPA 99-2024 [Sections 5.1.12.4.10.2, 5.1.12.4.10.3, 5.1.12.4.10.4, 5.1.1...]

Sections 5.1.12.4.10.2, 5.1.12.4.10.3, 5.1.12.4.10.4, 5.1.12.4.10.5

5.1.12.4.10.2

~~All~~ Each gas ~~outlets with~~ outlet with a gauge pressure of 345 kPa (50 psi), including, but not limited to, oxygen, nitrous oxide, medical air, and carbon dioxide, shall deliver 100 SLPM (3.5 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) when tested individually .

5.1.12.4.10.3

~~Medical~~ Each medical support gas ~~outlets shall~~ outlet shall deliver 140 SLPM (5.0 SCFM) with a pressure drop of not more than 35 kPa (5 psi) gauge and static pressure of 1100 kPa to 1275 kPa (160 psi to 185 psi) gauge when tested individually .

5.1.12.4.10.4

~~Medical–surgical~~ Each medical–surgical vacuum ~~inlets shall~~ inlet shall draw 85 Nl/min (3 SCFM) without reducing the vacuum pressure below 300 mm (12 in.) gauge HgV at any adjacent station inlet when tested individually .

5.1.12.4.10.5

~~Oxygen~~ Each oxygen and medical air ~~outlets serving~~ outlet serving Category 1 spaces shall allow a transient flow rate of 170 SLPM (6 SCFM) for 3 seconds ~~and a~~ with a pressure drop ~~of~~ not ~~more than~~ to exceed 70 kPa (10 psi) gauge when tested individually .

Statement of Problem and Substantiation for Public Input

The current wording can be interpreted as a design requirement for all outlets to be capable of 50 slpm when flowed simultaneously. It is understood that this paragraph is only intended as an individual outlet test to verify that no supply piping has been damaged (e.g. dented) during construction. The revised wording better reflects this intent.

Submitter Information Verification

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Submittal Date: Thu May 30 15:10:41 EDT 2024
Committee: HEA-PIP

Public Input No. 127-NFPA 99-2024 [Section No. 5.1.12.4.10.3]

5.1.12.4.10.3

Medical support gas outlets shall deliver 140 SLPM (5.0 SCFM) with a pressure drop of

- not more than ~~35 kPa (5 psi) gauge and static pressure of 1100 kPa to 1275 kPa (160 psi to 185 psi) gauge.~~ 10% of the static pressure when the static pressure is 100 psig pr greater.

- not more than 5 % of the static pressure when the static pressure is less than 100 psig.

Statement of Problem and Substantiation for Public Input

NFPA 99, 2024 adjusted the static pressure requirements for Instrument air and Nitrogen on table 5.1.11 to 0 - 300 psig from past NFPA 99 editions where the static pressures was 160 - 185 psig, then 55-185 psig. This adjustment allowed the end user to decide the operating pressure the best suits them. I believe the flow loss also needs adjusted based on the static pressure changes.
Equipment such as support gas driving surgical tools (drivers, drills, saws, etc) or tools to blow off glassware and catheters, as well as moving and braking booms in the OR and ICU relay on the support gases to flow and operate at pressures to meet the optimum design of the tools or needs.
Oxygen and Medical Air in Category 1 spaces was changed in 2024 to allow for a 10 psig (or 20%) drop in static pressure and not affect the design operations of ventilators. Non Cat 1 spaces require a flow and pressure drop test for medical gas outlets of 100 lpm with no more than a 5 psig with a static pressure of 50-55 psig (or 10 % loss). Section 5.1.1.12.4.10.3 under Operational Flow and Drop Test did not update the static pressure ranges for testing.
Looking for surgical tools used at pressures above 100 psig, I was hard pressed to find any surgical tools (or similar) manufacturers specifications that required support gases at pressures greater than 100 psig to require dynamic pressures to be maintained within 5 psig of the static pressure to operate correctly.
With static pressure of 300 psig and only a 5 psig lose variance, this equates to a 1.6% pressure lose at 140 LPM flow, and looking at other static pressures and allowing only a 5psig drop you will have:
250 psig = 2 % loss,
200 psig = 2.5%loss,
150 psig = 3.3% loss,
100 psig = 5% loss.
It seems that Boom/orbital/and similar manufacturers have a difficult time sizing support gas outlets and associated tubing to meet these flow & pressure drop requirements.
I found issues if there is too much pressure on the tools, but pressure ranges between 90-100 psig seems common to operate. (10% loss). Possibly there are precise surgical drills, drivers, saws, ... that require higher pressures and minimum pressure loss to operate, but I could not find those types of instruments with specifications requiring no or little (less than 5%) loss in pressure to operate.

Submitter Information Verification

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Submittal Date: Tue Apr 23 11:08:01 EDT 2024
Committee: HEA-PIP

Public Input No. 78-NFPA 99-2024 [Section No. 5.1.12.4.10.3]

5.1.12.4.10.3

Medical support gas outlets shall deliver 140 SLPM (5.0 SCFM) with a pressure drop of not more than 35 kPa (5 psi) gauge and static pressure of 1100 kPa to 1275 kPa (~~160 psi to 185 psi~~ 0 psi - 300 psi) gauge.

Statement of Problem and Substantiation for Public Input

Change pressures to match table in 5.1.11

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 77-NFPA 99-2024 [Section No. 5.1.11.2.2]	both pressure need to be update to match table 5.1.11

Submitter Information Verification

Submitter Full Name: Douglas Miller
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Submittal Date: Sun Mar 03 20:16:14 EST 2024
Committee: HEA-PIP

Public Input No. 40-NFPA 99-2024 [Section No. 5.1.12.4.14.6]

5.1.12.4.14.6 Medical–Surgical Vacuum Systems.

The proper functioning of the medical–surgical vacuum source system(s) shall be tested before it is put into service.

* 5.1.12.4.15 Emergency Oxygen Connection

(1)

(a)

i.

- A newly installed Emergency Oxygen Connection shall be tested as follows:

(2) include EOSC piping in all installer tests (5.1.12.2);

(3) confirm presence of physical protection by visual inspection (5.1.3.5.13.2 (1));

(4) confirm size(es) of inlet connection(s) (5.1.3.5.13.2 (2));

(5) confirm presence and operation of isolation valve (5.1.3.5.13.2 (3));

(6) confirm patentcy of the EOSC piping by pressurizing the EOSC connection and feeding the system through the inlet connection ;

(7) confirm operation of the two EOSC check valves by pressurization at the EOSC and pressurization at the Central Supply System. Ensure the check valves operate as required. (5.1.3.5.13.2 (4));

(8) confirm the relief valve is appropriate for the pressure of the system by visual inspection of the valve labelling. (5.1.3.5.13.2 (5));

(9) confirm the four (4) alarm connection points are connected to the master alarms and will operate signals on those alarms (5.1.3.5.13.2 (8)).

(10)

i.

- These tests may be conducted with Nitrogen NF or with Oxygen

* Annex 5.1.12. 4.15

These tests are intended to confirm that the EOSC is ready for use should it ever be required. 5.1.12.4.15.1 (1) is also added to ensure that the check valves required for the EOSC does not prevent installer testing of the sections of the piping between the check valves and the EOSC or the remote Central Supply System and the EOSC Check valve.

The Initial Pipng Blowdown and Initial Pressure Test will be complicated by the presence of the required check valves in the piping. It will be necessary to connect the nitrogen to the

EOSC itself and at the Central Supply System location to properly complete these operations.

Testing patentcy of the piping and operation of the check valves will

require g as to flow from the Central Supp ly Sy stem to the pipeline, and from the EOSC to the pipeline, but NOT from the EOSC to the Central Suppl y System or from the Central Supply Sy stem and out the EOSC.

As the four alarm connections may not be active at the masters, it ma y be necessary to adj ust alarm settings in accordance with manufacturer's instructions to perform this test.

Additional Proposed Changes

File Name	Description	Approved
PC_62_-_99_HEA_PIP.pdf	99_PC#62	

Statement of Problem and Substantiation for Public Input

his Public Input appeared as “Reject but Hold” in Public Comment No.62 of the (A2023) Second Draft Report for NFPA 99 and per the Regs. at 4.4.8.3.1 and needs to be reconsidered by the TC for the next edition of the document.

The Committee objected to the original PI due to lack of specifics for this test. These are provided here.In addition, it is proposed that the requirements be placed in 5.1.12.4.15 to properly fall under Verifier testing.5.1.12.4.15.1 (1) is specifically added to ensure that the check valves required for the EOSC does not prevent installer testing of the sections of the piping between the check valves and the EOSC or the remote Central Supply System and the EOSC Check valve.

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Submittal Date: Tue Jan 16 15:09:33 EST 2024
Committee: HEA-PIP

Public Comment No. 62-NFPA 99-2022 [Section No. 5.1.12.4.14.6]

5.1.12.4.14.6 Medical–Surgical Vacuum Systems.

The proper functioning of the medical–surgical vacuum source system(s) shall be tested before it is put into service.

Add new:

* 5.1.12.4.15 Emergency Oxygen Connection

5.1.12.4.15.1 A newly installed Emergency Oxygen Connection shall be tested as follows:

(1) include EOSC piping in all installer tests (5.1.12.2);

(2) confirm presence of physical protection by visual inspection (5.1.3.5.13.2 (1));

(3) confirm size(es) of inlet connection(s) (5.1.3.5.13.2 (2));

(4) confirm presence and operation of isolation valve (5.1.3.5.13.2 (3));

(5) confirm patentcy of the EOSC piping by pressurizing the EOSC connection and feeding the system through the inlet connection;

(6) confirm operation of the two EOSC check valves by pressurization at the EOSC and pressurization at the Central Supply System. Ensure the check valves operate as required. (5.1.3.5.13.2 (4));

(7) confirm the relief valve is appropriate for the pressure of the system by visual inspection of the valve labelling. (5.1.3.5.13.2 (5));

(8) confirm the four (4) alarm connection points are connected to the master alarms and will operate signals on those alarms (5.1.3.5.13.2 (8)).

5.1.12.4.15.2 These tests may be conducted with Nitrogen NF or with Oxygen

* Annex 5.1.12. 4.15

These tests are intended to confirm that the EOSC is ready for use should it ever be required. 5.1.12.4.15.1 (1) is also added to ensure that the check valves required for the EOSC does not prevent installer testing of the sections of the piping between the check valves and the EOSC or the remote Central Supply System and the EOSC Check valve.

The Initial Piping Blowdown and Initial Pressure Test will be complicated by the presence of the required check valves in the piping. It will be necessary to connect the nitrogen to the EOSC itself and at the Central Supply System location to properly complete these operations.

Testing patentcy of the piping and operation of the check valves will require gas to flow from the Central Supply System to the pipeline, and from the EOSC to the pipeline, but NOT from the EOSC to the Central Supply System or from the Central Supply System and out the EOSC.

As the four alarm connections may not be active at the masters, it may be necessary to adjust alarm settings in accordance with manufacturer's instructions to perform this test.

Statement of Problem and Substantiation for Public Comment

The Committee objected to the original PI due to lack of specifics for this test. These are provided here.
In addition, it is proposed that the requirements be placed in 5.1.12.4.15 to properly fall under Verifier testing.

5.1.12.4.15.1 (1) is specifically added to ensure that the check valves required for the EOSC does not prevent installer testing of the sections of the piping between the check valves and the EOSC or the remote Central Supply System and the EOSC Check valve.

Related Item

• PI 187

Submitter Information Verification

Submitter Full Name: Mark Allen
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Submittal Date: Sun May 15 08:38:22 EDT 2022
Committee: HEA-PIP

Committee Statement

Committee Action: Rejected but held

Resolution: The proposed revision contains requirements deemed to be new material. The comment will be held for the next revision cycle. Consider locating the new material in 5.1.12.4.4.

Public Input No. 406-NFPA 99-2024 [Section No. 5.1.13.1]

5.1.13.1* Applicability.

5.1.13.1.1

Medical support gases consist of nitrogen NF or instrument air and are used primarily for powering equipment used in patient care procedures. Medical support gas applications require delivery at pressures, cleanliness, or purities specific to their intended function(s) (e.g., to operate medical–surgical tools). Medical support gases shall be permitted to be piped into areas intended for any medical support purpose and, if appropriate to the procedures, to be piped into laboratories.

5.1.13.1.2*

Medical support gas sources shall be permitted to be used for many general utility uses.

5.1.13.1.3

Medical support gas systems shall not convey oxidizing gases other than air or gases not intended for patient ~~or staff~~ respiration.

Statement of Problem and Substantiation for Public Input

The current language conflicts with the definition in 3.3.111. A medical support gas is NOT intended for patient respiration. The phrase "staff respiration" appears completely misplaced as there are no medical gases intended for staff respiratory use.

Submitter Information Verification

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Submittal Date: Mon Jun 03 15:31:04 EDT 2024
Committee: HEA-PIP

Public Input No. 17-NFPA 99-2024 [Section No. 5.1.13.3.7.6]

5.1.13.3.7.6 Instrument Air Standby Headers.

Where instrument air systems are provided with a standby header, the header shall meet the following requirements:

(1) ~~It shall comply~~ Comply with 5.1.3.5.9, except that the number of attached cylinders shall be sufficient for 1 hour of normal operation.

(2) ~~It shall use~~ Use connectors as for medical air in the mandatory requirements of CGA V-1, *Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections* (ANSI B57.1).

(3) ~~It shall enter~~ Enter the system upstream of the final line filters.

(4) ~~It shall automatically~~ Automatically serve the system in the event of a failure of the compressor.

Statement of Problem and Substantiation for Public Input

The proposed change removes redundant text for clarity

Submitter Information Verification

Submitter Full Name: Vincent Della Croce
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Submittal Date: Fri Jan 12 16:40:14 EST 2024
Committee: HEA-PIP

Public Input No. 405-NFPA 99-2024 [Section No. 5.1.14.1.3]

5.1.14.1.3 Qualifications.

5.1.14.1.3.1

The person(s) designated as the responsible facility authority shall be qualified to interpret, implement, and advise on this Code.

5.1.14.1.3.2

Appropriate qualification shall be demonstrated by any of the following:

(1) Completion of an educational program acceptable to the health care facility's governing body and substantially equivalent or superior to either 5.1.14.1.3.2(2) or 5.1.14.1.3.2(3)

(2) Credentialing to the requirements of ASSE/IAPMO/ANSI 6010, *Professional Qualifications Standard for Medical Gas Systems Installers*, and technical competence on the specific equipment and design of that facility

(3) Credentialing to the requirements of ASSE/IAPMO/ANSI 6020, *Professional Qualifications Standard for Medical Gas Systems Inspectors*, and technical competence on the specific equipment and design of that facility

(4) Credentialing to the requirements of ASSE/IAPMO/ANSI 6030, *Professional Qualifications Standard for Medical Gas Systems Verifiers*, and technical competence on the specific equipment and design of that facility

(5) Credentialing to the requirements of ASSE/IAPMO/ANSI 6040, *Professional Qualifications Standard for Medical Gas Maintenance Personnel*, and technical competence on the specific equipment and design of that facility

(6) Credentialing to the requirements of ASSE/IAPMO/ANSI 6060, *Professional Qualifications Standard for Medical Gas System Designer* , and technical competence on the specific equipment and design of that facility

Statement of Problem and Substantiation for Public Input

The new ASSE 6060 requires similar levels of experience as the other cited certifications plus more in-depth code knowledge and far more detailed understanding of system requirements and design fundamentals in order for such a person to completely design and specify a medical gas system. The ASSE 6060 should be added to the list of acceptable qualifications for a RFA.

Submitter Information Verification

Submitter Full Name: David Braidich
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Submittal Date: Mon Jun 03 15:19:35 EDT 2024
Committee: HEA-PIP

Public Input No. 85-NFPA 99-2024 [Section No. 5.1.14.3.4]

5.1.14.3.4*

The medical–surgical vacuum and WAGD systems shall not be used for nonmedical applications~~.~~ ~~(e .g., vacuum steam condensate return).~~

Statement of Problem and Substantiation for Public Input

Items in parentheses should be moved to the annex and not included in the regulatory text. Also - not sure if there were supposed to be comas separating the terms used or if the example was intended to be only a "vacuum steam condensate return".

Submitter Information Verification

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Submittal Date: Mon Mar 11 17:07:10 EDT 2024
Committee: HEA-PIP

Public Input No. 171-NFPA 99-2024 [New Section after 5.1.14.3.6]

New

5.1.14.3.7 Automation

5.1.14.3.7.1 Remotely actuated control of medical gas supply systems (e.g. by building management systems) shall be permitted with the following limitations:

(1) The supply system shall have the capacity to operate entirely independent of the automation system in all respects and shall comply with this code in both standalone (e.g. with automation disabled) and automated operation;

(2) In the event of loss of automatic control for any reason, including loss of power to the supply system or to the automation system, the supply system shall default to standalone operation and disengage from the automation system. Restoration of automatic control shall require a manual restoration operation at the supply system site.

(3) A local and master alarm signal to notify loss of automatic control shall be permitted. If provided, the signal shall appear at the local alarm location and master alarm locations, but may appear at the master alarm as one of the system fault signals described in 5.1.9.2.4(10).

(4) Loss or restoration of automated control shall not create an unsafe condition for the operator or the equipment;

(5) Automatic control shall be via NFPA 72 Class A, B or C pathways;

(6) Local, Master and Area Alarms and all monitors shall be independent of the automation system, except that they may report to the automation system for control or secondary annunciation;

(7) Control enclosures shall include a warning that the system may be controlled remotely. The manufacturer or automation system integrator shall furnish instructions for supply systems and components under automated control. These instructions shall include at least:

a) how to determine if the system or component is under standalone or automated control.

b) how to safely disable automated control;

c) how to safely restore automated control;

(8) All testing in 5.1.12 shall be performed under standalone control. The verifier and responsible facility authority shall, based on risk analysis, determine which tests from 5.1.12 shall be repeated under automated control.

5.1.14.3.7.2 Remotely actuated control of distribution pipeline valves shall be permitted with the following limitations:

(1) a risk management plan detailing and mitigating forseeable risks from the use of an automated valve specific to any position where one is being contemplated shall be conducted by the responsible facility authority prior to permitting installation of the valve. This plan will be part of the permanent records of the facility.

(2) Remotely actuated valves shall comply with 5.1.4.1 through 5.1.4.8 in all respects;

(3) The actuator shall not substitute for, prevent or interfere with manual operation of the valve;

(4) Valve actuators shall, based on the responsible facility authority's risk analysis, either :

(a) be provided with uninteruptable power supplies of sufficient duration to enable them to operate until the normal or essential electrical system power source is available or;

(b) remain in place on power loss.

(5) A local and master alarm signal to notify loss of automatic control shall be permitted. If provided, the signal shall appear at least at the two required master alarms, but may appear at the master alarms as one of the system fault signals described in 5.1.9.2.4(10).

(6) At least one zone patient side of the automated valve shall be provided with an area alarm.

(7) Zone valves which are remotely actuated shall provide a signal at the relevant area alarm(s) on change of state in addition to the pressure/vacuum signal required in 5.1.9.4.2;

(8) Alarms and monitors in pipeline sections controlled by automated valves shall be independent of the automation system, except as per (5) and (7).

(9) Automatic control shall be via NFPA 72 Class A, B or C pathways;

(10) Valves shall be clearly labeled to include a warning that the valve may be actuated remotely;

(11) Verifier testing for automated valves shall be conducted with the automation disabled. Testing of the automation shall be at the discretion of the responsible facility authority following the risk management plan.

(12) Remotely actuated valves shall be specifically designated as such on all as-built drawings.

Statement of Problem and Substantiation for Public Input

Automation is creeping into the medical gas world in the form of remote monitoring and remote control (e.g. via BMS), primarily of sources but occasionally in valves as well. It is sensible that the standard be ahead of this trend and offer some guidance on the subject.

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Submittal Date: Tue Apr 30 08:48:22 EDT 2024
Committee: HEA-PIP

Public Input No. 398-NFPA 99-2024 [New Section after 5.1.14.4.1]

Nitrous oxide system integrity

Periodic testing must include procedures to asses for and mitigate leaks in the nitrous oxide gas system

Statement of Problem and Substantiation for Public Input

There is increasing evidence that there is a significant difference between the amount of nitrous oxide consumed in patient care applications and the amount dispensed from central supplies. Leakage of nitrous from these systems is a potential fire and life safety hazard. Additionally, leaks in nitrous oxide manifold and piping systems cause an increase in the amount of atmospheric release, which has negative environmental consequences. This data has caused some in the Anesthesiology community to recommend against the installation of piped nitrous systems in any new construction in favor of using portable liquified nitrous cylinders.

The purpose of this public input is to allow the technical committee to discuss how to best address this issue by code revision, research foundation referral or task group formation.

Submitter Information Verification

Submitter Full Name: David Lyons
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Submittal Date: Mon Jun 03 12:22:43 EDT 2024
Committee: HEA-PIP

Public Input No. 160-NFPA 99-2024 [New Section after 5.1.14.7.6]

Add new 5.1.14.7*

The Responsible Facility Authority shall ensure that accurate descriptive diagrams of the facilities medical gas systems as installed are maintained and updated when any additions or modifications to the systems are made. These diagrams shall be readily accessible in the event of emergency.

Annex A-5.1.14.7.7 "As built" drawings are important in the event of any medical gas work involving the pipe network. Infection control makes opening ceilings to find or trace piping problematic, so it is particularly essential that the location of the piping and especially the location of all valves be known to ensure quick and effective action in an emergency or during construction.

Renumber remainder

Statement of Problem and Substantiation for Public Input

Up to date as built drawings are essential to fast response in an emergency involving the piping systems and to accurate action even in more controlled situations. It is a well known problem in for facilities seeking to do any kind of medical gas work.

Submitter Information Verification

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Submittal Date: Tue Apr 30 08:04:02 EDT 2024
Committee: HEA-PIP

Public Input No. 462-NFPA 99-2024 [New Section after 5.1.14.7.6]

When isolating a source of supply for maintenance, repairs, testing, or any other procedure that affects an active medical gas central supply system, the RFA shall conduct a risk assessment to determine if the redundancy requirements of this code have been adhered to while the maintenance is conducted.

If the redundancies required by this code cannot be maintained during the isolation, then an additional temporary supply source shall be provided for these maintenance activities or a risk assessment shall be conducted by the RFA to detrminine if additional protections are required.

Statement of Problem and Substantiation for Public Input

During maintenance activities, supply sources are often isolated to perform various tasks on the equipment (i.e. change oil in a vacuum pump, replace motor on an air compressor). Since the code only requires an N+1 redundancy for the medical gas and vacuum systems, the required redundancy on these life support systems may not be active during the maintenance activities. Therefore, putting patients potentially at risk if the system was designed to meet the minimum standard. This change brings this potential for a catastrophic event to light for the RFA so that they can make an assessment as to the risk involved with these activities and mitigate these risks accordingly through the permit-to-work procedures.

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Public Input No. 456-NFPA 99-2024 [Section No. 5.1.14.7.7]

5.1.14.7.7

Procedures, as specified, shall be established for the following:

(1) Maintenance program for the medical air compressor supply system in accordance with the manufacturer's recommendations

(2) Facility testing and calibration procedure that ensures the medical air compressor supply system is producing USP grade medical air at least every three months or more often if recommended by the manufacturer

(3) Facility testing and calibration procedure that ensures carbon monoxide monitors are calibrated at least annually or more often if recommended by the manufacturer

(4) Maintenance program for 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

(5) Maintenance program for the WAGD system to ensure performance

(6) Facility testing and calibration procedure that ensures that oxygen concentration monitors are calibrated at least every three months, or more often if recommended by the manufacturer

(7) Where oxygen sources include concentrator units, maintenance programs for the oxygen concentrator units and all essential subcomponents

Statement of Problem and Substantiation for Public Input

Medical air compressor supply systems are required to produce USP grade medical air, which is then distributed through the pipeline distribution system eventually making its way to the lungs of patients. Due to the variables that can affect the air quality produced by these systems, the quality of the medical air should be checked regularly as is the case with all other USP grade medical gases, which is a requirement for manufacturer's of these gases. Since the hospital is essentially a manufacturer of medical air that is used directly on some of the most compromised patients in the hospital, this responsibility should not be ignored. In many other parts of the world, this USP testing and validation is mandated from as frequent as weekly to the longer time frame suggested in this proposal (every three months). This validation is necessary to ensure that patients are receiving quality of medical air that is required by this code.

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Public Input No. 455-NFPA 99-2024 [Section No. 5.1.14.7.8]

5.1.14.7.8

Audible and visual alarm indicators shall meet the following requirements:

(1) They shall be periodically tested to determine that they are functioning properly.

(2) Records of the test shall be maintained until the next test is performed.

(3) Each alarm shall be identifed as critical or non-critical to assist with emergency reponse protocols.

Statement of Problem and Substantiation for Public Input

The alarms fatigue in the health care setting has become a real issue for the proper response to medical gas alarm conditions and this proposal attempts to help with identifying which medical gas alarms are critical and non-critical. The typical hospital has both critical and non-critical alarms that are monitored by staff. This assessment of the alarms will assist in better understanding the required responses necessary for each type of alarm condition.

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Public Input No. 183-NFPA 99-2024 [Section No. 5.1.14.7.9]

5.1.14.7.9

Medical–surgical vacuum station inlet terminal performance, as required in 5.1.12.4.10.4, 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

(3) If older station inlets cannot flow as detailed in 5.1.12.4.10.4, and after appropriate actions are completed to ensure the inlets are not blocked, misadjusted, worn or damaged, the responsible facility authority in cooperation with the clinicians shall determine if the obtainable flow is sufficient for clinical needs and recommend action accordingly.

Statement of Problem and Substantiation for Public Input

It is understood that older vacuum inlets often struggle to meet the criteria in 5.1.12.4.10 and in many parts of the facility this is not a disqualification as they are adequate for the uses for which they are applied. The proposed addition provides a process to evaluate such terminals and agree to accept them.
The exception is only intended for legacy inlets, as any new inlet would be controlled under the testing for new work.

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Committee: HEA-PIP

Public Input No. 174-NFPA 99-2024 [New Section after 5.2.1.1]

Referring to the risk analysis required in 4.2.2, all patient care locations with risk of patient injury, but no unacceptable risk of death or major injury or other unacceptable risk in the event of total or partial loss of services shall be permitted to be supplied from Category 2 medical gas, vacuum and support gas systems.

Statement of Problem and Substantiation for Public Input

The elimination of 5.1.1.2, 5.2.1.2 and 5.3.1.2 in the 2024 edition removed the essential test for categories, throwing the entire decision onto the risk analysis from 4.2.2. However, 4.2.2 gives no clear guidance for this risk analysis as it applies specifically to medical gas systems.

Adding these clauses reminds the user to refer to this risk analysis, that the risk of greatest concern is total or partial loss of services but that other considerations may also apply, and explicitly ties the categories in Chapter 5 to the categories in Chapter 4.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 173-NFPA 99-2024 [New Section after 5.1.1.2]	
Public Input No. 175-NFPA 99-2024 [New Section after 5.3.1.1]	
Public Input No. 173-NFPA 99-2024 [New Section after 5.1.1.2]	
Public Input No. 175-NFPA 99-2024 [New Section after 5.3.1.1]	

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Submittal Date: Tue Apr 30 09:15:07 EDT 2024
Committee: HEA-PIP

Public Input No. 175-NFPA 99-2024 [New Section after 5.3.1.1]

Referring to the risk analysis required in 4.2.2, all patient care locations with no unacceptable risk of patient injury, and no risk of death or major injury or other unacceptable risk in the event of total or partial loss of services shall be permitted to be supplied from Category 3 medical gas, vacuum and support gas systems.

Statement of Problem and Substantiation for Public Input

The elimination of 5.1.1.2, 5.2.1.2 and 5.3.1.2 in the 2024 edition removed the essential test for categories, throwing the entire decision onto the risk analysis from 4.2.2. However, 4.2.2 gives no clear guidance for this risk analysis as it applies specifically to medical gas systems.

Adding these clauses reminds the user to refer to this risk analysis, that the risk of greatest concern is total or partial loss of services but that other considerations may also apply, and explicitly ties the categories in Chapter 5 to the categories in Chapter 4.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 174-NFPA 99-2024 [New Section after 5.2.1.1]	
Public Input No. 173-NFPA 99-2024 [New Section after 5.1.1.2]	
Public Input No. 174-NFPA 99-2024 [New Section after 5.2.1.1]	

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Public Input No. 342-NFPA 99-2024 [Chapter 15]

~~**Chapter 15** – Dental Gas and Vacuum Systems~~

~~**15.1** – Applicability.~~

~~This chapter shall apply to dental health care facilities that qualify to install dental gas and vacuum piping systems.~~

~~**15.1.1** –~~

~~Category 1 dental piped gas and piped vacuum system requirements shall be applied in facilities where general anesthesia and deep sedation is performed, as defined in 3.3.70.1 and 3.3.70.2 .~~

~~**15.1.2** –~~

~~Category 2 dental piped gas and piped vacuum system requirements shall be applied in facilities where only moderate and minimal sedation is performed, as defined in 3.3.70.3 and 3.3.70.4 .~~

~~**15.1.3** –~~

~~Category 3 dental piped gas and piped vacuum system requirements shall be applied in facilities where minimal or no sedation is performed, as defined in 3.3.70.4 .~~

~~**15.1.4** –~~

~~A single facility shall be permitted to include dental gas and vacuum systems for more than one category of dental piped gas and vacuum systems.~~

~~**15.1.5** –~~

~~An existing system that is not in strict compliance with the requirements of this code shall be permitted to continue in use unless the authority having jurisdiction has determined that such use constitutes a distinct hazard to life.~~

~~**15.1.6** –~~

~~This chapter shall apply to new health care facilities as specified by Section 1.3 unless otherwise specified by 15.1.7 , 15.1.8 , or 15.1.9 .~~

~~**15.1.7** –~~

~~The requirements for Category 1 dental gas and vacuum systems for the operation, management, and maintenance of gas and vacuum piping systems shall apply to both new and existing facilities within the scope of this chapter and in accordance with 5.1.1.5 .~~

~~**15.1.8** –~~

~~The following sections of this chapter shall apply to the operation, management, and maintenance of Category 2 dental gas and vacuum systems in both new and existing facilities:~~

(1) ~~15.1.5~~

(2) ~~Section 15.2~~

(3) ~~15.4.2.4.3~~

(4) ~~15.4.2.4.6~~

(5) ~~15.4.2.4.12~~

(6) ~~15.4.2.5.14~~

(7) ~~15.4.2.6.4~~

(8) ~~15.4.2.9~~

pp. 321 - 377 INTENTIONALLY OMITTED

~~**15.5.8.2.2** –~~

~~Copies of the manufacturer's instructions shall be provided to the facility and maintained at the facility.~~

~~**15.5.8.3** – Maintenance.~~

~~Dental air and vacuum system equipment shall be maintained by a qualified representative of the equipment manufacturer.~~

Replace Chapter 15 with attached proposal.

Additional Proposed Changes

File Name	Description	Approved
Consolidated_CH_15_Option_-_final_track_changes_v2.docx	Chpt 15 replacement - track changes V2	
Consolidated_CH_15_Option_-_final_clean_v2.docx	Chpt 15 replacement - clean v2	

Statement of Problem and Substantiation for Public Input

This proposal is from the Chapter 15 Task Group charged to, “Review and revise the proposed dental facility chapter revisions that were overturned by the correlating committee for the 2024 edition of NFPA 99. Submit Public Input and technical justification for any proposed revisions by the June 4, 2024 Public Input closing date. Per direction from NFPA, duplicative requirements are to be avoided. Where Ch. 5 requirements apply to dental facilities, the Ch. 5 requirements are to be referenced with any needed modifications applicable to dental facilities.”

This change is needed to resolve several problems in Chapter 15 including the following: First, the current category numbering does not align with Chapter 4 risk definitions or Chapter 5 applications (e.g. Chpt 15, Cat 1 is essentially Chapter 4 Cat 2 Risk level). Second, chapter 4 requires a risk assessment but chapter 15 prescriptively sets the Categories base on level of sedation only with no consideration for the range of treatments or patient classifications that would be part of a risk assessment. This proposal seeks to resolve these and related issues.

This proposal is mostly a restructuring of the chapter with limited technical changes only as needed to resolve conflicts created by the restructuring. A key feature is the alignment with Chapter 4 risk definitions and chapter 5 application of those definitions. The proposal includes a new Chpt 15 Cat 1 aligning with the same risk as Chpt 5 Cat 1 and therefore references Chpt 5, Cat 1 for its requirements. The original Chpt 15 Cat 1 becomes the new Chpt 15, Cat 2 as that risk aligns with Cat 2 risk in Chapters 4 and 5. The original Chpt 15, Cat 2 and Cat 3 becomes the new Cat 3 as the risk associated with both align with Cat 3 risk defined in Chapter 4 which is demonstrated in the new annex table referenced from A.15.1.2. The technical content is largely unchanged except that needed to coordinate the restructuring and to clearly define each of the categories. Where related technical changes are needed, they are also submitted under separate Public Input. For example, 15.4.3.4 Cat 3 Warning Systems (Oxygen and Nitrous Oxide) was found to essentially duplicate 15.4.2.10 Warning Systems (Oxygen and Nitrous Oxide) and therefore a separate PI was submitted.

Several versions were considered for this restructured Chpt 15. All of them aligned with Chapter 4 risk categories. One version (not submitted) maximized references to Chapter 5 to response to the committee charge to avoid duplication and resulted in the shortest overall chapter. However, while it minimized duplication, the task group unanimously concluded that this version was completely unusable and would reduce compliance and compromise patient safety due to the complete lack of chapter continuity and readability. The submitted proposal includes the exact same level of detail that is currently in Chapter 15 but restructured to align with Chapters 4 and 5. This level of detail was determined by the task group to be the minimum necessary to maintain a usable document to support compliance and patient safety.

The new Categories 1 and 2 both allow for all levels of sedation including General Anesthesia. The

new Cat 1 aligns directly with Chapter 4 and 5 and is justified below. While the new Cat 2 allows for all levels of sedation, the overall risk is limited which aligns with the with the types of procedures and patients normally intended for this category (see the Annex example). This aligns with the implied assumptions in the previous Cat 1 but are now explicitly stated. Note that the Annex table is not intended to mandate specific patient or procedure limitations but provides an example of how the risk determination is not only determined by the level of sedation but also the range of procedures and patient classification. This new annex material highlights the importance of the Risk Assessment required by Chapter 4 and provides a framework for the user to consider.

The inclusion of the new Chpt 15 Cat 1 and its alignment with Chpt 5 Cat 1 is a critical feature of this proposal as it reflects the trends in dentistry and provides a complete framework for any level of risk which the risk assessment may arrive at. In dentistry, the majority of oral healthcare occurs in an outpatient clinic setting (e.g. typical dental office). With rapid advancements in healthcare, dentistry has also seen an increase in the types and complexity of procedures and the growth of ambulatory or outpatient sedation and anesthesia. The population that dentists serve has widened to include older, more medically complex patients, including those with special healthcare needs. Additionally, it is anticipated that dental surgical facilities will expand to address the increasing need for access to facilities for more complex dental procedures and to address the growing demand for advanced anesthesia techniques. The proposed chapter structure better accommodates all such trends addressing the full range of potential usage and ensures that the facility requirements match the appropriate risk.

The proposed consolidation of the original Chpt 15, Cat 2 and Cat 3 into the new Cat 3 is supported by the new annex table (referenced from A.15.1.2) which considers not just the level of sedation but also the limitations on patient health history and complexity of treatment normally considered for such a dental facility. These considerations arrive at the same risk level. This is not a departure from the original chapter 15 as these same considerations were implied in how each category was structured and the system requirements that were included. For example, the original Cat 2 and Cat 3 dental air and vacuum systems were exactly the same. The only difference between the categories was that original Cat 2 included requirements for Oxygen and Nitrous Oxide. These medical gases may or may not be desirable or necessary in the new Category 3 but the requirements are included where they are used.

The new chapter 15 structure aligns with Chapters 4 and 5 risk requirements, removing previous contradictions and addresses the main concerns of the correlating committee. It provides a more complete and usable chapter framework to accommodate the trends in dental care, improving patient safety and code compliance.

For the future, the task group highly recommends that an exploratory committee be initiated to completely separate the dental requirements into its own standard/code due to the unique code users, unique range of care, specialized providers and limitations on patient classifications served. We believe, this would lead to even greater improvements in compliance and patient safety that can’t be achieved within the current framework.

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Chapter 15 Dental Gas and Vacuum Systems

15.1 Applicability.

This chapter shall apply to dental health care facilities that qualify to install dental gas and vacuum piping systems.

15.1.1

This chapter shall also apply to the altered, renovated, or modernized portions of existing systems or individual components.

15.1.1.1

Where the terms medical gas or medical support gas occur, the provisions shall apply to all piped systems for oxygen, nitrous oxide, medical air, carbon dioxide, helium, nitrogen, instrument air, and mixtures thereof. Wherever the name of a specific gas service occurs, the provision shall apply only to that gas.

15.1.1.2 5

An existing system that is not in strict compliance with the requirements of this code shall be permitted to continue in use unless the authority having jurisdiction has determined that such use constitutes a distinct hazard to life.

15.1.2 System Category Criteria.*

The dental health care facility's governing body shall designate the building system risk categories, in accordance with Sections 4.1 and 4.2.

A.15.1.2 Sample Risk Assessment Chart for Dental Facilities.

This sample risk assessment chart shows the types of treatments, sedation, and patient risk considerations that may be part of a facility specific risk assessment.

Reference	Sedation Levels	Risk of loss of piped gases presuming no user intervention*	Surgical / Procedural Risks - Range of Clinical Procedures*	American Society of Anesthesiologists (ASA) Physical Status (PS)*
Chpt 15 Cat 1 Chpt 5 Cat 1	General/Deep, Moderate, Minimal	Likely to cause major injury or death.	All levels of surgical risk (Chapter 5 patients considers both emergent and elective procedures). Would include dental procedures such as head and neck procedures such as orthognathic surgery, reconstructive (nonprosthetic) surgery, major cancer resections involving significant portions of the jaw or oropharyngeal structures, and open reduction and internal fixation of complex fractures of the face. May also include certain anesthesia procedures where neuromuscular blockade is used without immediate reversal agents such as suggamadex.	All levels of physical status. ASA PS 1-5 including PS 1E-5E
Chpt 15 Cat 2	General/Deep, moderate, minimal	Likely to cause minor injury.	Elective Surgery only, not emergent. Dentoalveolar procedures and superficial maxillofacial surgical procedures that carry very low surgical risk of death or loss of limb or function.	ASA PS 1-3

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			Might exclude head and neck procedures such as orthognathic surgery, reconstructive (nonprosthetic) surgery, major cancer resections involving significant portions of the jaw or oropharyngeal structures, and open reduction and internal fixation of complex fractures of the face. May also exclude certain anesthesia procedures where neuromuscular blockade is used without immediate reversal agents such as suggamadex.	
Chpt 15 Cat 3	Moderate/ Minimal or No Sedation	Not likely to cause injury. May cause discomfort.	Elective or Low Risk Procedures Dentoalveolar procedures and superficial surgical procedures that carry very low surgical risk of death or loss of limb or function	ASA PS 1-2, medically optimized 3 ASA 3, not medically optimized, or ASA IV for low-risk surgery (dental care) with either local anesthesia and/ or nitrous oxide only.

15.1.2.1~~X~~

The category of risk applied to each dental gas and vacuum system serving a space shall be independent of the category of risk applied to other systems serving that same space.

15.1.2.2~~X~~

~~Category 1 dental piped gas and piped vacuum system requirements shall be applied in facilities where general anesthesia and deep sedation is performed, as defined in 3.3.70.1 and 3.3.70.2.~~

Category 1 piped gas and vacuum system requirements shall be applied in dental facilities where Category 1 Risk is determined in Section 15.1.2 in accordance with section 4.2.

15.1.2.2.1
Category 1 piped gas and vacuum system requirements shall comply with Chapter 5 Section 5.1.

15.1.2.3~~1~~

~~Category 1 dental piped gas and piped vacuum system requirements shall be applied in facilities where general anesthesia and deep sedation is performed, as defined in 3.3.70.1 and 3.3.70.2.~~

Category 2 piped gas and vacuum system requirements shall be applied in dental facilities where Category 2 Risk is determined in Section 15.1.2 in accordance with section 4.2.

15.1.2.4

Category 3 piped gas and vacuum system requirements shall be applied in dental facilities where Category 3 Risk is determined in Section 15.1.2 in accordance with section 4.2 and only moderate, minimal or no sedation is performed.

15.1.2.4.~~2~~1
Deep sedation and general anesthesia shall not be permitted.

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15.1.2.4.2*

Facilities in this category may elect to have no medical gases as defined in 15.3.1.2. If piped medical gases are incorporated, such systems shall meet the requirements in this category.

A.15.1.2.4.2~~1~~
Facilities performing moderate sedation normally incorporate medical gases. Facilities performing minimal or no sedation do not normally utilize medical gases. If they choose to incorporate piped- systems, such systems would need to comply with the requirements within Category 3 dental gas systems.

~~**15.1.3**~~
~~Category 3 dental piped gas and piped vacuum system requirements shall be applied in facilities where minimal or no sedation is performed, as defined in 3.3.70.4.~~

15.1.3~~4~~
A single facility shall be permitted to include dental gas and vacuum systems for more than one category of dental piped gas and vacuum systems.

~~**15.1.5**~~
~~An existing system that is not in strict compliance with the requirements of this code shall be permitted to continue in use unless the authority having jurisdiction has determined that such use constitutes a distinct hazard to life.~~

15.1.4~~6~~
This chapter shall apply to new ~~health care~~ facilities as specified by Section 1.3 unless otherwise specified by 15.1.5~~7~~, and 15.1.6~~8, or 15.1.9~~.

15.1.5~~7~~
The requirements for Category 1 dental gas and vacuum systems for the operation, management, and maintenance of gas and vacuum piping systems shall apply to both new and existing facilities within the scope of this chapter and in accordance with 5.1.1.5.

15.1.6~~8~~
The following sections of this chapter shall apply to the operation, management, and maintenance of Category 3~~2~~ dental gas and vacuum systems in both new and existing facilities:

(1) 15.1.1.2 ~~15.1.5~~

(2) 15.1.9 ~~Section 15.2~~

(3) 15.3.2.3.3 ~~15.4.2.4.3~~

(4) 15.3.2.3.6 ~~15.4.2.4.6~~

(5) 15.3.2.3.12 ~~15.4.2.4.12~~

(6) 15.3.2.14.16 ~~15.4.2.5.14~~

(7) 15.3.2.5.5 ~~15.4.2.6.4~~

(8) 15.3.2.9 ~~15.4.2.9~~

(9) 15.2.3.10

~~**15.1.7~~9**~~
~~The following sections of this chapter shall apply to the operation, management, and maintenance of Category 3 dental gas and vacuum systems in both new and existing facilities:~~

~~(1) 15.1.5~~

~~(2) Section 15.2~~

~~(3) 15.5.8~~

15.1.7 ~~10~~
Where the term *responsible facility authority* is used, that entity shall follow the requirements of 5.1.14.1.

15.1.8 ~~2~~ Nature of Hazards of Gas and Vacuum Systems.
Potential fire and explosion hazards associated with positive-pressure dental gas systems and vacuum systems shall be considered in the design, installation, testing, operation, and maintenance of these systems.

~~**15.3 Category 1 Dental Gas and Vacuum Systems**~~

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~~Facilities that perform deep sedation and general anesthesia associated with dental treatment and where Category 1 Risk is determined per Chapter 4 shall comply with 5.1.~~

15.~~2~~3 Category 2~~1~~ Dental Gas and Vacuum Systems.
15.~~2~~3.1 General.
Facilities that perform deep sedation and general anesthesia associated with dental treatment and where Category 2 Risk or lower is determined per Chapter 4 shall meet the requirements for Category 2~~1~~ dental gas and vacuum systems.

15.~~2~~3.2 Category 2~~1~~ Medical Gas Systems (Dental).
15.~~2~~3.2.1 Medical Gas and Vacuum Sources.
15.~~2~~3.2.1.1 Central Supply System Identification and Labeling.
Category 2~~1~~ systems shall comply with 5.1.3.1.

15.~~2~~3.2.1.2 Central Supply Operations.
Category 2~~1~~ systems shall comply with 5.1.3.2.

15.~~2~~3.2.1.3 Central Supply System Locations.
Category 2~~1~~ systems shall comply with 5.1.3.3.

15.~~2~~3.2.1.4 Central Supply Systems.
Category 2~~1~~ systems shall comply with 5.1.3.5.

15.~~2~~3.2.1.5 Medical Air Supply Systems.
Category 2~~1~~ systems shall comply with 5.1.3.6, except as follows:

(1) Medical air compressors, dryers, aftercoolers, filters, and regulators shall be permitted to be simplex.

(2) The facility staff shall develop an emergency plan to deal with the loss of medical air.

15.~~2~~3.2.1.6 Oxygen Supply Systems Using Concentrators.
Category 2~~1~~ systems shall comply with 5.1.3.9, except as follows:

(1) Oxygen supply systems using concentrators shall be permitted to consist of two sources, one of which being a cylinder header with sufficient cylinder connections for an average day's supply.

15.~~2~~3.2.1.7 Dental–Surgical Vacuum Systems.
Category 2~~1~~ systems shall comply with 5.1.3.7, except as follows:

(1) Dental–surgical vacuum systems shall be permitted to be simplex.

(2) The facility staff shall develop an emergency plan to deal with the loss of dental–surgical vacuum.

15.~~2~~3.2.1.8 WAGD Systems.
Category 2~~1~~ systems shall comply with 5.1.3.8, except as follows:

(1) ~~Medical~~ WAGD pumps shall be permitted to be simplex.

(2) The facility staff shall develop an emergency plan to deal with the loss of WAGD.

15.~~2~~3.2.2 Valves.
Category 2~~1~~ systems shall comply with 5.1.4.

15.~~2~~3.2.3 Station Outlets and Inlets.
Category 2~~1~~ systems shall comply with 5.1.5.

15.~~2~~3.2.4 Manufactured Assemblies.
Category 2~~1~~ systems shall comply with 5.1.6.

15.~~2~~3.2.5 Surface-Mounted Medical Gas Rails.

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Category 2~~1~~ systems shall comply with 5.1.7.

15.2~~3~~.2.6 Pressure and Vacuum Indicators.
Category 2~~1~~ systems shall comply with 5.1.8.

15.2~~3~~.2.7 Warning Systems.
Warning systems associated with Category ~~1~~2 systems shall provide the master, area, and local alarm functions of a Category 1 system as required in 5.1.9, except as follows:

(1) Warning systems shall be permitted to be a single alarm panel.

(2) The alarm panel shall be located in an area of continuous surveillance while the facility is in operation.

(3) Pressure and vacuum switches/sensors shall be mounted at the source equipment with a pressure indicator at the master alarm panel.

15.2~~3~~.2.8 Medical Gas Distribution.
Category 2~~1~~ systems shall comply with 5.1.10.

15.2~~3~~.2.9 Labeling and Identification.
Category 2~~1~~ systems shall comply with 5.1.11.

15.2~~3~~.2.10 Performance Criteria and Testing ~~(~~for Medical Gas, Medical–Surgical Vacuum, and WAGD systems~~)~~.
Category 2~~1~~ systems shall comply with 5.1.12.

15.2~~3~~.2.11 Support Gases.
Category 2~~1~~ systems shall comply with 5.1.13, except as follows:

(1) Nitrogen source equipment shall be permitted to be installed in enclosures for Category 3 medical gases or in a mechanical room.

(2) Nitrogen source equipment shall include the following:

(a) One or more cylinders of nitrogen NF, sufficient for at least one average day's supply

(b) A manifold, if primary and secondary cylinders are provided

(c) A line pressure regulating valve

(d) A check valve downstream from the pressure regulating valve

(e) A pressure relief valve set at 50 percent above the normal line pressure and located downstream from the check valve

(f) A pressure relief valve discharge piped to the outdoors at a point that will not create a probable hazard and that is turned down to prevent the entry of rain or snow

15.2~~3~~.2.12 Medical Gas and Vacuum Operation and Management.
Category 2~~1~~ systems shall comply with 5.1.14.

15.2~~3~~.3 Category 2~~1~~ Dental Air and Vacuum Piping Systems.
15.2~~3~~.3.1 General.
15.2~~3~~.3.1.1
Dental vacuum systems shall include dental vacuum and nitrous oxide scavenging.

15.2.3.3.1.2
Dental vacuum and nitrous oxide scavenging systems as defined in Chapter 3 are independent of Medical-Surgical Vacuum and WAGD Systems.

15.2.3.3.1.2.1
Dental vacuum and n~~N~~itrous oxide scavenging systems shall not be used for WAGD service.

15.2.3.3.1.3
Dental Air systems as defined in Chapter 3 are independent of Medical Air and all other medical gas systems.

15.2.3.3.1.3.1

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Dental Air ~~Medical Air~~ shall not ~~only~~ be used for Medical Air purposes ~~in accordance to 5.1.3.6.2~~.

15.~~2~~3.3.2 Equipment Locations for Dental Air and Vacuum Systems.
15.~~2~~3.3.2.1 General.
Any of the following systems shall be permitted to be located together in the same room:

(1) Medical air compressor supply sources

(2) Dental air compressor sources and reserve headers

(3) Dental–surgical vacuum sources

(4) Dental vacuum sources

(5) WAGD sources

(6) Any other compressor, vacuum pump, or electrically powered machinery

15.~~2~~3.3.2.2 Cylinders and Containers.
Cylinders and containers for gases shall be handled in accordance with Chapter 11.
15.~~2~~3.3.2.3 Ventilation.
The following source locations for motor-driven equipment shall be adequately ventilated to prevent accumulation of heat:

(1) Medical air sources

(2) Instrument air sources

(3) Dental compressed air sources

(4) Dental–surgical vacuum sources

(5) Dental vacuum sources

(6) WAGD sources

15.~~2~~3.3.3 Dental Gas and Dental Vacuum Source Equipment.
15.~~2~~3.3.3.1
The capacity of source equipment shall be based on the design requirements for the facility, including the number of gas outlets, vacuum inlets, and other connections, and their individual capacities.

15.~~2~~3.3.3.2
The system design requirements shall be included in the data used for testing and verifying the operation of the gas and vacuum piping systems.

15.~~2~~3.3.4* Dental Air.
15.~~2~~3.3.4.1 General.
15.~~2~~3.3.4.1.1
Dental air use shall ~~comply~~ be used for purposes congruent with the following~~with the following requirements~~:

(1) Dental air shall be used for driving dental tools.

(2) Dental air shall be permitted to be used to supply air-driven equipment.

(3) Dental compressed air shall not be permitted to be used for respiration.

15.~~2~~3.3.4.1.2
Dental air outlets shall not be interchangeable with any other gas outlets
including but not limited to oxygen, nitrous oxide, medical air, instrument air, and nitrogen.

15.~~2~~3.3.4.2 Dental Air Compressor Units.
15.~~2~~3.3.4.2.1
Dental air compressor units shall include dental air compressors, vibration isolation, air receivers, coalescent air filters, adsorption dryers, exhaust silencer/filters, moisture indicators, and service access manifolds, electrical disconnects, motor wiring, and controls.

15.~~2~~3.3.4.2.2
Air compressors shall be scroll dental, reciprocating dental, or the oil-free dental types.

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15.~~23~~.3.4.2.3
Dental air sources for compressors located inside the building shall meet the following requirements:

(1) Be located in a space where no chemical-based materials are stored or used

(2) Be located in a space that is not used for patient treatment or dental procedures

(3) Be taken from a room or space in which there is no open or semi-open discharge from a dental vacuum or dental scavenging system

(4) Drawn from a remote location, such as the building return air system, when the compressor is located in a room with an open or semi-open discharge from a dental vacuum or dental scavenging system

15.~~23~~.3.5* Dental Vacuum.
15.~~23~~.3.5.1 General.
15.~~23~~.3.5.1.1
Dental vacuum shall be used for oral evacuation and nitrous oxide scavenging.

15.~~23~~.3.5.1.2
Dental vacuum inlets shall not be interchangeable with any other vacuum inlets, including dental–surgical vacuum.

15.~~23~~.3.5.2 Dental Vacuum Units.
15.~~23~~.3.5.2.1
Dental vacuum pumps shall comply with both of the following:

(1) Pumps shall be dental dry vacuum or dental liquid (wet) ring pumps.

(2) Pumps shall be oil-free or oil-lubricated and suitable for nitrous oxide scavenging.

~~Dental vacuum units shall include dental vacuum pumps, vibration isolation, separation tanks, vacuum inlet, vacuum exhaust, condensate drain, motor wiring, and controls.~~
~~**15.23.3.5.2.2**~~
~~Dental vacuum pumps shall be dental dry vacuum or dental liquid (wet) ring pumps. Pumps shall be oil-free or oil-lubricated, and suitable for nitrous oxide scavenging.~~
15.~~23~~.3.5.2.~~23~~
Dental vacuum exhaust shall comply with one of the following requirements:

(1) Be exhausted to the outdoors in accordance with the manufacturer's recommendations

(2) Be filtered and diffused locally with a ULPA filter element capable of retaining 99.99 percent of particulates

(3) Discharge outdoors if used for nitrous oxide scavenging

15.~~23~~.3.5.2.~~34~~
Dental vacuum system piping shall comply with all of the following:

(1) Horizontal piping in dental vacuum systems shall be sloped a minimum of 7 mm per 3.05 m (1/4 in. per 10 ft) toward the vacuum source equipment.

(2) Horizontal piping shall include no sags or low points that would permit fluid or debris to accumulate in the piping.

(3) Voids in the vacuum piping shall be avoided to prevent buildup and obstructions.

(4) Accessible cleanouts shall be permitted to be installed in the vertical downflow pipe to clear obstructions, where necessary.

(5) Dental vacuum cleanouts shall not to be installed on horizontal piping.

(6) Dental vacuum inlets shall be capable of 283 L/min (10 SCFM) or greater flow capacity.

15.~~23~~.3.6 Nitrous Oxide Scavenging.
15.~~23~~.3.6.1 General.
15.~~23~~.3.6.1.1
The use of scavenging shall be limited to portions of dental facilities where moderate or minimal sedation is administered. WAGD shall be provided where the dental treatment involves general anesthesia or deep sedation.

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15.23.3.6.1.2
Active nitrous oxide scavenging shall include the use of a nasal mask on the patient. The nasal mask shall be connected to a scavenging inlet in the dental vacuum system through a flow-limiting adapter.

15.23.3.6.1.3
Nitrous oxide scavenging inlets shall not be interchangeable with any other vacuum inlets, including medical–surgical vacuum, dental vacuum, and WAGD.

15.23.3.6.2 Connection to Dental Vacuum.
Scavenging connections to the dental vacuum system shall be a direct high-volume evacuation (HVE) connection to a high-volume vacuum port with a capacity of 45 L/min (1.6 cfm).

15.23.3.7 Piping for Dental Air and Vacuum Systems.
15.23.3.7.1 General.
15.23.3.7.1.1
Piping for dental compressed air systems shall comply with 15.23.3.7.2.

15.23.3.7.1.2
Piping for dental vacuum systems and scavenging systems shall comply with 15.23.3.7.3.

15.23.3.7.2 Piping for Dental Air Systems.
15.23.3.7.2.1 General.
Pipe, fittings, and joints in piping for dental compressed air systems shall be in accordance with 15.23.3.7.2.2 through 15.23.3.7.2.5.

15.23.3.7.2.2 Pipe.
Piping materials for dental air systems shall comply with one of the following:
(1) ASTM B88, *Standard Specification for Seamless Copper Water Tube,* Type L or K
(2) ASTM B819, *Standard Specification for Seamless Copper Tube for Medical Gas Systems,* Type L or K
(3) ASTM B280, *Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service*, ACR tube (O.D. size)
(4) ASTM B103/B103M, *Standard Specification for Phosphor Bronze Plate, Sheet, Strip, and Rolled Bar*, listed corrugated medical tubing (CMT) fabricated from copper alloy No. 51000 strip, as follows:
(a) Having a design margin of 3.5
(b) Externally coated with a nonmetallic sheath marked with the manufacturer's marking
(c) Listing includes testing to demonstrate that CMT systems can be consistently gas-purged with results equivalent to comparable medical gas copper tubing

15.23.3.7.2.3 Copper Tube.
Copper tube shall be hard temper or annealed (soft temper).

15.23.3.7.2.4 Fittings.
Fittings for dental air piping systems shall be permitted to be any of the following acceptable joining methods:

(1) Brazed or soldered fittings complying with ASME B16.22, *Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings*

(2) Brazed fittings complying with ANSI/ASME B16.50, *Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings*

(3) Brazed fittings complying with ASME B16.22, with socket depths equal to or greater than braze-joint pressure fittings complying with ANSI/ASME B16.50

(4) Flared fittings complying with ASME B16.26, *Cast Copper Alloy Fittings for Flared Copper Tubes*

(5) Compression fittings (3/4 in. maximum size)

(6) Axially swaged fittings shall include metal-to-metal seats, shall be rated for not less than 538°C (1000°F) and 2070 kPa (300 psi), and provide permanent, nonseparable joints. Fittings shall be installed by qualified technicians in accordance with the manufacturer's instructions. ~~Axially swaged fittings complying with 15.4.4.2.3.5~~

15.23.3.7.2.5 Joints.
Joints for piping under 15.23.3.7.2 shall comply with the following:

(1) Joints shall be brazed, soldered, threaded, flared, or the compression type.

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(2) Where joints are brazed, they shall comply with the requirements of ~~15.42.6~~ 15.~~2.3.8.9~~2.3.8.10.

(3) Soldered joints shall be made in accordance with ASTM B828, *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 B32, *Standard Specification for Solder Metal*.

15.~~2~~3.3.7.3 Piping for Dental Vacuum Systems and Scavenging Systems.
15.~~2~~3.3.7.3.1 General.
Piping for dental vacuum systems and scavenging systems shall be copper, PVC plastic, or CPVC plastic.

15.~~2~~3.3.7.3.2 Copper Piping.
Copper piping under 15.~~2~~3.3.7.3 shall be in accordance with 15.~~2~~3.3.7.3.2.1~~(A)~~ through 15.~~2~~3.3.7.3.2.3~~(C)~~.

15.2.3.7.3.2.1~~(A)~~ Copper Tube.
Copper tubing shall be hard temper or annealed (soft temper) and comply with the following:

(1) ASTM B88, *Standard Specification for Seamless Copper Water Tube,* Type L or K

(2) ASTM B819, *Standard Specification for Seamless Copper Tube for Medical Gas Systems,* Type L or K

(3) ASTM B280, *Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service*, ACR tube (O.D. size)

15.2.3.7.3.2.2~~(B)~~ Copper Fittings.
Copper fittings shall comply 15.2.3.7.2.4(1)- 15.2.3.7.2.4(5).

~~with the following:~~

~~(1) Brazed or soldered fittings conforming to ASME B16.22, *Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings*~~

~~(2) Brazed fittings conforming to ANSI/ASME B16.50, *Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings*~~

~~(3) Brazed fittings conforming to ASME B16.22 with socket depths equal to or greater than braze-joint pressure fittings conforming to ANSI/ASME B16.50~~

~~(4) Flared fittings conforming to ASME B16.26, *Cast Copper Alloy Fittings for Flared Copper Tubes*~~

~~(5) Compression fittings (~~3/4~~ in. maximum size)~~

15.2.3.7.3.2.3~~(C)~~ Joints for Copper Piping.
Joints in copper tubing shall comply 15.2.3.7.2.5.~~with the following:~~

~~(1) Joints shall be brazed, soldered, threaded, flared, or the compression type.~~
~~(2) Where joints are brazed, they shall comply with the requirements of 15.4.6.~~
~~(3) Soldered joints shall be made in accordance with ASTM B828, *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 B32, *Standard Specification for Solder Metal*.~~

15.~~2~~3.3.7.3.3 PVC Plastic Piping.
PVC plastic piping under 15.~~3~~2.3.7.3 shall comply with the following:

(1) PVC plastic pipe shall be Schedule 40 or Schedule 80, conforming to ASTM D1785, *Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120*.

(2) PVC plastic fittings shall be Schedule 40 or Schedule 80 to match the pipe, conforming to ASTM D2466, *Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40*, or ASTM D2467, *Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80*.

(3) Joints in PVC plastic piping shall be solvent-cemented in accordance with ASTM D2672, *Standard Specification for Joints for IPS PVC Pipe Using Solvent Cement*.

15.~~2~~3.3.7.3.4 CPVC Plastic Piping.
CPVC plastic piping under 15.~~2~~3.3.7.3 shall comply with the following:

(1) CPVC IPS plastic pipe shall be Schedule 40 or Schedule 80, conforming to ASTM F441/F441M, *Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80*.

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(2) CPVC IPS plastic fittings shall be Schedule 40 or Schedule 80 to match the pipe, conforming to ASTM F438, *Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40*, or ASTM F439, *Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80*.

(3) CPVC CTS plastic pipe and fittings ½ in. through 2 in. nominal size shall be SDR 11, conforming to ASTM D2846/D2846M, *Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems*.

(4) Solvent cement for joints in CPVC plastic piping shall comply with ASTM F493, *Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride)(CPVC) Plastic Pipe and Fittings*.

15.2.3.8 Installation of Dental Air, and Dental Vacuum Piping.
15.2.3.8.1 General.
15.2.3.8.1.1
Dental Gas and dental vacuum piping systems shall be as listed in Section 15.2.

15.2.3.8.1.2
Piping materials shall be as listed in 15.2.3.7.

~~**15.2.3.8.1.3 Piping for Nitrogen.**~~
~~Nitrogen piping in dental facilities shall comply with 15.2.4.2, including cleaning for oxygen service.~~

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

~~**15.3.5.3 Minimum Pipe Sizes.**~~
~~The minimum size of the following piping shall be as follows:~~

~~(1) Category 3 oxygen piping shall be not less than DN10 (NPS ⅜ in.) (½ in. O.D.) size.~~

~~(2) Category 3 nitrous oxide piping shall be not less than DN8 (NPS ¼ in.) (⅜ in. O.D.) size.~~

~~(3) Category 3 oxygen piping shall be at least 1 size larger than piping for nitrous oxide.~~

15.2.3.8.3 Location of Piping.

Piping shall not be located where subject to contact with oil.

15.2.3.8.4 Protection of Piping.
15.2.3.8.4.1
Piping shall be protected against freezing, corrosion, and physical damage.

15.2.3.8.4.2
Piping exposed in corridors and other locations where subject to physical damage from the movement of equipment shall be protected.

15.2.3.8.5 Pipe Support.
Piping shall be supported from the building structure.

15.2.3.8.5.1~~3.5.6.2~~
Hangers and supports shall comply with and be installed in accordance with MSS SP-58, *Pipe Hangers and Supports — Materials, Design, Manufacture, Selection, Application, and Installation*.

15.2.3.8.5.2~~3.5.6.3~~
Hangers and supports shall be sized for the tube or pipe being supported.

15.2.3.8.5.3~~3.5.6.4~~
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.

15.2.3.8.5.4~~3.5.6.5~~
The maximum support spacing for copper tube shall be in accordance with Table 15.3.5.6.5.

Table 15.3.5.6.5 Maximum Copper Tube Support Spacing

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Pipe Size	Hanger Spacing mm	ft
DN8 (NPS 1/4) (3/8 in. O.D.)	1520	5
DN10 (NPS 3/8) (1/2 in. O.D.)	1830	6
DN15 (NPS 1/2) (5/8 in. O.D.)	1830	6
DN20 (NPS 3/4) (7/8 in. O.D.)	2130	7
DN25 (NPS 1) (1 1/8 in. O.D.)	2440	8
DN32 (NPS 1 1/4) (1 3/8 in. O.D.)	2740	9
DN40 (NPS 1 1/2) (1 5/8 in. O.D.) and larger	3050	10
Vertical risers, all sizes, every floor, but not to exceed	4570	15

15.2.3.8.5~~3.5.6.6~~
The maximum support spacing for plastic pipe shall be in accordance with Table 15.4.5.6.6.

Table 15.3.5.6.6 Maximum Plastic Pipe Support Spacing

Pipe Size	Hanger Spacing mm	ft
DN15 (NPS 1/2) (5/8 in. O.D.)	1220	4
DN20 (NPS 3/4) (7/8 in. O.D.)	1220	4
DN25 (NPS 1) (1 1/8 in. O.D.)	1320	4.33
DN32 (NPS 1 1/4) (1 3/8 in. O.D.)	1320	4.33
DN40 (NPS 1 1/2) (1 5/8 in. O.D.)	1420	4.66
DN50 (NPS 2) (2 3/8 in. O.D.)	1420	4.66
DN65 (NPS 2 1/2) (2 7/8 in. O.D.) and larger	1520	5
Vertical risers, all sizes, every floor, but not to exceed	3040	10

15.2.3.8.6 Underground Piping Outside of Buildings.

15.2.3.8.6.1~~3.5.7.1~~
Buried piping outside of buildings shall be installed below the local level of frost penetration.

15.2.3.8.6.2~~3.5.7.2~~
The installation procedure for underground piping shall prevent physical damage to the piping while being back-filled.

15.2.3.8.6.3~~3.5.7.3~~
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.

15.2.3.8.6.4~~3.5.7.4~~
Buried piping that is subject to surface loads shall be buried at a depth that will protect the piping, its enclosure, or both, from excessive stresses.

15.2.3.8.6.5~~3.5.7.5~~
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.

15.2.3.8.6.6~~3.5.7.6~~

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

15.2.3.8.6.7~~3.5.7.7~~
Backfill shall be clean, free from material that can damage the pipe, and compacted.

15.2.3.8.6.8~~3.5.7.8~~
A continuous warning tape or marker shall be placed immediately above the piping or its enclosure to clearly identify the pipeline by specific name.

15.2.3.8.6.9~~3.5.7.9~~
A continuous warning means shall also be placed above the pipeline at approximately one-half the depth of burial.

15.2.3.8.6.10~~3.5.7.10~~
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.

15.2.3.8.7 Underground Piping Within Buildings.

15.2.3.8.7.1
The installation procedure for underground piping shall prevent physical damage to the piping while being back-filled.

15.2.3.8.7.2
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.

15.2.3.8.7.3
The piping shall be backfilled with clean sand or gravel.

15.2.3.8.8 Piping Within Floor Slabs Prohibited.
Dental gas and vacuum piping shall not be installed within floor slabs.

15.~~4.5.10~~2.3.8.9 Hose and Flexible Connectors.
15.~~4.5.10~~2.3.8.9.1
Hose and flexible connectors, both metallic and nonmetallic, shall be no longer than necessary nor penetrate or be concealed in walls, floors, ceilings, or partitions.

15.~~4.5.10~~2.3.8.9.2
Hose and flexible connectors, metallic or nonmetallic, shall have a minimum burst gauge pressure of 6895 kPa (1000 psi).

15.~~4.5.10~~2.3.8.9.3
Medical gas hose and flexible connectors shall be oxygen compatible.

15.~~4.5.10~~2.3.8.9.4
Hose and flexible connectors shall be clearly identified as to the gas content.

15.~~4.5.10~~2.3.8.9.5
Hose and flexible connectors for dental medical gases shall be gas-specific and not be permitted to conduct any other gas, gas mixture, or liquid.

15.~~2.3.8.9~~2.3.8.10 Brazing Copper Tubing.
15.~~2.3.8.9~~2.3.8.10.1 Qualification of Brazing Procedures and Brazers.

15.~~2.3.8.9~~2.3.8.10.1.1 ~~3.6.1.1~~
Brazing procedures and brazer performance for the installation of dental piping shall be in accordance with either Section IX, "Welding and Brazing Qualifications," of the ASME *Boiler and Pressure Vessel Code,* or AWS B2.2/B2.2M, *Specification for Brazing Procedure and Performance Qualification*, both as modified by ~~15.4.6~~15.~~2.3.8.9~~2.3.8.10.

15.~~2.3.8.9~~2.3.8.10.1.2 ~~3.6.1.2~~
Brazers shall be qualified by visual examination of the test coupons followed by sectioning.

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15.~~2.3.8.9~~2.3.8.10.1.3 ~~3.6.1.3~~
The brazing procedure specification shall address cleaning, joint clearance, overlap, internal purge gas, purge gas flow rate, and filler metal.

15.~~2.3.8.9~~2.3.8.10.1.4 ~~3.6.1.4~~
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.

15.~~2.3.8.9~~2.3.8.10.1.5 ~~3.6.1.5~~
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 record 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.

15.~~2.3.8.9~~2.3.8.10.1.6 ~~3.6.1.6~~
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.

15.~~2.3.8.9~~2.3.8.10.1.7 ~~3.6.1.7~~
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.

15.~~2.3.8.9~~2.3.8.10.2 ~~15.2.3.8.10~~ Brazed Joints.

15.~~2.3.8.9~~2.3.8.10.2.1 ~~3.6.2.1~~
Brazed tube joints shall be of the socket type.

15.~~2.3.8.9~~2.3.8.10.2.2 ~~3.6.2.2~~
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.

15.~~2.3.8.9~~2.3.8.10.2.3 ~~3.6.2.3~~
Filler metals shall bond with and be metallurgically compatible with the base metal being joined.

15.~~2.3.8.9~~2.3.8.10.2.4 ~~3.6.2.4~~
Filler metals shall comply with ANSI/AWS A5.8M/A5.8, *Specification for Filler Metals for Brazing and Braze Welding*.

15.~~2.3.8.9~~2.3.8.10.2.5 ~~3.6.2.5~~
Copper-to-copper joints shall be brazed using a copper-phosphorus or copper-phosphorus-silver brazing filler metal (i.e., BCuP series) without flux.

15.~~2.3.8.9~~2.3.8.10.2.6 ~~3.6.2.6~~
Joints to be brazed in place shall be accessible for necessary preparation, assembly, heating, filler application, cooling, cleaning, and inspection.

15.~~2.3.8.9~~2.3.8.10.3 ~~15.2.3.8.11~~ Cutting Tube Ends.

15.~~2.3.8.9~~2.3.8.10.3.1 ~~3.6.3.1~~
Tube ends shall be cut square using a sharp tubing cutter to avoid deforming the tube.

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15.~~2.3.8.9~~2.3.8.10.3.2 ~~3.6.3.2~~
The cutting wheels on tubing cutters shall be free from grease, oil, or other lubricants not recommended for oxygen service.

15.~~2.3.8.9~~2.3.8.10.3.3 ~~3.6.3.3~~
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.

15.~~2.3.8.9~~2.3.8.10.4 ~~15.2.3.8.12~~ Cleaning Joints for Brazing.

15.~~2.3.8.9~~2.3.8.10.4.1 ~~3.6.4.1~~
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.

15.~~2.3.8.9~~2.3.8.10.4.2 ~~3.6.4.2~~
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.

15.~~2.3.8.9~~2.3.8.10.4.3 ~~3.6.4.3~~
Nonabrasive pads shall be used to clean the exterior surfaces of tube ends.

15.~~2.3.8.9~~2.3.8.10.4.4 ~~3.6.4.4~~
The use of steel wool, sand cloth, or wire brushes shall be prohibited.

15.~~2.3.8.9~~2.3.8.10.4.5 ~~3.6.4.5~~
The cleaning process shall not result in grooving the surfaces to be joined.

15.~~2.3.8.9~~2.3.8.10.4.6 ~~3.6.4.6~~
After being abraded, the surfaces shall be wiped using a clean, lint-free white cloth.

15.~~2.3.8.9~~2.3.8.10.4.7 ~~3.6.4.7~~
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.

15.~~2.3.8.9~~2.3.8.10.4.8 ~~3.6.4.8~~
Material that has become contaminated internally and is not clean for oxygen service shall not be installed.

15.~~2.3.8.9~~2.3.8.10.4.9 ~~3.6.4.9~~

Joints shall be brazed within 8 hours after being cleaned for brazing.

15.~~2.3.8.9~~2.3.8.10.5 ~~15.2.3.8.13~~ Brazing Dissimilar Metals.

15.~~2.3.8.9~~2.3.8.10.5.1 ~~3.6.5.1~~
Flux shall only be used when brazing dissimilar metals, such as copper and bronze or brass, using a silver brazing filler metal (i.e., BAg series).

15.~~2.3.8.9~~2.3.8.10.5.2 ~~3.6.5.2~~
Cast metals shall not be field brazed.

15.~~2.3.8.9~~2.3.8.10.5.3 ~~3.6.5.3~~
Surfaces shall be cleaned for brazing in accordance with 15.~~2.3.8.9~~2.3.8.10.4~~15.4.6.4~~.

15.~~2.3.8.9~~2.3.8.10.5.4 ~~3.6.5.4~~
Flux shall be applied sparingly to minimize contamination of the inside of the tube with flux.

15.~~2.3.8.9~~2.3.8.10.5.5 ~~3.6.5.5~~
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.

15.~~2.3.8.9~~2.3.8.10.5.6 ~~3.6.5.6~~
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.

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15.~~2.3.8.9~~2.3.8.10.5.7 ~~3.6.5.7~~
On joints DN20 (NPS ¾) (⅞ 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.

15.~~2.3.8.9~~2.3.8.10.6 ~~15.2.3.8.13~~ Nitrogen Purge.

15.~~2.3.8.9~~2.3.8.10.6.1 ~~3.6.6.1~~
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.

15.~~2.3.8.9~~2.3.8.10.6.2 ~~3.6.6.2~~
The source of the nitrogen purge gas shall be monitored, and the installer shall be audibly alerted when the content is low.

15.~~2.3.8.9~~2.3.8.10.6.3 ~~3.6.6.3~~
The nitrogen purge gas flow rate shall not be high enough to produce a positive pressure in the piping system.

15.~~2.3.8.9~~2.3.8.10.6.4 ~~3.6.6.4~~
The nitrogen purge gas flow shall be controlled by the use of both a pressure regulator and a flowmeter or a combination thereof.

15.~~2.3.8.9~~2.3.8.10.6.5 ~~3.6.6.5~~
Pressure regulators alone shall not be used to control nitrogen purge gas flow rates.

15.~~2.3.8.9~~2.3.8.10.6.6 ~~3.6.6.6~~
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.

15.~~2.3.8.9~~2.3.8.10.6.7 ~~3.6.6.7~~
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.

15.~~2.3.8.9~~2.3.8.10.6.8 ~~3.6.6.8~~
The flow of nitrogen purge gas shall be maintained until the joint is cool to the touch.

15.~~2.3.8.9~~2.3.8.10.6.9 ~~3.6.6.9~~
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.

15.~~2.3.8.9~~2.3.8.10.7 ~~15.2.3.8.14~~ Assembling and Heating Brazed Joints.

15.~~2.3.8.9~~2.3.8.10.7.1 ~~3.6.7.1~~
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 (i.e., overlap) specified in ANSI/ASME B16.50, *Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings*.

15.~~2.3.8.9~~2.3.8.10.7.2 ~~3.6.7.2~~
Where flux is permitted, joints shall be heated slowly until the flux has liquefied.

15.~~2.3.8.9~~2.3.8.10.7.3 ~~3.6.7.3~~
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.

15.~~2.3.8.9~~2.3.8.10.7.4 ~~3.6.7.4~~
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 VIII, "Brazed Joints," in the CDA *Copper Tube Handbook*.

15.~~2.3.8.9~~2.3.8.10.8 ~~15.2.3.8.15~~ Inspection of Brazed Joints.

15.~~2.3.8.9~~2.3.8.10.8.1 ~~3.6.8.1~~
After brazing, the outside of all joints shall be cleaned by washing with water and a wire brush to remove any residue and allow clear visual inspection of the joint.

15.~~2.3.8.9~~2.3.8.10.8.2 ~~3.6.8.2~~

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

15.~~2.3.8.9~~2.3.8.10.8.3 ~~3.6.8.3~~
Each joint shall be visually inspected after cleaning the outside surfaces.

15.~~2.3.8.9~~2.3.8.10.8.4 ~~3.6.8.4~~
Joints exhibiting the following conditions shall not be permitted:

(1) Flux or flux residue (where 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 *(see 15.2.3.9.5~~3.7.4.4~~)* and standing pressure test *(see 15.2.3.9.7~~3.7.4.6~~)*

15.~~2.3.8.9~~2.3.8.10.8.5 ~~3.6.8.5~~
Joints that are identified as defective under conditions specified in 15.~~2.3.8.9~~2.3.8.10.8.4 ~~3.6.8.4~~(2) or 15.~~2.3.8.9~~2.3.8.10.8.4 ~~3.6.8.4~~(5) shall be replaced.

15.~~2.3.8.9~~2.3.8.10.8.6 ~~3.6.8.6~~
Joints that are found to be defective under conditions specified in 15.~~2.3.8.9~~2.3.8.10.8.4 ~~3.6.8.4~~(1), 15.~~2.3.8.9~~2.3.8.10.8.4 ~~3.6.8.4~~(3), 15.~~2.3.8.9~~2.3.8.10.8.4 ~~3.6.8.4~~(4), 15.~~2.3.8.9~~2.3.8.10.8.4 ~~3.6.8.4~~(6), or 15.~~2.3.8.9~~2.3.8.10.8.4 ~~3.6.8.4~~(7) shall be permitted to be repaired, except that no joint shall be reheated more than once before being replaced.

~~**15.23.7.3.5 Piping Within Floor Slabs Prohibited.**~~
~~Dental gas and vacuum piping shall not be installed within floor slabs.~~
15.~~2~~3.3.~~8~~9 Dental Air and Vacuum Systems Testing.
15.~~2~~3.3.~~9~~8.1 General.
15.~~2~~3.3.~~9~~8.1.1
Inspection and testing shall be performed on all new piped dental gas and vacuum systems, additions, renovations, temporary installations, or repaired systems to ensure, by a documented procedure, that the following have been completed:

(1) All applicable requirements of this code have been followed.

(2) System integrity has been achieved or maintained.

(3) Piping systems are ready for testing and verification.

(4) Piping systems are performing in accordance with their design requirements.

15.~~2~~3.3.~~9~~8.1.2
The inspection and testing reports shall be submitted directly to the party that contracted for the testing, who then submits the reports through channels to the responsible facility authority and any others that are required.

15.~~2~~3.3.~~9~~8.1.3
Reports shall contain detailed listings of all findings and results.

15.~~2~~3.3.~~9~~8.1.4
The responsible facility authority shall review the inspection and testing records prior to the use of any systems to ensure that all findings and results of the inspection and testing have been successfully completed before use.

15.~~2~~3.3.~~9~~8.1.5
All documentation pertaining to inspections and testing shall be maintained on-site within the facility.

15.~~2~~3.3.~~9~~8.2 Category ~~2~~1 Dental Air and Vacuum Systems.
15.~~2~~3.3.~~9~~8.2.1

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All Category ~~1~~ 2 dental air and vacuum piping systems indicated in 15.2~~3~~.3 shall be initially tested in accordance with 15.2~~3~~.3.9~~8~~.3.

15.2~~3~~.3.9~~8~~.2.2
Dental air, vacuum, and scavenging systems shall be final tested in accordance with 15.2~~3~~.3.9~~8~~.3.5 and 15.2~~3~~.3.9~~8~~.3.6.

15.2~~3~~.3.9~~8~~.3 Initial Testing of Piping Systems.
15.2~~3~~.3.9~~8~~.3.1 ~~General.~~
~~(A)~~
Where plastic vacuum and plastic scavenging piping systems are installed, they shall be visually inspected for cross-connections to oxygen and nitrous oxide systems before applying positive test pressures to the copper piping systems.

15.2.3.9.3.2~~(B)~~
During the process of initial testing, the identification and labeling of the dental gas and vacuum piping shall be checked.

15.2~~3~~.3.9~~8~~.~~4~~3.2 Initial Cross-Connection Test for Plastic Vacuum and Plastic Scavenging Piping Systems.
15.2.3.9.4.1~~(A)~~
Plastic piping shall be tested before copper piping.

15.2.3.9.4.2~~(B)~~
Tests shall be conducted to determine that no cross-connections exist between any plastic vacuum piping systems or plastic scavenging piping systems and any copper piping systems.

15.2.3.9.4.3~~(C)~~
The vacuum or scavenging source shutoff valves for the vacuum or scavenging piping systems shall remain closed during the tests, unless they are being used for the cross-connection test vacuum source.

15.2.3.9.4.4~~(D)~~
The cross-connection test vacuum shall be a minimum of 300 mm (12 in.) HgV.

15.2.3.9.4.5~~(E)~~
The source of test vacuum shall be connected only to the vacuum or scavenging piping system being tested.

15.2.3.9.4.6~~(F)~~
All individual gas system outlets and vacuum or scavenging system inlets shall be checked to determine that the test vacuum is only present in the vacuum or scavenging piping system being tested.

15.2.3.9.4.7~~(G)~~
The cross-connection tests shall be repeated for each installed vacuum and scavenging system with plastic piping.

15.2.3.9.4.8~~(H)~~
Any cross-connections shall be removed and the associated piping repaired and leak tested.

15.2.3.9.4.9~~(I)~~
The proper labeling and identification of system outlets/inlets shall be confirmed during the initial tests.

15.2~~3~~.3.9~~8~~.~~5~~ ~~3.3~~ Initial Pressure Test.
15.2.3.9.5.1~~(A)~~
Each section of the piping in dental air systems and copper vacuum systems shall be pressure tested. Plastic vacuum and plastic scavenging piping shall not be pressure tested.

15.2.3.9.5.2 ~~(B)~~
Initial pressure tests shall be conducted as follows:

(1) After installation of station outlet/inlet rough-in asse~~mb~~lies

(2) Prior to the installation of components of the distribution piping system that would be damaged by the test pressure (e.g., pressure/vacuum alar~~m~~ devices, pressure/vacuum indicators, line pressure relief valves)

15.2.3.9.5.3 ~~(C)~~ Th
~~Th~~e source shutoff valve shall remain closed during the pressure tests.

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15.2.3.9.5.4 ~~(D)~~
The test pressure for dental air piping and copper vacuum piping shall be 1.5 times the system operating pressure but not less than a gauge pressure of 1035 kPa (150 psi).

15.2.3.9.5.5 ~~(E)~~
The test pressure shall be maintained until each joint has been examined for leakage by means of a leak detectant that is safe for use with oxygen and does not contain ammonia.

15.2.3.9.5.6 ~~(F)~~
Any leaks shall be located, repaired (if permitted) or replaced (if required) by the installer, and retested.

15.~~2~~3.3.~~9~~8.~~3.4~~6 Initial Piping Purge Test.
15.2.3.8.6.1~~(A)~~
The outlets in each dental air piping system shall be purged to remove any particulate matter from the distribution piping.

15.2.3.9.6.2~~(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.

15.2.3.9.6.3~~(C)~~
The purging shall be started at the closest outlet to the piping shutoff valve and continue to the furthest outlet from the shutoff valve.

15.~~2~~3.3.~~9~~8.~~7 3.5~~ Standing Pressure Test for Dental Air and Copper Vacuum Piping.
15.2.3.9.7.1~~(A)~~
After successful completion of the initial pressure tests in 15.~~4~~2.8.1, the dental air systems and copper vacuum systems shall be subject to a standing pressure test.

15.2.3.9.7.2 ~~(B)~~
Tests shall be conducted after the final installation of station outlet valve bodies, faceplates, and other distribution system components (e.g., pressure alarm devices, pressure indicators, line pressure relief valves, manufactured assemblies, hoses).

15.2.3.9.7.3 ~~(C)~~
The source valve shall be closed during this test.

15.2.3.9.7.4 ~~(D)~~
The piping systems shall be subjected to 24-hour standing pressure tests using oil-free, dry nitrogen NF.

15.2.3.9.7.5 ~~(E)~~
Test pressures shall be 20 percent above the normal system operating line pressure.

15.2.3.9.7.6 ~~(F)~~
At the conclusion of the tests, there shall be no change in the test pressure except that attributed to specific changes in ambient temperature.

15.2.3.9.7.7 ~~(G)~~
Any leaks shall be located, repaired (if permitted) or replaced (if required) by the installer, and retested. The piping shall be repurged if necessary.

15.~~2~~3.3.~~9~~8.~~8 3.6~~ Standing Vacuum Test for Plastic Vacuum Piping.
15.2.3.9.8.1 ~~(A)~~
After successful completion of the initial pressure tests in 15.4.8.1, vacuum distribution piping, including scavenging, shall be subjected to a standing vacuum test.

15.2.3.9.8.2 ~~(B)~~
Tests shall be conducted after installation and connection of all components of the vacuum system.

15.2.3.9.8.3 ~~(C)~~
The piping systems shall be subjected to a 24-hour standing vacuum test.

15.2.3.9.8.4 ~~(D)~~
Test pressure shall be between 300 mm (12 in.) HgV and full vacuum.

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15.2.3.9.8.5 ~~(E)~~
During the test, the source of test vacuum shall be disconnected from the piping system.

15.2.3.9.8.6 ~~(F)~~
At the conclusion of the test, there shall be no change in the vacuum pressure other than that attributed to changes of ambient temperature.

15.2.3.9.8.7 ~~(G)~~
Any leaks shall be located, repaired (if permitted) or replaced (if required) by the installer, and retested.

15.~~2~~3.3.10 ~~8.4~~ Operation and Management.
15.~~2~~3.3.10~~8.4~~.1 System Shutdowns.
15.2.3.10.1.1 ~~(A)~~
Dental Gas and dental vacuum piping systems shall be shut down at the end of each workday.

15.2.3.10.1.2 ~~(B)~~
Emergency shutoff valves or remote actuators shall not be used for daily shutdown of the systems.

15.2.3.10.1.3 ~~(C)~~
If cylinders for dental gas are used, ~~C~~cylinder gas valves shall be used for daily shutdowns.

15.~~2~~3.3.10.2~~8.4.2~~ Prohibited Interconnections.
Two or more piping systems for different gases or different vacuums shall not be interconnected for testing or any other reason.

15.~~2~~3.3.10.3~~8.4.3~~ Manufacturer's Instructions.
15.2.3.10.3.1 ~~(A)~~
Piping system components shall be installed, adjusted, operated, and maintained in accordance with the manufacturer's instructions.

15.2.3.10.3.2 ~~(B)~~
Copies of the manufacturer's instructions shall be provided to and maintained at the facility.

15.~~2~~3.3.10.4~~8.4.4~~ Maintenance.
15.2.3.10.4.1 ~~(A)~~
Gas and vacuum system equipment shall be maintained by a qualified person.

15.2.3.10.4.2 ~~(B)~~
Every facility shall establish a procedure for manually turning off the gas supply at the cylinder valves of Category 2 dental gas and vacuum systems at the end of each day.

15.~~2~~3.3.~~8~~10.5 Periodic Testing.
Station outlets for oxygen and nitrous oxide shall be tested for flow and pressure on an approved schedule.

15.~~3~~4 Category ~~3~~2 Dental Gas and Vacuum Systems.
15.~~3~~4.1 General.
15.~~3~~4.1.1
Category ~~3~~2 dental gas and vacuum system shall be limited to facilities that provide no greater than moderate sedation~~, at most, provide moderate, and minimal or no sedation~~ and where Risk Category 3 or lower is determined per ~~Chapter 4~~15.1.2.

15.~~3~~4.1.2
The medical gases shall be limited to oxygen and nitrous oxide.

15.~~3~~4.1.3
Dental air shall be provided from a dental air source system.

15.~~3~~4.1.4
The dental vacuum systems shall be dental vacuum and nitrous oxide scavenging.

15.~~3~~4.1.5
All connections within Category ~~3~~2 medical gas (oxygen and nitrous oxide) shall be gas-specific to prevent cross-connections with other piping systems, including dental vacuum, water, and dental air.

15.3.2 Category 3 Medical Gas Systems (Dental Oxygen and Nitrous Oxide).

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15.3.2.1 Central Supply System Identification and Labeling.

15.3.2.1.1 ~~**4.2.2.1**~~
Cylinders, containers, and tanks shall be designed, fabricated, tested, and marked (i.e., stamped) in accordance with Department of Transportation (DOT) regulations, Transport Canada's (TC) *Transportation of Dangerous Goods Regulations*, or the ASME *Boiler and Pressure Vessel Code*. [**55:**7.1.5.1]

15.3.2.1.2 ~~**4.2.2.2**~~
Cylinder contents shall be identified by attached labels or stencils naming the contents in accordance with the mandatory requirements of CGA C-7, *Guide to Classification and Labeling of Compressed Gases*.

15.3.2.1.3 ~~**4.2.2.3**~~
Liquid containers shall have additional product identification visible from all directions with a minimum of 51 mm (2 in.) high letters, such as a 360-degree wraparound tape for medical liquid containers.

15.3.2.1.4 ~~**4.2.2.4**~~
Cryogenic liquid containers shall be provided with gas-specific outlet connections in accordance with the mandatory requirements of CGA V-5, *Standard for Diameter Index Safety System (Noninterchangeable Low Pressure Connections for Medical Gas Applications)*, or CGA V-1, *Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections*.

15.3.2.1.5 ~~**4.2.2.5**~~
Cylinder and cryogenic liquid container outlet connections shall be affixed in such a manner as to be integral to the valve(s), unremovable with ordinary tools, or so designed as to render the attachment point unusable when removed.

15.3.2.1.6 ~~**4.2.2.6**~~
The contents of cylinders and cryogenic liquid containers shall be verified prior to use.

15.3.2.1.7 ~~**4.2.2.7**~~
Labels shall not be defaced, altered, or removed, and connecting fittings shall not be modified.

15.3.2.1.8 ~~**4.2.2.8**~~
Source locations containing positive-pressure gases other than oxygen and medical air shall be provided with signage located on or immediately adjacent to the door that is visible upon entering the space as follows ~~Locations containing positive-pressure gases other than oxygen and medical air shall have their door(s) labeled as follows~~:

~~-~~**Positive-Pressure Gases**
NO Smoking or Open Flame
Room May Have Insufficient Oxygen
Open Door and Allow Room to Ventilate Before Entering

15.3.2.1.9 ~~**4.2.2.9**~~
Locations containing central supply systems or cylinders containing only oxygen or medical air shall have their door(s) labeled as follows:
Medical Gases
NO Smoking or Open Flame

15.3.2.2 Central Supply Operations.

15.3.2.2.1 ~~**4.2.3.1**~~
The use of adapters or conversion fittings to adapt one gas-specific fitting to another shall be prohibited.

15.3.2.2.2 ~~**4.2.3.2**~~
Cylinders and containers shall be handled in strict accordance with 11.6.2.

15.3.2.2.3 ~~**4.2.3.3**~~
Only gas cylinders, reusable shipping containers, and their accessories shall be permitted to be stored in rooms containing central supply systems or gas cylinders.

15.3.2.2.4 ~~**4.2.3.4**~~
No flammable materials, cylinders containing flammable gases, or containers containing flammable liquids shall be stored in rooms with gas cylinders.

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15.3.2.5 ~~**4.2.3.5**~~
If cylinders are wrapped when received, the wrappers shall be removed prior to storage.

15.3.2.6 ~~**4.2.3.6**~~
Cylinders without correct markings or whose markings and gas-specific fittings do not match shall not be used.

15.3.2.7 ~~**4.2.3.7**~~
Cryogenic liquid storage units intended to supply gas to the facility shall not be used to transfill other liquid storage vessels.

15.3.2.8 ~~**4.2.3.8**~~
Care shall be exercised when handling cylinders that have been exposed to freezing temperatures or containers that contain cryogenic liquids to prevent injury to the skin.

15.3.2.9 ~~**4.2.3.9**~~
Cylinders containing compressed gases and containers for volatile liquids shall be kept away from radiators, steam piping, and like sources of heat.

15.3.2.10 ~~**4.2.3.10**~~
Where cylinder valve protection caps are supplied, they shall be secured tightly in place unless the cylinder is connected for use.

15.3.2.11 ~~**4.2.3.11**~~
Containers shall not be stored in a tightly closed space.

15.3.2.12 ~~**4.2.3.12**~~
Cylinders in use and in storage shall be prevented from reaching temperatures in excess of 52°C (125°F).

15.3.2.13 ~~**4.2.3.13**~~
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 never be lower than −7°C (20°F) or greater than 52°C (125°F).

15.3.2.3 Central Supply System Locations.

15.3.2.3.1
Gas storage locations in facilities with Category 3 medical gas systems with a total of all gases in cylinders or containers, except nitrogen, connected and in storage at one time that does not exceed 85 m^3 (3000 ft^3) at standard temperature and pressure (STP), or 142 m^3 (5000 ft^3) STP if oxygen is stored in a DOT specification 4 L (cryogenic liquid) container shall comply with 15.4.2.4.3 through 15.4.2.4.15.

15.3.2.3.2*
Gas storage locations in facilities with Category 3 medical gas systems with a total of all gases in cylinders or containers exceeding quantities listed in 15.3.2.34.1 shall comply with 5.1.3.3.

15.3.2.3.3
Enclosures shall serve no purpose other than to contain the medical gas source equipment (oxygen and nitrous oxide), except that nitrogen source equipment and compressed air cylinders shall be permitted in the enclosure.

15.3.2.3.4
Natural or mechanical ventilation for oxygen and nitrous oxide manifold locations shall be in accordance with 9.3.6.5.

15.3.2.3.5
Storage of full or empty gas cylinders, or both, shall be permitted in the same enclosure.

15.3.2.3.6
Air compressors, vacuum pumps, and other equipment shall not be located in enclosures for medical gas cylinders (oxygen and nitrous oxide source equipment).

15.3.2.3.7*
If enclosures are outdoors or remote from the treatment facilities that they serve, they shall be kept locked.

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15.3.2.3.8
Cylinders in use and in storage shall be prevented from reaching temperatures in excess of 52°C (125°F). Nitrous oxide cylinders shall be prevented from reaching temperatures lower than −7°C (20°F).

15.3.2.3.9
Indoor enclosures shall not communicate directly with medical gas (oxygen and nitrous oxide) use points or storage locations for flammable materials or gases.

15.3.2.3.10
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).

15.3.2.3.11
Enclosures for medical gas (oxygen and nitrous oxide) source equipment shall be provided with doors or gates.

15.3.2.3.12
Cylinders in use or in storage shall be individually secured and located to prevent falling or being knocked over.

15.3.2.3.13
Locations containing positive-pressure gases or cylinders containing oxygen, nitrous oxide, or both shall be separated from the rest of the building by walls and floors having a 1-hour fire resistance rating with doors and other opening projective having a ¾-hour fire protection rating.

15.3.2.3.14
Locations containing positive-pressure gases or cylinders containing positive-pressure gases shall be provided with an automatic sprinkler system in accordance with NFPA 13.

15.3.2.4 Central Supply Systems.

15.3.2.4.1 Medical Gas Source Equipment (Oxygen and Nitrous Oxide).
15.3.2.4.2
Mechanical means shall be provided to ensure that the medical gas source equipment is connected to the correct medical gas distribution piping system.

15.3.2.4.3
Cylinder valve outlets for oxygen and nitrous oxide shall comply with CGA V-1, *Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections*.

15.3.2.4.4
Threaded connections to manifolds shall comply with CGA V-5, *Standard for Diameter Index Safety System (Noninterchangeable Low Pressure Connections for Medical Gas Applications)*.

15.3.2.4.5
A check valve shall be provided downstream of each pressure regulator.

15.3.2.4.6
A pressure relief valve set at 50 percent above the normal line pressure shall be located downstream of the check valve in 15.3.3.1.4.5.

15.3.2.4.7
Pressure relief valves shall be brass, bronze, or stainless steel and designed for oxygen service.

15.3.2.4.8
Hose and flexible connectors shall have a gauge pressure rating not less than 6895 kPa (1000 psi).

15.3.2.4.9
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 3000 kPa (435 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.

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(4) If intended for outdoor installation, materials shall be installed in accordance with the manufacturer's requirements.

15.3.2.4.10
Nonmetallic hoses and flexible connectors shall not exceed 1.52 m (5 ft) in length nor be concealed or penetrate walls, floors, ceilings, or partitions.

15.3.2.4.11
Source equipment shall not be connected to the piping system through flexible connectors.

15.3.2.4.12
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 one average day's supply.

15.3.2.4.13
The two banks of each medical gas source shall be manifolded so that either bank can supply its distribution piping system.

15.3.2.4.14
Where the source equipment is remote from a single treatment facility and an in-use bank is unable to supply the system, the manifold shall automatically switch to the secondary bank.

15.3.2.4.15
Where the source equipment serves multiple treatment facilities and an in-use bank is unable to supply the system, the manifold shall automatically switch to the secondary bank.

15.3.2.4.16
Where the source equipment is not remote and is accessible from a single treatment facility served and an in-use bank is unable to supply the system, the manifold shall be manually or automatically switched to the secondary bank..

15.3.2.5 Valves.
15.3.2.5.1 Emergency Shutoff Valves (Oxygen and Nitrous Oxide).
15.3.2.5.2*
All Category 3 medical gas systems shall have an emergency shutoff valve accessible from all use-point locations in an emergency.

15.3.2.5.3
Where a central medical gas supply system supplies two treatment facilities, each facility shall be provided with an emergency shutoff valve located in that treatment facility accessible from all use-point locations in an emergency.

15.3.2.5.4
Each emergency shutoff valve shall be labeled to indicate the gas it controls and shut off only the gas to the treatment facility that it serves.

15.3.2.5.5
A remotely activated shutoff valve at a gas supply manifold shall not be used for emergency shutoff.

15.3.2.5.5.1
For clinical purposes, a remote valve actuator shall not fail-close in the event of loss of electric power.

15.3.2.5.5.2
Where remote actuators are the type that fail-open, cylinder shutoff valves shall be closed whenever the system is not in-use.

15.3.2.5.6
Emergency shutoff valves shall be located to meet the following requirements:

(1) Be readily operable from a standing position

(2) Be installed where visible and accessible at all times

(3) Be installed where they will not be hidden from plain view, such as not behind normally open or normally closed doors

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(4) Be installed in the egress pathway near the exit from the treatment area that will be used in an emergency

(5) Be installed in rooms, areas, or closets that are not capable of being closed or locked

15.3.2.6 ~~4.2.7~~ Station Outlets and Risers (Oxygen and Nitrous Oxide).

15.3.2.6.1 ~~4.2.7.1~~
Each gas outlet shall be gas specific.

15.3.2.6.2 ~~4.2.7.2~~
Gas outlets shall consist of a primary and a secondary valve or assembly.

15.3.2.6.3 ~~4.2.7.3~~
Each gas outlet shall be legibly identified.

15.3.2.6.4 ~~4.2.7.4~~
Threaded outlets shall be noninterchangeable connections complying with the mandatory requirements of CGA V-5, *Standard for Diameter Index Safety System (Noninterchangeable Low Pressure Connections for Medical Gas Applications)*.

15.3.2.6.5 ~~4.2.7.5~~
Factory-installed copper inlet tubes on station outlets extending no further than 205 mm (8 in.) from the body of the terminal shall be not less than DN8 (NPS 1/4) (3/8 in. O.D.) size, with 8 mm (0.3 in.) minimum inside diameter.

15.3.2.7 Manufactured Assemblies.
Category 3 systems shall comply with 5.1.6.

15.3.2.8 Surface-Mounted Medical Gas Rails.
Category 3 systems shall comply with 5.1.7.

15.3.2.9 Pressure and Vacuum Indicators.
Category 3 systems shall comply with 5.1.8.

15.3.2.10 Warning Systems (Oxygen and Nitrous Oxide).
15.3.2.10.1 Warning Systems (Oxygen and Nitrous Oxide).
Category 3 warning systems shall comply with 5.2.9, except as follows:

(1) Warning systems shall be permitted to be a single alarm panel.

(2) The alarm panel shall be located in an area of continuous surveillance while the facility is in operation.

(3) Pressure and vacuum switches/sensors shall be mounted at the source equipment with a pressure indicator at the master alarm panel.

(4) Warning systems for medical gas systems shall provide the following alarms:

(a) Oxygen main line pressure low

(b) Oxygen main line pressure high

(c) Oxygen changeover to secondary bank or about to changeover (if automatic)

(d) Nitrous oxide main line pressure low

(e) Nitrous oxide main line pressure high

(f) Nitrous oxide changeover to secondary bank or about to changeover (if automatic)

(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.
(6) Visual indications shall remain until the situation that caused the alarm is resolved.
(7) Pressure switches/sensors shall be installed downstream of any emergency shutoff valves and any other shutoff valves in the system and cause an alarm for the medical gas if the pressure decreases or increases 20 percent from the normal operating pressure.

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(8) A cancelable audible indication of each alarm condition that produces a sound at the alarm panel shall reinitiate the audible signal if another alarm condition occurs while the audible signal is silenced.

~~**15.3.2.10.1 General.**~~
~~**15.3.2.10.1.1**~~
~~The warning systems in Category 3 dental gas and vacuum systems shall comply with applicable requirements of 5.2.9 and 15.3.2.10.~~

~~**15.3.2.10.1.2**~~
~~The master, area, and local alarm functions shall be permitted to be provided by a single alarm panel, as indicated in 5.2.9.~~

~~**15.3.2.10.2 Master Alarm Panels.**~~
~~**15.3.2.10.2.1**~~
~~A master alarm panel shall be located in the facility at a point of continuous surveillance when the facility is in operation.~~

~~**15.3.2.10.2.2**~~
~~The master alarm panel shall indicate the following:~~

~~(1) Oxygen supply pressure ±20 percent from normal~~

~~(2) Nitrous oxide supply pressure ±20 percent from normal~~

~~(3) Changeover of oxygen supply source~~

~~(4) Changeover of nitrous oxide supply source~~

~~**15.3.2.10.3 Area Alarm Panels.**~~
~~**15.3.2.10.3.1**~~
~~An area alarm panel shall be centrally located where two or more treatment areas are supplied from the same zoned dental gas piping.~~

~~**15.3.2.10.3.2**~~

~~Area alarm panels shall indicate the following:~~

~~(1) Oxygen supply pressure ±20 percent from normal~~

~~(2) Nitrous oxide supply pressure ±20 percent from normal~~

~~**15.3.2.10.4 Local Alarms.**~~
~~**15.3.2.10.4.1**~~
~~Local alarms shall be located in source equipment control panels or separate control panels in the equipment rooms for source equipment.~~

15.3.2.11 ~~4.4.2~~ Piping for Oxygen and Nitrous Oxide Systems.

15.3.2.11.1 ~~4.4.2.1~~ Cleaning for Oxygen Service.

15.3.2.11.1.1 ~~4.4.2.1.1~~
For oxygen and nitrous oxide, the pipe, fittings, valves, gas/vacuum outlets/inlets, and other piping components shall be cleaned for oxygen by the manufacturer prior to installation in accordance with CGA G-4.1, *Cleaning Equipment for Oxygen Service*.

15.3.2.11.1.2 ~~4.4.2.1.2~~
Fittings shall be permitted to be cleaned by a supplier or agency other than the manufacturer.

15.3.2.11.2 ~~4.4.2.2~~ Pipe.
Piping materials for oxygen and nitrous oxide shall be one of the following:

(1) Hard-drawn seamless copper in accordance with ASTM B819, *Standard Specification for Seamless Copper Tube for Medical Gas Systems,* medical gas tube, Type L or Type K

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(2) Listed corrugated medical tubing (CMT) fabricated from copper alloy No. 51000 strip, meeting ASTM B103/B103M, *Standard Specification for Phosphor Bronze Plate, Sheet, Strip, and Rolled Bar*, as follows:

(a) Having a design margin of 3.5

(b) Externally coated with a nonmetallic sheath marked with the manufacturer's marking

(c) Listing includes testing to demonstrate that CMT systems can be consistently gas-purged with results equivalent to comparable medical gas copper tubing

15.3.2.11.2.1 ~~4.4.2.2.1~~
CMT shall have a flame spread index of 25 or less and a smoke developed index of 50 or less as determined by ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*.

15.3.2.11.2 ~~4.4.2.2.2~~
CMT shall be identified by the manufacturer as suitable for oxygen service at a minimum of every 0.92 m (3 ft).

15.3.2.11.3 ~~4.4.2.3~~ Fittings.
15.3.2.11.3.1 ~~4.4.2.3.1~~
Fittings shall be brazed, memory metal, or axially swaged.

15.3.2.11.3.2 ~~4.4.2.3.2~~
Brazed fittings shall be the wrought copper capillary type complying with the following:

(1) ASME B16.22, *Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings*

(2) ANSI/ASME B16.50, *Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings*

(3) ASME B16.22 with socket depths equal to or greater than brazed joint pressure fittings in accordance with ANSI/ASME B16.50

15.3.2.11.3.3 ~~4.4.2.3.3~~
Cast copper alloy fittings shall not be used with field-brazed joints.

15.3.2.11.3.4 ~~4.4.2.3.4~~
Memory metal fittings shall be rated for not less than 538°C (1000°F) and 2070 kPa (300 psi) and be installed by qualified technicians in accordance with the manufacturer's instructions.

15.3.2.11.3.5 ~~4.4.2.3.5~~
Axially swaged fittings shall comply with 15.2.3.7.2.4 (6). ~~Axially swaged couplings shall include metal-to-metal seats, shall be rated for not less than 538°C (1000°F) and 2070 kPa (300 psi), and provide permanent, nonseparable joints. Fittings shall be installed by qualified technicians in accordance with the manufacturer's instructions.~~

15.3.2.11.4 ~~4.4.2.4~~ Joints.
15.3.2.11.4.1 ~~4.4.2.4.1~~ Brazed.
Brazing of copper joints shall be in accordance with 15.~~2.3.8.9~~2.3.8.10 ~~4.6~~.

15.3.2.11.4.2 ~~4.4.2.4.2~~ Threaded.
Threaded joints shall be limited to connections to pressure indicators, alarm devices, and source equipment and shall comply with the following:

(1) Threads shall be tapered complying with ASME B1.20.1, *Pipe Threads, General Purpose, Inch*.

(2) Threads shall be made up with polytetrafluoroethylene (PTFE) tape or other thread sealant recommended for oxygen service, with the sealant applied to the male threads only.

15.3.2.11.4.3 ~~4.4.2.4.3~~ Prohibited Joints.
The following joints shall be prohibited under 15.3.2.11.4 ~~15.4.4.2.4~~:

(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

(4) Pipe crimping tools used to permanently stop the flow of medical gas and vacuum piping

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15.3.2.11.5~~1~~ Pipe sizing

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

15.3.2.11.5.2 Minimum Pipe Sizes

The minimum size of the following piping shall be as follows:

(1) Category 3 oxygen piping shall be not less than DN10 (NPS ⅜ in.) (½ in. O.D.) size.

(2) Category 3 nitrous oxide piping shall be not less than DN8 (NPS ¼ in.) (⅜ in. O.D.) size.

(3) Category 3 oxygen piping shall be at least 1 size larger than piping for nitrous oxide

15.3.2.12 Labeling and Identification.
Category 3 systems shall comply with 5.1.11.

15.3.2.13 ~~4.7~~ Performance Criteria and Testing (Oxygen and Nitrous Oxide).
15.3.2.13.1 ~~4.7.1~~ Testing and Verification.
15.3.2.13.1.1 ~~4.7.1.1~~ General.
15.3.2.13.1.1.1 ~~4.7.1.1.1~~
Inspection and testing shall be performed on all new piped oxygen and nitrous oxide systems, additions, renovations, temporary installations, or repaired systems to ensure, by a documented procedure, that the following have been completed:

(1) All applicable requirements of this code have been followed.

(2) System integrity has been achieved or maintained.

(3) Piping systems are ready for testing and verification.

(4) Piping systems are performing in accordance with their design requirements.

15.~~4.7~~3.2.13.1.1.2
The inspection and testing reports shall be submitted directly to the party that contracted for the testing, who then submits the reports through channels to the responsible facility authority and any others that are required.
15.~~4.7~~3.2.13.1.1.3
Reports shall contain detailed listings of all findings and results.

15.~~4.7~~3.2.13.1.1.4
The responsible facility authority shall review the inspection and testing records prior to the use of any systems to ensure that all findings and results of the inspection and testing have been successfully completed before use.

15.~~4.7~~3.2.13.1.1.5
All documentation pertaining to inspections and testing shall be maintained on-site within the facility.

15.~~4.7~~3.2.13.2 Required Testing and Verification.
15.~~4.7~~3.2.13.2.1 Category 2 Medical Gas Systems (Oxygen and Nitrous Oxide).
All Category 2 oxygen and nitrous oxide piping systems indicated in 15.4.2 shall be initially tested in accordance with 15.~~4.7~~3.2.13.4.

15.~~4.7~~3.2.13.2.2
The oxygen and nitrous oxide piping systems shall be verified in accordance with 15.~~4.7~~3.2.13.5.

15.~~4.7~~3.2.13.3 Qualification of System Testers and Verifiers (Oxygen and Nitrous Oxide).
15.~~4.7~~3.2.13.3.1
Individuals who perform the initial and final tests of the oxygen and nitrous oxide piping systems shall be certified to ASSE 6010, *Professional Qualifications Standard for Medical Gas Systems Installers*, or verifiers who comply with 15.~~4.7~~3.2.13.3.2.

15.~~4.7~~3.2.13.3.2
Individuals who verify the oxygen and nitrous oxide piping systems shall be certified to ASSE 6030, *Professional Qualifications Standard for Medical Gas Systems Verifiers*.

15.~~4.7~~3.2.13.4 Initial Testing of Piping Systems (Oxygen and Nitrous Oxide).
15.~~4.7~~3.2.13.4.1 General.

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15.~~4.7~~3.2.13.4.1.1
The initial tests required by 15.~~4.7~~3.2.13.4 shall be performed prior to either the final tests or the verification tests listed in 15.~~4.7~~3.2.13.5.

15.~~4.7~~3.2.13.4.1.2
The test gas for gas piping systems shall be oil-free, dry nitrogen NF.

15.~~4.7~~3.2.13.4.1.3
Where manufactured assemblies are to be installed, the initial tests required by 15.~~4.7~~3.2.13.4 shall be performed as follows:

(1) After completion of the distribution piping but before the standing pressure test

(2) Prior to installation of manufactured assemblies supplied through flexible hose or flexible tubing

(3) For all station outlets/inlets on installed manufactured assemblies supplied through copper tubing

15.~~4.7~~3.2.13.4.1.4
Where plastic vacuum and plastic scavenging piping systems are installed, they shall be visually inspected for cross-connections to positive-pressure systems before applying positive test pressures to the copper piping systems.

15.~~4.7~~3.2.13.4.1.5
Where brazed joints in copper tubing are found to be defective, they shall be repaired if permitted by 15.4.6.8.6 or replaced if required by 15.4.6.8.5, and retested. The piping shall be repurged if necessary.

15.~~4.7~~3.2.13.4.1.6
During the process of initial testing, the identification and labeling of the medical gas and vacuum piping shall be checked.

15.~~4.7~~3.2.13.4.2 Initial Piping Blowdown (Oxygen and Nitrous Oxide).
Piping in dental air 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 outlet/inlet rough-in assemblies and other system components (e.g., pressure/vacuum alarm devices, pressure/vacuum indicators, pressure relief valves, manifolds, and source equipment).

15.~~4.7~~3.2.13.4.3 Initial Cross-Connection Test for Copper Piping Systems.
15.~~4.7~~3.2.13.4.3.1
Copper piping shall not be tested before any plastic piping.

15.~~4.7~~3.2.13.4.3.2
It shall be determined that no cross-connections exist between the various medical gas and vacuum piping systems.

15.~~4.7~~3.2.13.4.3.3
All piping systems shall be reduced to atmospheric pressure.

15.~~4.7~~3.2.13.4.3.4
Sources of test gas shall be disconnected from all piping systems except for the one system being tested.

15.~~4.7~~3.2.13.4.3.5
The system under test shall be charged with oil-free, dry nitrogen NF to a gauge pressure of 345 kPa (50 psi).

15.~~4.7~~3.2.13.4.3.6
After the installation of the individual faceplates with appropriate adapters matching outlet/inlet labels, each individual outlet/inlet in each installed medical gas and vacuum piping system shall be checked to determine that the test gas is dispensed only from the piping system tested.

15.~~4.7~~3.2.13.4.3.7
The initial cross-connection test in 15.~~4.7~~3.2.13.4.3 shall be repeated for each installed medical gas and vacuum piping system with copper piping.

15.~~4.7~~3.2.13.4.3.8
Any cross-connections shall be removed and the associated piping repaired and leak tested.

15.~~4.7~~3.2.13.4.3.9

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The proper labeling and identification of system outlets/inlets shall be confirmed during these tests.

15.~~4.7~~3.2.13.4.4 Initial Pressure Test.
15.~~4.7~~3.2.13.4.4.1
Each section of the piping in positive-pressure gas systems and copper vacuum systems shall be pressure tested. Plastic vacuum and plastic scavenging piping shall not be pressure tested.

15.~~4.7~~3.2.13.4.4.2
Initial pressure tests shall be conducted as follows:

(1) After blowdown of the distribution piping

(2) After installation of station outlet/inlet rough-in assemblies

(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, and line pressure relief valves)

15.~~4.7~~3.2.13.4.4.3
The source shutoff valve shall remain closed during the pressure tests.

15.~~4.7~~3.2.13.4.4.4
The test pressure for oxygen and nitrous oxide piping shall be 1.5 times the system operating pressure but not less than a gauge pressure of 1035 kPa (150 psi).

15.~~4.7~~3.2.13.4.4.5*
The test pressure shall be maintained until each joint has been examined for leakage by means of a leak detectant that is safe for use with oxygen and does not contain ammonia.

15.~~4.7~~3.2.13.4.4.6
Any leaks shall be located, repaired (if permitted), or replaced (if required) by the installer, and retested.

15.~~4.7~~3.2.13.4.5 Initial Piping Purge Test.
15.~~4.7~~3.2.13.4.5.1
The outlets in each oxygen and nitrous oxide piping system shall be purged to remove any particulate matter from the distribution piping.
15.~~4.7~~3.2.13.4.5.2
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.

15.~~4.7~~3.2.13.4.5.3
The purging shall be started at the closest outlet to the piping shutoff valve and continue to the furthest outlet from the shutoff valve.

15.~~4.7~~3.2.13.4.6 Standing Pressure Test for Oxygen and Nitrous Oxide Piping.
15.~~4.7~~3.2.13.4.6.1
After successful completion of the initial pressure tests in 15.~~4.7~~3.2.13.4.4, the gas distribution piping shall be subject to a standing pressure test.

15.~~4.7~~3.2.13.4.6.2
Tests shall be conducted after the final installation of station outlet valve bodies, faceplates, and other distribution system components (e.g., pressure alarm devices, pressure indicators, line pressure relief valves, manufactured assemblies, and hoses).

15.~~4.7~~3.2.13.4.6.3
The source valve shall be closed during this test.

15.~~4.7~~3.2.13.4.6.4
The piping systems shall be subjected to 24-hour standing pressure tests using oil-free, dry nitrogen NF.

15.~~4.7~~3.2.13.4.6.5
Test pressures shall be 20 percent above the normal system operating line pressure.

15.~~4.7~~3.2.13.4.6.6
At the conclusion of the tests, there shall be no change in the test pressure except that attributed to specific changes in ambient temperature.

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15.~~4.7~~3.2.13.4.6.7
Any leaks shall be located, repaired (if permitted), or replaced (if required) by the installer, and retested. The piping shall be repurged if necessary.

15.~~4.7~~3.2.13.4.6.8
The 24-hour standing pressure tests shall be witnessed by the authority having jurisdiction or its designee. A form indicating that these tests have been performed and witnessed shall be provided to the verifier at the start of the verification tests in 15.~~4.7~~3.2.13.5.

15.~~4.7~~3.2.13.5 Verification of Piping Systems (Oxygen and Nitrous Oxide).
15.~~4.7~~3.2.13.5.1 General.
15.~~4.7~~3.2.13.5.1.1
The oxygen and nitrous oxide piping systems requiring initial testing and verification shall be as indicated in 15.~~4.7~~3.2.13.2 for the different dental facilities.

15.~~4.7~~3.2.13.5.1.2
Required verification of oxygen and nitrous oxide piping systems shall be performed only after all initial tests required in 15.~~4.7~~3.2.13.4 have been completed.

15.~~4.7~~3.2.13.5.1.3
The test gas shall be oil-free, dry nitrogen NF or the system gas or vacuum where permitted.

15.~~4.7~~3.2.13.5.1.4
Verification shall be conducted by a party technically competent and experienced in the field of medical gas and vacuum piping system testing and certified for ASSE 6030, *Professional Qualifications Standard for Medical Gas Systems Verifiers*.

15.~~4.7~~3.2.13.5.1.5
Verification shall be performed by a party other than the installing contractor.

15.~~4.7~~3.2.13.5.1.6
All required verification tests shall be performed after installation of any manufactured assemblies supplied through tubing or flexible hose.

15.~~4.7~~3.2.13.5.1.7
Where there are multiple possible connection points for terminals, each possible position shall be tested independently.

15.~~4.7~~3.2.13.5.1.8
Where brazed joints in copper tubing are found to be defective, they shall be repaired if permitted by 15.4.6.8.6 or replaced if required by 15.4.6.8.5, and retested. The piping shall be repurged if necessary.

15.~~4.7~~3.2.13.5.1.9
During the process of verification, the presence and proper labeling of source equipment, station outlets/inlets, zone valve boxes, shutoff valves, and alarms shall be checked.

15.~~4.7~~3.2.13.5.2 Verifier Standing Pressure Test.
Oxygen and nitrous oxide piping systems requiring verification shall be subjected to a 10-minute standing pressure test at operating line pressure using the following procedure:

(1) After the system is filled with nitrogen or the source gas, the source valve shall be closed.

(2) The piping system shall show no decrease in pressure after not less than 10 minutes.

(3) Any leaks shall be located, repaired (if permitted), or replaced (if required) by the installer, and retested.

15.~~4.7~~3.2.13.5.3 Verifier Cross-Connection Test.
The piping systems shall be tested for cross-connections between the systems using the following procedure:

(1) All medical gas and vacuum piping systems shall be reduced to atmospheric pressure.

(2) All sources of test gas for all of the gas and vacuum systems, with the exception of the one system to be checked, shall be disconnected.

(3) The system being checked shall be pressurized to a gauge pressure of 345 kPa (50 psi).

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(4) With adapters matching outlet labels, each individual station outlet/inlet of all medical gas and vacuum systems installed shall be checked to determine that test gas is dispensed only from the outlets/inlets of the piping system being tested.

(5) The source of test gas shall be disconnected, and the system that was tested reduced to atmospheric pressure.

(6) Each additional piping system shall be tested until all gas and vacuum piping systems requiring verification are free of cross-connections.

(7) Any cross-connections shall be removed and the associated piping repaired and tested for leaks.

15.~~4.7~~3.2.13.5.4 Verifier Piping Purge Test.
15.~~4.7~~3.2.13.5.4.1
To remove any traces of particulate matter deposited in the oxygen and nitrous oxide piping during construction, a heavy, intermittent purging of the piping shall be done.

15.~~4.7~~3.2.13.5.4.2
The appropriate adapter shall be obtained and high purge rates of at least 225 Nl/min (8 SCFM) shall be put on each outlet.

15.~~4.7~~3.2.13.5.4.3
After each 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.

15.~~4.7~~3.2.13.5.4.4
To avoid possible damage to the outlet and its components, this test shall not be conducted using any implement other than the proper adapter.

15.~~4.7~~3.2.13.5.4.5
No pronounced or objectionable odor shall be discernible from any positive-pressure outlet.

15.~~4.7~~3.2.13.5.5 Verifier Piping Particulate Test.
15.~~4.7~~3.2.13.5.5.1
For each oxygen and nitrous oxide system, the cleanliness of the piping system shall be verified.
15.~~4.7~~3.2.13.5.5.2
The test shall be performed with the use of oil-free, dry nitrogen NF.

15.~~4.7~~3.2.13.5.5.3
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 Nl/min (3.5 SCFM).

15.~~4.7~~3.2.13.5.5.4
Twenty five percent of the zones shall be tested at the outlet most remote from the source.

15.~~4.7~~3.2.13.5.5.5
The filter shall accrue no more than 0.001 g (1 mg) of matter from any outlet tested.

15.~~4.7~~3.2.13.5.5.6
If any outlet fails this test, the most remote outlet in every zone shall be tested.

15.~~4.7~~3.2.13.5.6 Verifier Piping Purity Test.
15.~~4.7~~3.2.13.5.6.1
For each oxygen and nitrous oxide system, the purity of the piping system shall be verified in accordance with 15.~~4.7~~3.2.13.5.6.

15.~~4.7~~3.2.13.5.6.2
These tests shall be performed with oil-free, dry nitrogen NF or the system gas.

15.~~4.7~~3.2.13.5.6.3
The outlet most remote from the source shall be tested for total nonmethane hydrocarbons and compared to the test of the source gas.

15.~~4.7~~3.2.13.5.6.4
If the system gas is used as the source gas, it shall be tested at the source equipment.

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15.~~4.7~~3.2.13.5.6.5
The difference between the two tests shall in no case exceed 5 ppm of total nonmethane hydrocarbons.

15.~~4.7~~3.2.13.5.6.6
The difference between the two tests shall in no case exceed 5 ppm of halogenated hydrocarbons.

15.~~4.7~~3.2.13.5.6.7
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).

15.~~4.7~~3.2.13.5.7 Verifier Final Tie-in Test.
15.~~4.7~~3.2.13.5.7.1
Prior to the connection of any work or any extension or addition to an existing piping system, the verification tests in 15.~~4.7~~3.2.13.5 shall be successfully performed on the new work.

15.~~4.7~~3.2.13.5.7.2
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 a leak detectant that is safe for use with oxygen and does not contain ammonia.

15.~~4.7~~3.2.13.5.7.3
For oxygen and nitrous oxide, immediately after the final brazed connection is made and leak-tested, 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 15.~~4.7~~3.2.13.5.4.

15.~~4.7~~3.2.13.5.7.4
Before the new work is used for patient care, oxygen and nitrous oxide shall be tested for operational pressure and gas concentration in accordance with 15.~~4.7~~3.2.13.5.8 and 15.~~4.7~~3.2.13.5.9.

15.~~4.7~~3.2.13.5.7.5
Permanent records of these tests shall be maintained.

15.~~4.7~~3.2.13.5.8 Verifier Operational Pressure Test.
15.~~4.7~~3.2.13.5.8.1
Operational pressure tests shall be performed at each station outlet or terminal where the user makes connections and disconnections.

15.~~4.7~~3.2.13.5.8.2
Tests shall be performed with the gas of system designation.

15.~~4.7~~3.2.13.5.8.3
All medical gas outlets with a gauge pressure of 345 kPa (50 psi), including 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).

15.~~4.7~~3.2.13.5.9 Verifier Gas Concentration Test.
After purging each system with the gas of system designation, the following shall be performed:

(1) Each pressure gas source and outlet 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

(b) Nitrous oxide ≥99 percent

(c) Other gases ±1 percent unless otherwise specified

15.3.2.14 Support Gases.
Category 3 systems shall comply with 5.1.13, except as follows:

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(1) Nitrogen source equipment shall be permitted to be installed in enclosures for Category 3 medical gases or in a mechanical room.

(2) Nitrogen source equipment shall include the following:

(a) One or more cylinders of nitrogen NF, sufficient for at least one average day's supply

(b) A manifold, if primary and secondary cylinders are provided

(c) A line pressure regulating valve

(d) A check valve downstream from the pressure regulating valve

(e) A pressure relief valve set at 50 percent above the normal line pressure and located downstream from the check valve

(f) A pressure relief valve discharge piped to the outdoors at a point that will not create a probable hazard and that is turned down to prevent the entry of rain or snow

(3) Nitrogen piping shall comply with 15.3.2.11.

15.3.2.15~~2~~ Medical Gas and Vacuum Operation and Management.
Category 3 systems shall comply with 5.1.14.

~~**15.3.4.1.6**~~
~~Station outlets and piped outlets for Category 3 medical gas and dental air having nonstandard operating pressures shall comply with the following additional requirements:~~

~~(1) They shall be gas specific.~~

~~(2) They shall be pressure specific where a single gas is piped at more than one operating pressure.~~

~~(3) They shall be a D.I.S.S connection if operated at a gauge pressure in excess of 550 kPa (80 psi).~~

~~(4) They shall 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).~~

~~**15.3.4.1.7**~~
~~Requirements for Category 3 dental gas and vacuum systems relating to the operation, management, and maintenance of oxygen and nitrous oxide piping systems shall apply both new and existing facilities as specified in 15.1.8.~~
~~**15.3.4.2 Medical Gas Systems (Oxygen and Nitrous Oxide).**~~
~~**15.3.4.2.1 Installer Qualifications (Oxygen and Nitrous Oxide).**~~
~~**15.3.4.2.1.1**~~
~~Installers of medical gas systems shall be certified in accordance with ASSE/IAPMO/ANSI 6010, *Professional Qualifications Standard for Medical Gas Systems Installers*, regardless of the capacity of the source equipment.~~
~~**15.3.4.2.1.2**~~
~~Installers of medical gas systems shall not use their certification to oversee installation by noncertified personnel.~~
~~**15.3.4.2.1.3**~~
~~Brazing of medical gas piping systems shall be performed by individuals who are qualified in accordance with 15.4.6.1.~~
~~**15.3.4.2.1.4**~~
~~Prior to any installation work involving brazing, the installer of the medical gas piping systems shall provide documentation required by 15.4.6.1 for the qualifications of the brazing procedures and individual brazers.~~
~~**15.3.4.2.2 Central Supply System Identification and Labeling (Oxygen and Nitrous Oxide).**~~
~~**15.3.4.2.2.1**~~
~~Cylinders, containers, and tanks shall be designed, fabricated, tested, and marked (i.e., stamped) in accordance with Department of Transportation (DOT) regulations, Transport Canada's (TC) *Transportation of Dangerous Goods Regulations*, or the ASME *Boiler and Pressure Vessel Code*. [**55:**7.1.5.1]~~
~~**15.3.4.2.2.2**~~
~~Cylinder contents shall be identified by attached labels or stencils naming the contents in accordance with the mandatory requirements of CGA C-7, *Guide to Classification and Labeling of Compressed Gases*.~~
~~**15.3.4.2.2.3**~~
~~Liquid containers shall have additional product identification visible from all directions with a minimum of 51 mm (2 in.) high letters, such as a 360-degree wraparound tape for medical liquid containers.~~

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15.34.2.2.4
Cryogenic liquid containers shall be provided with gas-specific outlet connections in accordance with the mandatory requirements of CGA V-5, *Standard for Diameter Index Safety System (Noninterchangeable Low Pressure Connections for Medical Gas Applications)*, or CGA V-1, *Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections*.
15.34.2.2.5
Cylinder and cryogenic liquid container outlet connections shall be affixed in such a manner as to be integral to the valve(s), unremovable with ordinary tools, or so designed as to render the attachment point unusable when removed.
15.34.2.2.6
The contents of cylinders and cryogenic liquid containers shall be verified prior to use.
15.34.2.2.7
Labels shall not be defaced, altered, or removed, and connecting fittings shall not be modified.
15.34.2.2.8
Locations containing positive-pressure gases other than oxygen and medical air shall have their door(s) labeled as follows:
Positive-Pressure Gases
NO Smoking or Open Flame
Room May Have Insufficient Oxygen
Open Door and Allow Room to Ventilate Before Entering
15.34.2.2.9
Locations containing central supply systems or cylinders containing only oxygen or medical air shall have their door(s) labeled as follows:
Medical Gases
NO Smoking or Open Flame
15.34.2.3 Central Supply System Operations (Oxygen and Nitrous Oxide).
15.34.2.3.1
The use of adapters or conversion fittings to adapt one gas-specific fitting to another shall be prohibited.
15.34.2.3.2
Cylinders and containers shall be handled in strict accordance with 11.6.2.
15.34.2.3.3
Only gas cylinders, reusable shipping containers, and their accessories shall be permitted to be stored in rooms containing central supply systems or gas cylinders.
15.34.2.3.4
No flammable materials, cylinders containing flammable gases, or containers containing flammable liquids shall be stored in rooms with gas cylinders.
15.34.2.3.5
If cylinders are wrapped when received, the wrappers shall be removed prior to storage.
15.34.2.3.6
Cylinders without correct markings or whose markings and gas-specific fittings do not match shall not be used.
15.34.2.3.7
Cryogenic liquid storage units intended to supply gas to the facility shall not be used to transfill other liquid storage vessels.
15.34.2.3.8
Care shall be exercised when handling cylinders that have been exposed to freezing temperatures or containers that contain cryogenic liquids to prevent injury to the skin.
15.34.2.3.9
Cylinders containing compressed gases and containers for volatile liquids shall be kept away from radiators, steam piping, and like sources of heat.
15.34.2.3.10
Where cylinder valve protection caps are supplied, they shall be secured tightly in place unless the cylinder is connected for use.
15.34.2.3.11
Containers shall not be stored in a tightly closed space.
15.34.2.3.12
Cylinders in use and in storage shall be prevented from reaching temperatures in excess of 52°C (125°F).
15.34.2.3.13
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 never be lower than −7°C (20°F) or greater than 52°C (125°F).
15.34.2.4 Locations of Medical Gas Source Equipment (Oxygen and Nitrous Oxide).
15.34.2.4.1
Gas storage locations in facilities with Category 2 medical gas systems with a total of all gases in cylinders or containers, except nitrogen, connected and in storage at one time that does not exceed 85 m^3 (3000 ft^3) at

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~~standard temperature and pressure (STP), or 142 m^3 (5000 ft^3) STP if oxygen is stored in a DOT specification 4 L (cryogenic liquid) container shall comply with 15.4.2.4.3 through 15.4.2.4.15.~~

~~**15.3.4.2.4.2***~~
~~Gas storage locations in facilities with Category 2 medical gas systems with a total of all gases in cylinders or containers exceeding quantities listed in 15.4.2.4.1 shall comply with 5.1.3.3.~~

~~**15.3.4.2.4.3**~~
~~Enclosures shall serve no purpose other than to contain the medical gas source equipment (oxygen and nitrous oxide), except that nitrogen source equipment and compressed air cylinders shall be permitted in the enclosure.~~

~~**15.3.4.2.4.4**~~
~~Natural or mechanical ventilation for oxygen and nitrous oxide manifold locations shall be in accordance with 9.3.6.5.~~

~~**15.3.4.2.4.5**~~
~~Storage of full or empty gas cylinders, or both, shall be permitted in the same enclosure.~~

~~**15.3.4.2.4.6**~~
~~Air compressors, vacuum pumps, and other equipment shall not be located in enclosures for medical gas cylinders (oxygen and nitrous oxide source equipment).~~

~~**15.3.4.2.4.7***~~
~~If enclosures are outdoors or remote from the treatment facilities that they serve, they shall be kept locked.~~

~~**15.3.4.2.4.8**~~
~~Cylinders in use and in storage shall be prevented from reaching temperatures in excess of 52°C (125°F). Nitrous oxide cylinders shall be prevented from reaching temperatures lower than –7°C (20°F).~~

~~**15.3.4.2.4.9**~~
~~Indoor enclosures shall not communicate directly with medical gas (oxygen and nitrous oxide) use points or storage locations for flammable materials or gases.~~

~~**15.3.4.2.4.10**~~
~~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).~~

~~**15.3.4.2.4.11**~~
~~Enclosures for medical gas (oxygen and nitrous oxide) source equipment shall be provided with doors or gates.~~

~~**15.3.4.2.4.12**~~
~~Cylinders in service or in storage shall be individually secured and located to prevent falling or being knocked over.~~

~~**15.3.4.2.4.13**~~
~~Locations containing positive-pressure gases or cylinders containing oxygen, nitrous oxide, or both shall be separated from the rest of the building by walls and floors having a 1-hour fire resistance rating with doors and other opening projective having a ¾ hour fire protection rating.~~

~~**15.3.4.2.4.14**~~
~~Locations containing positive-pressure gases or cylinders containing positive-pressure gases shall be ventilated in accordance with 9.3.6.5.~~

~~**15.3.4.2.4.15**~~
~~Locations containing positive-pressure gases or cylinders containing positive-pressure gases shall be provided with an automatic sprinkler system in accordance with NFPA 13.~~**~~15.3.4.2.5 Medical Gas Source Equipment (Oxygen and Nitrous Oxide).~~**

~~**15.3.4.2.5.1**~~
~~Mechanical means shall be provided to ensure that the medical gas source equipment is connected to the correct medical gas distribution piping system.~~

~~**15.3.4.2.5.2**~~
~~Cylinder valve outlets for oxygen and nitrous oxide shall comply with CGA V-1, *Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections*.~~

~~**15.3.4.2.5.3**~~
~~Threaded connections to manifolds shall comply with CGA V-5, *Standard for Diameter Index Safety System (Noninterchangeable Low Pressure Connections for Medical Gas Applications)*.~~

~~**15.3.4.2.5.4**~~
~~A check valve shall be provided downstream of each pressure regulator.~~

~~**15.3.4.2.5.5**~~
~~A pressure relief valve set at 50 percent above the normal line pressure shall be located downstream of the check valve in 15.3.4.2.5.4.~~

~~**15.3.4.2.5.6**~~
~~Pressure relief valves shall be brass, bronze, or stainless steel and designed for oxygen service.~~

~~**15.3.4.2.5.7**~~
~~Hose and flexible connectors shall have a gauge pressure rating not less than 6895 kPa (1000 psi).~~

~~**15.3.4.2.5.8**~~
~~Materials used in central supply systems shall meet the following requirements:~~

~~(1) In those portions of systems intended to handle oxygen at gauge pressures greater than 3000 kPa (435 psi), interconnecting hose shall contain no polymeric materials.~~

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(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 in accordance with the manufacturer's requirements.

15.34.2.5.9
Nonmetallic hoses and flexible connectors shall not exceed 1.52 m (5 ft) in length nor be concealed or penetrate walls, floors, ceilings, or partitions.
15.34.2.5.9.1
Source equipment shall not be connected to the piping system through flexible connectors.
15.34.2.5.10
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 one average day's supply.
15.34.2.5.11
The two banks of each medical gas source shall be manifolded so that either bank can supply its distribution piping system.
15.34.2.5.12
Where the source equipment is remote from a single treatment facility and an in-use bank is unable to supply the system, the manifold shall automatically switch to the secondary bank.
15.34.2.5.13
Where the source equipment serves multiple treatment facilities and an in-use bank is unable to supply the system, the manifold shall automatically switch to the secondary bank.
15.34.2.5.14
Where the source equipment is not remote and is accessible from a single treatment facility served and an in-use bank is unable to supply the system, the manifold shall be manually or automatically switched to the secondary bank.
15.34.2.6 Emergency Shutoff Valves (Oxygen and Nitrous Oxide).
15.34.2.6.1*
All Category 32 medical gas systems shall have an emergency shutoff valve accessible from all use-point locations in an emergency.
15.34.2.6.2
Where a central medical gas supply system supplies two treatment facilities, each facility shall be provided with an emergency shutoff valve located in that treatment facility accessible from all use-point locations in an emergency.
15.34.2.6.3
Each emergency shutoff valve shall be labeled to indicate the gas it controls and shut off only the gas to the treatment facility that it serves.
15.34.2.6.4
A remotely activated shutoff valve at a gas supply manifold shall not be used for emergency shutoff.
15.34.2.6.4.1
For clinical purposes, a remote valve actuator shall not fail-close in the event of loss of electric power.
15.34.2.6.4.2
Where remote actuators are the type that fail-open, cylinder shutoff valves shall be closed whenever the system is not in-use.
15.34.2.6.4.3
Emergency shutoff valves shall be located to meet the following requirements:

(1) Be readily operable from a standing position

(2) Be installed where visible and accessible at all times

(3) Be installed where they will not be hidden from plain view, such as not behind normally open or normally closed doors

(4) Be installed in the egress pathway near the exit from the treatment area that will be used in an emergency

(5) Be installed in rooms, areas, or closets that are not capable of being closed or locked

15.34.2.7 Station Outlets and Risers (Oxygen and Nitrous Oxide).
15.34.2.7.1
Each gas outlet shall be gas specific.
15.34.2.7.2
Gas outlets shall consist of a primary and a secondary valve or assembly.
15.34.2.7.3

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~~Each gas outlet shall be legibly identified.~~

~~15.34.2.7.4~~

~~Threaded outlets shall be noninterchangeable connections complying with the mandatory requirements of CGA V-5, *Standard for Diameter Index Safety System (Noninterchangeable Low Pressure Connections for Medical Gas Applications)*.~~

~~15.34.2.7.5~~

~~Factory-installed copper inlet tubes on station outlets extending no further than 205 mm (8 in.) from the body of the terminal shall be not less than DN8 (NPS 1/4) (3/8 in. O.D.) size, with 8 mm (0.3 in.) minimum inside diameter.~~

~~15.34.2.8 Manufactured Assemblies (Oxygen and Nitrous Oxide).~~

~~Category 32 systems shall comply with 5.1.6.~~

~~15.34.2.9 Pressure and Vacuum Indicators (Oxygen and Nitrous Oxide).~~

~~Category 32 systems shall comply with 5.1.8.~~

~~15.34.2.10 Warning Systems (Oxygen and Nitrous Oxide).~~

~~Category 32 warning systems shall comply with 5.2.9, except as follows:~~

~~(1) Warning systems shall be permitted to be a single alarm panel.~~

~~(2) The alarm panel shall be located in an area of continuous surveillance while the facility is in operation.~~

~~(3) Pressure and vacuum switches/sensors shall be mounted at the source equipment with a pressure indicator at the master alarm panel.~~

~~(4) Warning systems for medical gas systems shall provide the following alarms:~~

~~(a) Oxygen main line pressure low~~

~~(b) Oxygen main line pressure high~~

~~(c) Oxygen changeover to secondary bank or about to changeover (if automatic)~~

~~(d) Nitrous oxide main line pressure low~~

~~(e) Nitrous oxide main line pressure high~~

~~(f) Nitrous oxide changeover to secondary bank or about to changeover (if automatic)~~

~~(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.~~

~~(6) Visual indications shall remain until the situation that caused the alarm is resolved.~~

~~(7) Pressure switches/sensors shall be installed downstream of any emergency shutoff valves and any other shutoff valves in the system and cause an alarm for the medical gas if the pressure decreases or increases 20 percent from the normal operating pressure.~~

~~(8) A cancelable audible indication of each alarm condition that produces a sound at the alarm panel shall reinitiate the audible signal if another alarm condition occurs while the audible signal is silenced.~~

~~15.34.2.11 Labeling and Identification.~~

~~Category 32 systems shall comply with 5.1.11.~~

15.34.3 Category 3~~2~~ Dental Air and Vacuum Piping Systems.

Category 3 Dental air and vacuum systems shall comply with section 15.2.3

~~15.34.3.1 General.~~

~~Dental vacuum systems shall include dental vacuum and nitrous oxide scavenging.~~

~~15.34.3.2 Equipment Locations for Dental Air and Vacuum Systems.~~

~~15.34.3.2.1 General.~~

~~Any of the following systems shall be permitted to be located together in the same room:~~

~~(1) Dental air compressor sources and reserve headers~~

~~(2) Dental–surgical vacuum sources~~

~~(3) Dental vacuum sources~~

~~(4) Any other compressor, vacuum pump, or electrically powered machinery~~

~~15.34.3.2.2 Cylinders and Containers.~~

~~Cylinders and containers for gases shall be handled in accordance with Chapter 11.~~

~~15.34.3.2.3 Ventilation for Motor-Driven Equipment.~~

~~The following source locations shall be adequately ventilated to prevent accumulation of heat:~~

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(1) Medical air sources

(2) Instrument air sources

(3) Dental compressed air sources

(4) Dental–surgical vacuum sources

(5) Dental vacuum sources

(6) WAGD sources

15.34.3.3 Dental Gas and Vacuum Source Equipment.
15.34.3.3.1 General.
15.34.3.3.1.1
The capacity of source equipment shall be based on the design requirements for the facility, including the number of gas outlets, vacuum inlets, and other connections, and their individual capacities.
15.34.3.3.1.2
The system design requirements shall be included in the data used for testing and verifying the operation of the gas and vacuum piping systems.
15.34.3.3.2 Dental Air.
15.34.3.3.2.1 General.
(A)
Dental air use shall comply with the following requirements:

(1) Dental air shall be used for driving dental tools.

(2) Dental air shall be permitted to be used to supply air-driven equipment.

(3) Dental compressed air shall not be permitted to be used for respiration.

(B)
Dental air outlets shall not be interchangeable with any other gas outlets, including oxygen, nitrous oxide, medical air, instrument air, and nitrogen.
15.34.3.3.2.2 Dental Air Compressor Units.
(A)
Dental air compressor units shall include dental air compressors, vibration isolation, air receivers, coalescent air filters, adsorption dryers, exhaust silencer/filters, moisture indicators, service access manifolds, electrical disconnects, motor wiring, and controls.
(B)
Air compressors shall be scroll dental, reciprocating dental, or the oil-free dental types.
(C)
Dental air sources for compressors located inside the building shall meet the following requirements:

(1) Be located in a space where no chemical-based materials are stored or used

(2) Be located in a space that is not used for patient treatment or dental procedures

(3) Be taken from a room or space in which there is no open or semi-open discharge from a dental vacuum or dental scavenging system

(4) Be drawn from a remote location, such as the building return air system, when the compressor is located in a room with an open or semi-open discharge from a dental vacuum or dental scavenging system

15.34.3.3.3 Dental Vacuum.
15.34.3.3.1 General.
(A)
Dental vacuum shall be used for oral evacuation and nitrous oxide scavenging.
(B)
Dental vacuum inlets shall not be interchangeable with any other vacuum inlets, including dental–surgical vacuum.
15.34.3.3.2 Dental Vacuum Units.
(A)
Dental vacuum units shall include dental vacuum pumps, vibration isolation, separation tanks, vacuum inlet, vacuum exhaust, condensate drain, motor wiring, and controls.
(B)
Dental vacuum pumps shall comply with both of the following:

(1) Pumps shall be dental dry vacuum or dental liquid (wet) ring pumps.

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(2) Pumps shall be oil-free or oil-lubricated and suitable for nitrous oxide scavenging.

(C)
Dental vacuum exhaust shall comply with one of the following requirements:

(1) It shall be exhausted to the outdoors in accordance with the manufacturer's recommendations.

(2) It shall be filtered and diffused locally with a ULPA filter element capable of retaining 99.99 percent of particulates.

(3) If used for nitrous oxide scavenging, it shall discharge outdoors.

(D)
Dental vacuum system piping shall comply with all of the following:

(1) Horizontal piping in dental vacuum systems shall be sloped a minimum of 7 mm per 3.05 m (¼ in. per 10 ft) toward the vacuum source equipment.

(2) Horizontal piping shall include no sags or low points that would permit fluid or debris to accumulate in the piping.

(3) Voids in the vacuum piping shall be avoided to prevent buildup and obstructions.

(4) Accessible cleanouts shall be permitted to be installed in the vertical downflow pipe to clear obstructions, where necessary.

(5) Dental vacuum cleanouts shall not to be installed on horizontal piping.

(6) Dental vacuum inlets shall be capable of 283 L/min (10 SCFM) or greater flow capacity.

15.34.3.3.4 Nitrous Oxide Scavenging.
15.34.3.3.4.1 General.
(A)
The use of scavenging shall be limited to portions of dental facilities where moderate or minimal sedation is administered.
(B)
Active nitrous oxide scavenging shall include the use of a nasal mask on the patient that is connected to a scavenging inlet in the dental vacuum system through a flow-limiting adapter.
(C)
Nitrous oxide scavenging inlets shall not be interchangeable with any other vacuum inlets, including medical–surgical vacuum, dental vacuum, and WAGD.
15.34.3.3.4.2 Connection to Dental Vacuum.
Scavenging connections to the dental vacuum system shall be a direct HVE connection to a high-volume vacuum port with a capacity of 45 L/min (1.6 cfm).
15.34.3.4 Category 32 Warning Systems (Oxygen and Nitrous Oxide).
15.34.3.4.1 General.
15.34.3.4.1.1
The warning systems in Category 2 dental gas and vacuum systems shall comply with applicable requirements of 5.2.9 and 15.4.3.4.2 through 15.4.3.4.4.
15.34.3.4.1.2
The master, area, and local alarm functions shall be permitted to be provided by a single alarm panel, as indicated in 5.2.9.
15.34.3.4.2 Master Alarm Panels.
15.34.3.4.2.1
A master alarm panel shall be located in the facility at a point of continuous surveillance when the facility is in operation.
15.34.3.4.2.2
The master alarm panel shall indicate the following:

(1) Oxygen supply pressure ±20 percent from normal

(2) Nitrous oxide supply pressure ±20 percent from normal

(3) Changeover of oxygen supply source

(4) Changeover of nitrous oxide supply source

15.34.3.4.3 Area Alarm Panels.

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~~**15.34.3.4.3.1**~~
~~An area alarm panel shall be centrally located where two or more treatment areas are supplied from the same zoned dental gas and vacuum piping.~~
~~**15.34.3.4.3.2**~~
~~Area alarm panels shall indicate the following:~~

~~(1) Oxygen supply pressure ±20 percent from normal~~

~~(2) Nitrous oxide supply pressure ±20 percent from normal~~

~~**15.34.3.4.4 Local Alarms.**~~
~~**15.34.3.4.4.1**~~
~~Local alarms shall be located in source equipment control panels or separate control panels in the equipment rooms for source equipment.~~
~~**15.34.4 Piping for Category 2 Medical Gas, Dental Air, and Vacuum Systems.**~~
~~**15.34.4.1 General.**~~
~~**15.34.4.1.1**~~
~~Piping for the following systems shall comply with 15.34.4.2:~~

~~(1) Oxygen~~

~~(2) Nitrous oxide~~

~~**15.34.4.1.2**~~
~~Piping for dental air systems shall comply with 15.34.4.3.~~
~~**15.34.4.1.3**~~
~~Piping for dental vacuum systems and scavenging systems shall comply with 15.34.4.4.~~
~~**15.34.4.2 Piping for Oxygen and Nitrous Oxide Systems.**~~
~~**15.34.4.2.1 Cleaning for Oxygen Service.**~~
~~**15.34.4.2.1.1**~~
~~For oxygen and nitrous oxide, the pipe, fittings, valves, gas/vacuum outlets/inlets, and other piping components shall be cleaned for oxygen by the manufacturer prior to installation in accordance with CGA G-4.1, *Cleaning Equipment for Oxygen Service*.~~
~~**15.34.4.2.1.2**~~
~~Fittings shall be permitted to be cleaned by a supplier or agency other than the manufacturer.~~
~~**15.34.4.2.2 Pipe.**~~
~~Piping materials for oxygen and nitrous oxide shall be one of the following:~~

~~(1) Hard-drawn seamless copper in accordance with ASTM B819, *Standard Specification for Seamless Copper Tube for Medical Gas Systems,* medical gas tube, Type L or Type K~~

~~(2) Listed corrugated medical tubing (CMT) fabricated from copper alloy No. 51000 strip, meeting ASTM B103/B103M, *Standard Specification for Phosphor Bronze Plate, Sheet, Strip, and Rolled Bar*, as follows:~~

~~(a) Having a design margin of 3.5~~

~~(b) Externally coated with a nonmetallic sheath marked with the manufacturer's marking~~

~~(c) Listing includes testing to demonstrate that CMT systems can be consistently gas-purged with results equivalent to comparable medical gas copper tubing~~

~~**15.34.4.2.2.1**~~
~~CMT shall have a flame spread index of 25 or less and a smoke developed index of 50 or less as determined by ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*.~~
~~**15.34.4.2.2.2**~~
~~CMT shall be identified by the manufacturer as suitable for oxygen service at a minimum of every 0.92 m (3 ft).~~
~~**15.34.4.2.3 Fittings.**~~
~~**15.34.4.2.3.1**~~
~~Fittings shall be brazed, memory metal, or axially swaged.~~
~~**15.34.4.2.3.2**~~
~~Brazed fittings shall be the wrought copper capillary type complying with the following:~~

~~(1) ASME B16.22, *Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings*~~

~~(2) ANSI/ASME B16.50, *Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings*~~

~~(3) ASME B16.22 with socket depths equal to or greater than brazed joint pressure fittings in accordance with ANSI/ASME B16.50~~

Commented [MC1]: Move 15.2.3.10

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15.34.4.2.3.3
Cast copper alloy fittings shall not be used with field-brazed joints.
15.34.4.2.3.4
Memory metal fittings shall be rated for not less than 538°C (1000°F) and 2070 kPa (300 psi) and be installed by qualified technicians in accordance with the manufacturer's instructions.
15.34.4.2.3.5
Axially swaged couplings shall include metal-to-metal seats, shall be rated for not less than 538°C (1000°F) and 2070 kPa (300 psi), and provide permanent, nonseparable joints. Fittings shall be installed by qualified technicians in accordance with the manufacturer's instructions.
15.34.4.2.4 Joints.
15.34.4.2.4.1 Brazed.
Brazing of copper joints shall be in accordance with 15.4.6.
15.34.4.2.4.2 Threaded.
Threaded joints shall be limited to connections to pressure indicators, alarm devices, and source equipment and shall comply with the following:

(1) Threads shall be tapered complying with ASME B1.20.1, *Pipe Threads, General Purpose, Inch*.

(2) Threads shall be made up with polytetrafluoroethylene (PTFE) tape or other thread sealant recommended for oxygen service, with the sealant applied to the male threads only.

15.34.4.2.4.3 Prohibited Joints.
The following joints shall be prohibited under 15.34.4.2.4:

(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

(4) Pipe crimping tools used to permanently stop the flow of medical gas and vacuum piping

Commented [MC2]: Covered in 15.3.2.11

15.34.4.3 Piping for Dental Air Systems.
15.34.4.3.1 General.
Pipe, fittings, and joints in piping for dental compressed air systems shall be in accordance with 15.2.334.4.3.2 through 15.34.4.3.4.
15.34.4.3.2 Pipe.
Piping materials for dental air systems shall comply with one of the following:

(1) ASTM B88, *Standard Specification for Seamless Copper Water Tube*, Type L or K

(2) ASTM B819, *Standard Specification for Seamless Copper Tube for Medical Gas Systems*, Type L or K

(3) ASTM B280, *Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service*, ACR tube (O.D. size)

(4) ASTM B103/B103M, *Standard Specification for Phosphor Bronze Plate, Sheet, Strip, and Rolled Bar*, listed corrugated medical tubing (CMT) fabricated from copper alloy No. 51000 strip, as follows:

(a) Having a design margin of 3.5

(b) Externally coated with a nonmetallic sheath marked with the manufacturer's marking

(c) Listing includes testing to demonstrate that CMT systems can be consistently gas purged with results equivalent to comparable medical gas copper tubing

15.34.4.3.2.1
Copper tube shall be hard temper or annealed (soft temper).
15.34.4.3.3 Fittings.
Fittings for dental air piping systems shall be permitted to be any of the following acceptable joining methods:

(1) Brazed or soldered fittings complying with ASME B16.22, *Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings*

(2) Brazed fittings complying with ANSI/ASME B16.50, *Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings*

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(3) Brazed fittings complying with ASME B16.22, with socket depths equal to or greater than braze-joint pressure fittings complying with ANSI/ASME B16.50

(4) Flared fittings complying with ASME B16.26, *Cast Copper Alloy Fittings for Flared Copper Tubes*

(5) Compression fittings (3/4 in. maximum size)

(6) Axially swaged fittings complying with 15.34.4.2.3.5

15.34.4.3.4 Joints.
Joints for piping under 15.34.4.3 shall comply with 15.34.4.3.4.1 through 15.34.4.3.4.3.
15.34.4.3.4.1
Joints shall be brazed, soldered, threaded, flared, or the compression type.
15.34.4.3.4.2
Where joints are brazed, they shall comply with the requirements of 15.34.6.
15.34.4.3.4.3
Soldered joints shall be made in accordance with ASTM B828, *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 B32, *Standard Specification for Solder Metal*.

Commented [MC3]: Duplicated text, Covered in 15.2.3

15.34.4.4 Piping for Dental Vacuum Systems and Scavenging Systems.
15.34.4.4.1 General.
Piping for dental vacuum systems and scavenging systems shall be copper, PVC plastic, or CPVC plastic.15.2.3
15.34.4.4.2 Copper Piping.
Copper piping under 15.4.4.4 shall be in accordance with 15.4.4.4.2.1 through 15.4.4.4.2.3.
15.34.4.4.2.1 Copper Tube.
Copper tubing shall be hard temper or annealed (soft temper) and shall comply with the following:

(1) ASTM B88, *Standard Specification for Seamless Copper Water Tube*, Type L or K

(2) ASTM B819, *Standard Specification for Seamless Copper Tube for Medical Gas Systems*, Type L or K

(3) ASTM B280, *Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service*, ACR tube (O.D. size)

15.34.4.4.2.2 Copper Fittings.
Copper fittings shall comply with the following:

(1) Brazed or soldered fittings conforming to ASME B16.22, *Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings*

(2) Brazed fittings conforming to ANSI/ASME B16.50, *Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings*

(3) Brazed fittings conforming to ASME B16.22 with socket depths equal to or greater than braze-joint pressure fittings conforming to ANSI/ASME B16.50

(4) Flared fittings conforming to ASME B16.26, *Cast Copper Alloy Fittings for Flared Copper Tubes*

(5) Compression fittings (3/4 in. maximum size)

15.34.4.4.2.3 Joints for Copper Piping.
Joints in copper tubing shall be in accordance with the following:

(1) Joints shall be brazed, soldered, threaded, flared, or the compression type.

(2) Where joints are brazed, they shall comply with the requirements of 15.4.6.

(3) Soldered joints shall be made in accordance with ASTM B828, *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 B32, *Standard Specification for Solder Metal*.

15.34.4.4.3 PVC Plastic Piping.
PVC plastic piping under 15.4.4.4 shall be in accordance with the following:

(1) PVC plastic pipe shall be Schedule 40 or Schedule 80, conforming to ASTM D1785, *Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120*.

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(2) PVC plastic fittings shall be Schedule 40 or Schedule 80 to match the pipe, conforming to ASTM D2466, *Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40*, or ASTM D2467, *Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80*.

(3) Joints in PVC plastic piping shall be solvent-cemented in accordance with ASTM D2672, *Standard Specification for Joints for IPS PVC Pipe Using Solvent Cement*.

15.34.4.4.4 CPVC Plastic Piping.
CPVC plastic piping under 15.4.4.4 shall be in accordance with the following:

(1) CPVC IPS plastic pipe shall be Schedule 40 or Schedule 80, conforming to ASTM F441/F441M, *Standard Specification for 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, conforming to ASTM F438, *Standard Specification for Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40*, or ASTM F439, *Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80*.

(3) CPVC CTS plastic pipe and fittings ½ in. through 2 in. size shall be SDR 11, conforming to ASTM D2846/D2846M, *Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems*.

(4) Solvent cement for joints in CPVC plastic piping shall comply with ASTM F493, *Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings*.

15.34.4.5 Piping for Nitrogen.
Nitrogen piping in dental facilities shall comply with 15.4.4.2, including cleaning for oxygen service.

Commented [MC4]: Duplicated text, covered in 15.2.3

15.34.5 Installation of Medical Gas, Dental Air, and Vacuum Piping.
15.34.5.1 General.
15.34.5.1.1
Gas and vacuum piping systems shall be as listed in Section 15.4.
15.34.5.1.2
Piping materials shall be as listed in 15.4.4.
15.34.5.2 Pipe Sizing.
Piping systems shall be designed and sized to deliver the required flow rates at the utilization pressures.
15.34.5.3 Minimum Pipe Sizes.
The minimum size of the following piping shall be as follows:

(1) Category 2 oxygen piping shall be not less than DN10 (NPS ⅜ in.) (½ in. O.D.) size.

(2) Category 2 nitrous oxide piping shall be not less than DN8 (NPS ¼ in.) (⅜ in. O.D.) size.

(3) Category 2 oxygen piping shall be at least 1 size larger than piping for nitrous oxide.

15.34.5.4 Location of Piping.
Piping shall not be located where subject to contact with oil.
15.34.5.5 Protection of Piping.
15.34.5.5.1
Piping shall be protected against freezing, corrosion, and physical damage.
15.34.5.5.2
Piping exposed in corridors and other locations where subject to physical damage from the movement of equipment shall be protected.
15.34.5.6 Pipe Support.
15.34.5.6.1
Piping shall be supported from the building structure.
15.34.5.6.2
Hangers and supports shall comply with and be installed in accordance with MSS SP-58, *Pipe Hangers and Supports — Materials, Design, Manufacture, Selection, Application, and Installation*.
15.34.5.6.3
Hangers and supports shall be sized for the tube or pipe being supported.
15.34.5.6.4
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.
15.34.5.6.5
The maximum support spacing for copper tube shall be in accordance with Table 15.34.5.6.5.
Table 15.34.5.6.5 Maximum Copper Tube Support Spacing

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Pipe Size	Hanger Spacing mm	Hanger Spacing ft
DN8 (NPS ¼) (⅜ in. O.D.)	1520	5
DN10 (NPS ⅜) (½ in. O.D.)	1830	6
DN15 (NPS ½) (⅝ in. O.D.)	1830	6
DN20 (NPS ¾) (⅞ in. O.D.)	2130	7
DN25 (NPS 1) (1⅛ in. O.D.)	2440	8
DN32 (NPS 1¼) (1⅜ in. O.D.)	2740	9
DN40 (NPS 1½) (1⅝ in. O.D.) and larger	3050	10
Vertical risers, all sizes, every floor, but not to exceed	4570	15

15.3.4.5.6.6

The maximum support spacing for plastic pipe shall be in accordance with Table 15.4.5.6.6.

Table 15.3.4.5.6.6 Maximum Plastic Pipe Support Spacing

Pipe Size	Hanger Spacing mm	Hanger Spacing ft
DN15 (NPS ½) (⅝ in. O.D.)	1220	4
DN20 (NPS ¾) (⅞ in. O.D.)	1220	4
DN25 (NPS 1) (1⅛ in. O.D.)	1320	4.33
DN32 (NPS 1¼) (1⅜ in. O.D.)	1320	4.33
DN40 (NPS 1½) (1⅝ in. O.D.)	1420	4.66
DN50 (NPS 2) (2⅜ in. O.D.)	1420	4.66
DN65 (NPS 2½) (2⅜ in. O.D.) and larger	1520	5
Vertical risers, all sizes, every floor, but not to exceed	3040	10

15.3.4.5.7 Underground Piping Outside of Buildings.

15.3.4.5.7.1

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

15.3.4.5.7.2

The installation procedure for underground piping shall prevent physical damage to the piping while being back-filled.

15.3.4.5.7.3

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.

15.3.4.5.7.4

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

15.3.4.5.7.5

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.

15.3.4.5.7.6

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

15.3.4.5.7.7

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

15.3.4.5.7.8

A continuous warning tape or marker shall be placed immediately above the piping or its enclosure to clearly identify the pipeline by specific name.

15.3.4.5.7.9

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A continuous warning means shall also be placed above the pipeline at approximately one-half the depth of burial.

15.24.5.7.10

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.

15.24.5.8 Underground Piping Within Buildings.

15.24.5.8.1

The installation procedure for underground piping shall prevent physical damage to the piping while being back-filled.

15.24.5.8.2

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.

15.24.5.8.3

The piping shall be backfilled with clean sand or gravel.

15.24.5.9 Piping Within Floor Slabs Prohibited.

Dental gas and vacuum piping shall not be installed within floor slabs.

15.24.5.10 Hose and Flexible Connectors.

15.24.5.10.1

Hose and flexible connectors, both metallic and nonmetallic, shall be no longer than necessary nor penetrate or be concealed in walls, floors, ceilings, or partitions.

15.24.5.10.2

Hose and flexible connectors, metallic or nonmetallic, shall have a minimum burst gauge pressure of 6895 kPa (1000 psi).

15.24.5.10.3

Medical gas hose and flexible connectors shall be oxygen compatible.

15.24.5.10.4

Hose and flexible connectors shall be clearly identified as to the gas content.

15.24.5.10.5

Hose and flexible connectors for dental medical gases shall be gas-specific and not be permitted to conduct any other gas, gas mixture, or liquid.

15.24.6 Brazing Copper Tubing.

15.24.6.1 Qualification of Brazing Procedures and Brazers.

15.24.6.1.1

Brazing procedures and brazer performance for the installation of dental piping shall be in accordance with either Section IX, "Welding and Brazing Qualifications," of the ASME *Boiler and Pressure Vessel Code*, or AWS B2.2/B2.2M, *Specification for Brazing Procedure and Performance Qualification*, both as modified by 15.4.6.

15.24.6.1.2

Brazers shall be qualified by visual examination of the test coupons followed by sectioning.

15.24.6.1.3

The brazing procedure specification shall address cleaning, joint clearance, overlap, internal purge gas, purge gas flow rate, and filler metal.

15.24.6.1.4

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.

15.24.6.1.5

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 record 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.

15.24.6.1.6

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.

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(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.

15.24.6.1.7
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.

15.24.6.2 Brazed Joints.

15.24.6.2.1
Brazed tube joints shall be of the socket type.

15.24.6.2.2
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.

15.24.6.2.3
Filler metals shall bond with and be metallurgically compatible with the base metal being joined.

15.24.6.2.4
Filler metals shall comply with ANSI/AWS A5.8M/A5.8, *Specification for Filler Metals for Brazing and Braze Welding*.

15.24.6.2.5
Copper-to-copper joints shall be brazed using a copper-phosphorus or copper-phosphorus-silver brazing filler metal (i.e., BCuP series) without flux.

15.24.6.2.6
Joints to be brazed in place shall be accessible for necessary preparation, assembly, heating, filler application, cooling, cleaning, and inspection.

15.24.6.3 Cutting Tube Ends.

15.24.6.3.1
Tube ends shall be cut square using a sharp tubing cutter to avoid deforming the tube.

15.24.6.3.2
The cutting wheels on tubing cutters shall be free from grease, oil, or other lubricants not recommended for oxygen service.

15.24.6.3.3
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.

15.24.6.4 Cleaning Joints for Brazing.

15.24.6.4.1
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.

15.24.6.4.2
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.

15.24.6.4.3
Nonabrasive pads shall be used to clean the exterior surfaces of tube ends.

15.24.6.4.4
The use of steel wool, sand cloth, or wire brushes shall be prohibited.

15.24.6.4.5
The cleaning process shall not result in grooving the surfaces to be joined.

15.24.6.4.6
After being abraded, the surfaces shall be wiped using a clean, lint-free white cloth.

15.24.6.4.7
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.

15.24.6.4.8
Material that has become contaminated internally and is not clean for oxygen service shall not be installed.

15.24.6.4.9
Joints shall be brazed within 8 hours after being cleaned for brazing.

15.24.6.5 Brazing Dissimilar Metals.

15.24.6.5.1
Flux shall only be used when brazing dissimilar metals, such as copper and bronze or brass, using a silver brazing filler metal (i.e., BAg series).

15.24.6.5.2
Cast metals shall not be field brazed.

15.24.6.5.3
Surfaces shall be cleaned for brazing in accordance with 15.4.6.4.

15.24.6.5.4
Flux shall be applied sparingly to minimize contamination of the inside of the tube with flux.

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15.24.6.5.5
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.
15.24.6.5.6
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.
15.24.6.5.7
On joints DN20 (NPS ¾) (⅞ 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.
15.24.6.6 Nitrogen Purge.
15.24.6.6.1
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.
15.24.6.6.2
The source of the nitrogen purge gas shall be monitored, and the installer shall be audibly alerted when the content is low.
15.24.6.6.3
The nitrogen purge gas flow rate shall not be high enough to produce a positive pressure in the piping system.
15.24.6.6.4
The nitrogen purge gas flow shall be controlled by the use of both a pressure regulator and a flowmeter or a combination thereof.
15.24.6.6.5
Pressure regulators alone shall not be used to control nitrogen purge gas flow rates.
15.24.6.6.6
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.
15.24.6.6.7
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.
15.24.6.6.8
The flow of nitrogen purge gas shall be maintained until the joint is cool to the touch.
15.24.6.6.9
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.
15.24.6.7 Assembling and Heating Brazed Joints.
15.24.6.7.1
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 (i.e., overlap) specified in ANSI/ASME B16.50, *Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings*.
15.24.6.7.2
Where flux is permitted, joints shall be heated slowly until the flux has liquefied.
15.24.6.7.3
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.
15.24.6.7.4
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 VIII, "Brazed Joints," in the CDA *Copper Tube Handbook*.
15.24.6.8 Inspection of Brazed Joints.
15.24.6.8.1
After brazing, the outside of all joints shall be cleaned by washing with water and a wire brush to remove any residue and allow clear visual inspection of the joint.
15.24.6.8.2
Where flux has been used, the wash water shall be hot.
15.24.6.8.3
Each joint shall be visually inspected after cleaning the outside surfaces.
15.24.6.8.4
Joints exhibiting the following conditions shall not be permitted:

(1) Flux or flux residue (where flux or flux-coated BAg rods are used with dissimilar metals)

(2) Base metal melting or erosion

(3) Unmelted filler metal

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(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 *(see 15.34.7.4.4)* and standing pressure test *(see 15.34.7.4.6)*

15.34.6.8.5
Joints that are identified as defective under conditions specified in 15.34.6.8.4(2) or 15.43.6.8.4(5) shall be replaced.

15.34.6.8.6
Joints that are found to be defective under conditions specified in 15.34.6.8.4(1), 15.34.6.8.4(3), 15.34.6.8.4(4), 15.34.6.8.4(6), or 15.34.6.8.4(7) shall be permitted to be repaired, except that no joint shall be reheated more than once before being replaced.

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15.34.7 Performance Criteria and Testing (Oxygen and Nitrous Oxide).

15.34.7.1 Testing and Verification.

15.34.7.1.1 General.

153.4.7.1.1.1
Inspection and testing shall be performed on all new piped oxygen and nitrous oxide systems, additions, renovations, temporary installations, or repaired systems to ensure, by a documented procedure, that the following have been completed:

(1) All applicable requirements of this code have been followed.

(2) System integrity has been achieved or maintained.

(3) Piping systems are ready for testing and verification.

(4) Piping systems are performing in accordance with their design requirements.

15.34.7.1.1.2
The inspection and testing reports shall be submitted directly to the party that contracted for the testing, who then submits the reports through channels to the responsible facility authority and any others that are required.

15.34.7.1.1.3
Reports shall contain detailed listings of all findings and results.

15.34.7.1.1.4
The responsible facility authority shall review the inspection and testing records prior to the use of any systems to ensure that all findings and results of the inspection and testing have been successfully completed before use.

15.34.7.1.1.5
All documentation pertaining to inspections and testing shall be maintained on-site within the facility.

15.34.7.2 Required Testing and Verification.

15.34.7.2.1 Category 2 Medical Gas Systems (Oxygen and Nitrous Oxide).
All Category 2 oxygen and nitrous oxide piping systems indicated in 15.34.2 shall be initially tested in accordance with 15.34.7.4.

15.34.7.2.2
The oxygen and nitrous oxide piping systems shall be verified in accordance with 15.34.7.5.

15.34.7.3 Qualification of System Testers and Verifiers (Oxygen and Nitrous Oxide).

15.34.7.3.1
Individuals who perform the initial and final tests of the oxygen and nitrous oxide piping systems shall be certified to ASSE 6010, *Professional Qualifications Standard for Medical Gas Systems Installers*, or verifiers who comply with 15.34.7.3.2.

15.34.7.3.2
Individuals who verify the oxygen and nitrous oxide piping systems shall be certified to ASSE 6030, *Professional Qualifications Standard for Medical Gas Systems Verifiers*.

15.34.7.4 Initial Testing of Piping Systems (Oxygen and Nitrous Oxide).

15.34.7.4.1 General.

15.34.7.4.1.1
The initial tests required by 15.34.7.4 shall be performed prior to either the final tests or the verification tests listed in 15.34.7.5.

15.34.7.4.1.2
The test gas for gas piping systems shall be oil-free, dry nitrogen NF.

15.34.7.4.1.3
Where manufactured assemblies are to be installed, the initial tests required by 15.34.7.4 shall be performed as follows:

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(1) After completion of the distribution piping but before the standing pressure test

(2) Prior to installation of manufactured assemblies supplied through flexible hose or flexible tubing

(3) For all station outlets/inlets on installed manufactured assemblies supplied through copper tubing

15.34.7.4.1.4
Where plastic vacuum and plastic scavenging piping systems are installed, they shall be visually inspected for cross-connections to positive-pressure systems before applying positive test pressures to the copper piping systems.
15.34.7.4.1.5
Where brazed joints in copper tubing are found to be defective, they shall be repaired if permitted by 15.34.6.8.6 or replaced if required by 15.34.6.8.5, and retested. The piping shall be repurged if necessary.
15.34.7.4.1.6
During the process of initial testing, the identification and labeling of the medical gas and vacuum piping shall be checked.
15.34.7.4.2 Initial Piping Blowdown (Oxygen and Nitrous Oxide).
Piping in dental air 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 outlet/inlet rough-in assemblies and other system components (e.g., pressure/vacuum alarm devices, pressure/vacuum indicators, pressure relief valves, manifolds, and source equipment).
15.34.7.4.3 Initial Cross-Connection Test for Copper Piping Systems.
15.34.7.4.3.1
Copper piping shall not be tested before any plastic piping.
15.34.7.4.3.2
It shall be determined that no cross-connections exist between the various medical gas and vacuum piping systems.
15.34.7.4.3.3
All piping systems shall be reduced to atmospheric pressure.
15.34.7.4.3.4
Sources of test gas shall be disconnected from all piping systems except for the one system being tested.
15.34.7.4.3.5
The system under test shall be charged with oil-free, dry nitrogen NF to a gauge pressure of 345 kPa (50 psi).
15.34.7.4.3.6
After the installation of the individual faceplates with appropriate adapters matching outlet/inlet labels, each individual outlet/inlet in each installed medical gas and vacuum piping system shall be checked to determine that the test gas is dispensed only from the piping system tested.
15.34.7.4.3.7
The initial cross-connection test in 15.34.7.4.3 shall be repeated for each installed medical gas and vacuum piping system with copper piping.
15.34.7.4.3.8
Any cross-connections shall be removed and the associated piping repaired and leak tested.
15.34.7.4.3.9
The proper labeling and identification of system outlets/inlets shall be confirmed during these tests.
15.34.7.4.4 Initial Pressure Test.
15.34.7.4.4.1
Each section of the piping in positive-pressure gas systems and copper vacuum systems shall be pressure tested. Plastic vacuum and plastic scavenging piping shall not be pressure tested.
15.34.7.4.4.2
Initial pressure tests shall be conducted as follows:

(1) After blowdown of the distribution piping

(2) After installation of station outlet/inlet rough-in assemblies

(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, and line pressure relief valves)

15.34.7.4.4.3
The source shutoff valve shall remain closed during the pressure tests.
15.34.7.4.4.4
The test pressure for oxygen and nitrous oxide piping shall be 1.5 times the system operating pressure but not less than a gauge pressure of 1035 kPa (150 psi).
15.34.7.4.4.5*

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~~The test pressure shall be maintained until each joint has been examined for leakage by means of a leak detectant that is safe for use with oxygen and does not contain ammonia.~~

~~**15.34.7.4.4.6**~~

~~Any leaks shall be located, repaired (if permitted), or replaced (if required) by the installer, and retested.~~

~~**15.34.7.4.5 Initial Piping Purge Test.**~~

~~**15.34.7.4.5.1**~~

~~The outlets in each oxygen and nitrous oxide piping system shall be purged to remove any particulate matter from the distribution piping.~~

~~**15.34.7.4.5.2**~~

~~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.~~

~~**15.34.7.4.5.3**~~

~~The purging shall be started at the closest outlet to the piping shutoff valve and continue to the furthest outlet from the shutoff valve.~~

~~**15.34.7.4.6 Standing Pressure Test for Oxygen and Nitrous Oxide Piping.**~~

~~**15.34.7.4.6.1**~~

~~After successful completion of the initial pressure tests in 15.34.7.4.4, the gas distribution piping shall be subject to a standing pressure test.~~

~~**15.34.7.4.6.2**~~

~~Tests shall be conducted after the final installation of station outlet valve bodies, faceplates, and other distribution system components (e.g., pressure alarm devices, pressure indicators, line pressure relief valves, manufactured assemblies, and hoses).~~

~~**15.34.7.4.6.3**~~

~~The source valve shall be closed during this test.~~

~~**15.34.7.4.6.4**~~

~~The piping systems shall be subjected to 24-hour standing pressure tests using oil-free, dry nitrogen NF.~~

~~**15.34.7.4.6.5**~~

~~Test pressures shall be 20 percent above the normal system operating line pressure.~~

~~**15.34.7.4.6.6**~~

~~At the conclusion of the tests, there shall be no change in the test pressure except that attributed to specific changes in ambient temperature.~~

~~**15.34.7.4.6.7**~~

~~Any leaks shall be located, repaired (if permitted), or replaced (if required) by the installer, and retested. The piping shall be repurged if necessary.~~

~~**15.34.7.4.6.8**~~

~~The 24-hour standing pressure tests shall be witnessed by the authority having jurisdiction or its designee. A form indicating that these tests have been performed and witnessed shall be provided to the verifier at the start of the verification tests in 15.4.7.5.~~

~~**15.34.7.5 Verification of Piping Systems (Oxygen and Nitrous Oxide).**~~

~~**15.34.7.5.1 General.**~~

~~**15.34.7.5.1.1**~~

~~The oxygen and nitrous oxide piping systems requiring initial testing and verification shall be as indicated in 15.34.7.2 for the different dental facilities.~~

~~**15.34.7.5.1.2**~~

~~Required verification of oxygen and nitrous oxide piping systems shall be performed only after all initial tests required in 15.34.7.4 have been completed.~~

~~**15.34.7.5.1.3**~~

~~The test gas shall be oil-free, dry nitrogen NF or the system gas or vacuum where permitted.~~

~~**15.34.7.5.1.4**~~

~~Verification shall be conducted by a party technically competent and experienced in the field of medical gas and vacuum piping system testing and certified for ASSE 6030, *Professional Qualifications Standard for Medical Gas Systems Verifiers*.~~

~~**15.34.7.5.1.5**~~

~~Verification shall be performed by a party other than the installing contractor.~~

~~**15.34.7.5.1.6**~~

~~All required verification tests shall be performed after installation of any manufactured assemblies supplied through tubing or flexible hose.~~

~~**15.34.7.5.1.7**~~

~~Where there are multiple possible connection points for terminals, each possible position shall be tested independently.~~

~~**15.34.7.5.1.8**~~

~~Where brazed joints in copper tubing are found to be defective, they shall be repaired if permitted by 15.34.6.8.6 or replaced if required by 15.34.6.8.5, and retested. The piping shall be repurged if necessary.~~

~~**15.34.7.5.1.9**~~

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~~During the process of verification, the presence and proper labeling of source equipment, station outlets/inlets, zone valve boxes, shutoff valves, and alarms shall be checked.~~

~~15.3.4.7.5.2 Verifier Standing Pressure Test.~~

~~Oxygen and nitrous oxide piping systems requiring verification shall be subjected to a 10-minute standing pressure test at operating line pressure using the following procedure:~~

~~(1) After the system is filled with nitrogen or the source gas, the source valve shall be closed.~~

~~(2) The piping system shall show no decrease in pressure after not less than 10 minutes.~~

~~(3) Any leaks shall be located, repaired (if permitted), or replaced (if required) by the installer, and retested.~~

~~15.3.4.7.5.3 Verifier Cross-Connection Test.~~

~~The piping systems shall be tested for cross-connections between the systems using the following procedure:~~

~~(1) All medical gas and vacuum piping systems shall be reduced to atmospheric pressure.~~

~~(2) All sources of test gas for all of the gas and vacuum systems, with the exception of the one system to be checked, shall be disconnected.~~

~~(3) The system being checked shall be pressurized to a gauge pressure of 345 kPa (50 psi).~~

~~(4) With adapters matching outlet labels, each individual station outlet/inlet of all medical gas and vacuum systems installed shall be checked to determine that test gas is dispensed only from the outlets/inlets of the piping system being tested.~~

~~(5) The source of test gas shall be disconnected, and the system that was tested reduced to atmospheric pressure.~~

~~(6) Each additional piping system shall be tested until all gas and vacuum piping systems requiring verification are free of cross-connections.~~

~~(7) Any cross-connections shall be removed and the associated piping repaired and tested for leaks.~~

~~15.3.4.7.5.4 Verifier Piping Purge Test.~~

~~15.3.4.7.5.4.1~~

~~To remove any traces of particulate matter deposited in the oxygen and nitrous oxide piping during construction, a heavy, intermittent purging of the piping shall be done.~~

~~15.3.4.7.5.4.2~~

~~The appropriate adapter shall be obtained and high purge rates of at least 225 Nl/min (8 SCFM) shall be put on each outlet.~~

~~15.3.4.7.5.4.3~~

~~After each 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.~~

~~15.3.4.7.5.4.4~~

~~To avoid possible damage to the outlet and its components, this test shall not be conducted using any implement other than the proper adapter.~~

~~15.3.4.7.5.4.5~~

~~No pronounced or objectionable odor shall be discernible from any positive-pressure outlet.~~

~~15.3.4.7.5.5 Verifier Piping Particulate Test.~~

~~15.3.4.7.5.5.1~~

~~For each oxygen and nitrous oxide system, the cleanliness of the piping system shall be verified.~~

~~15.3.4.7.5.5.2~~

~~The test shall be performed with the use of oil-free, dry nitrogen NF.~~

~~15.3.4.7.5.5.3~~

~~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 Nl/min (3.5 SCFM).~~

~~15.3.4.7.5.5.4~~

~~Twenty five percent of the zones shall be tested at the outlet most remote from the source.~~

~~15.3.4.7.5.5.5~~

~~The filter shall accrue no more than 0.001 g (1 mg) of matter from any outlet tested.~~

~~15.3.4.7.5.5.6~~

~~If any outlet fails this test, the most remote outlet in every zone shall be tested.~~

~~15.3.4.7.5.6 Verifier Piping Purity Test.~~

~~15.3.4.7.5.6.1~~

~~For each oxygen and nitrous oxide system, the purity of the piping system shall be verified in accordance with 15.3.4.7.5.6.~~

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~~**15.34.7.5.6.2**~~
~~These tests shall be performed with oil-free, dry nitrogen NF or the system gas.~~
~~**15.34.7.5.6.3**~~
~~The outlet most remote from the source shall be tested for total nonmethane hydrocarbons and compared to the test of the source gas.~~
~~**15.34.7.5.6.4**~~
~~If the system gas is used as the source gas, it shall be tested at the source equipment.~~
~~**15.34.7.5.6.5**~~
~~The difference between the two tests shall in no case exceed 5 ppm of total nonmethane hydrocarbons.~~
~~**15.34.7.5.6.6**~~
~~The difference between the two tests shall in no case exceed 5 ppm of halogenated hydrocarbons.~~
~~**15.34.7.5.6.7**~~
~~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).~~
~~**15.34.7.5.7 Verifier Final Tie-in Test.**~~
~~**15.34.7.5.7.1**~~
~~Prior to the connection of any work or any extension or addition to an existing piping system, the verification tests in 15.34.7.5 shall be successfully performed on the new work.~~
~~**15.34.7.5.7.2**~~
~~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 a leak detectant that is safe for use with oxygen and does not contain ammonia.~~
~~**15.34.7.5.7.3**~~
~~For oxygen and nitrous oxide, immediately after the final brazed connection is made and leak-tested, 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 15.34.7.5.4.~~
~~**15.34.7.5.7.4**~~
~~Before the new work is used for patient care, oxygen and nitrous oxide shall be tested for operational pressure and gas concentration in accordance with 15.34.7.5.8 and 15.34.7.5.9.~~
~~**15.34.7.5.7.5**~~
~~Permanent records of these tests shall be maintained.~~
~~**15.34.7.5.8 Verifier Operational Pressure Test.**~~
~~**15.34.7.5.8.1**~~
~~Operational pressure tests shall be performed at each station outlet or terminal where the user makes connections and disconnections.~~
~~**15.34.7.5.8.2**~~
~~Tests shall be performed with the gas of system designation.~~
~~**15.34.7.5.8.3**~~
~~All medical gas outlets with a gauge pressure of 345 kPa (50 psi), including 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).~~
~~**15.34.7.5.9 Verifier Gas Concentration Test.**~~
~~After purging each system with the gas of system designation, the following shall be performed:~~

~~(1) Each pressure gas source and outlet 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~~

~~(b) Nitrous oxide ≥99 percent~~

~~(c) Other gases ±1 percent unless otherwise specified~~

~~**15.34.8 Performance Criteria and Testing (Dental Air and Vacuum).**~~
~~**15.34.8.1 Dental Air and Vacuum Systems Testing.**~~
~~Dental air and dental vacuum systems shall be tested in accordance with 15.2.3.9~~
~~**15.34.8.1.1 General.**~~
~~**15.34.8.1.1.1**~~
~~Inspection and testing shall be performed on all new piped dental gas and vacuum systems, additions, renovations, temporary installations, or repaired systems to ensure, by a documented procedure, that the following have been completed:~~

~~(1) All applicable requirements of this code have been followed.~~

Commented [BDJCUC(6]: All of this is already covered in the reference to 15.2.3. Delete?

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(2) System integrity has been achieved or maintained.

(3) Piping systems are ready for testing and verification.

(4) Piping systems are performing in accordance with their design requirements.

15.34.8.1.1.2
The inspection and testing reports shall be submitted directly to the party that contracted for the testing, who then submits the reports through channels to the responsible facility authority and any others that are required.
15.34.8.1.1.3
Reports shall contain detailed listings of all findings and results.
15.34.8.1.1.4
The responsible facility authority shall review the inspection and testing records prior to the use of any systems to ensure that all findings and results of the inspection and testing have been successfully completed before use.
15.34.8.1.1.5
All documentation pertaining to inspections and testing shall be maintained on-site within the facility.
15.34.8.1.2 Category 32 Dental Air and Vacuum Systems.
15.34.8.1.2.1
All Category 32 dental air and vacuum piping systems indicated in 15.34.3 shall be initially tested in accordance with 15.34.8.1.
15.34.8.1.2.2
Dental air, vacuum, and scavenging systems shall be final tested in accordance with 15.34.8.1.7 and 15.34.8.1.8.
15.34.8.1.3 Initial Testing of Piping Systems.
15.34.8.1.3.1
Where plastic vacuum and plastic scavenging piping systems are installed, they shall be visually inspected for cross-connections to oxygen and nitrous oxide systems before applying positive test pressures to the copper piping systems.
15.34.8.1.3.2
During the process of initial testing, the identification and labeling of the dental gas and vacuum piping shall be checked.
15.34.8.1.4 Initial Cross-Connection Test for Plastic Vacuum and Plastic Scavenging Piping Systems.
15.34.8.1.4.1
Plastic piping shall be tested before copper piping.
15.34.8.1.4.2
Tests shall be conducted to determine that no cross-connections exist between any plastic vacuum piping systems or plastic scavenging piping systems and any copper piping systems.
15.34.8.1.4.3
The vacuum or scavenging source shutoff valves for the vacuum or scavenging piping systems shall remain closed during the tests, unless they are being used for the cross-connection test vacuum source.
15.34.8.1.4.4
The cross-connection test vacuum shall be a minimum of 300 mm (12 in.) HgV.
15.34.8.1.4.5
The source of test vacuum shall be connected only to the vacuum or scavenging piping system being tested.
15.34.8.1.4.6
All individual gas system outlets and vacuum or scavenging system inlets shall be checked to determine that the test vacuum is only present in the vacuum or scavenging piping system being tested.
15.34.8.1.4.7
The cross-connection tests shall be repeated for each installed vacuum and scavenging system with plastic piping.
15.34.8.1.4.8
Any cross-connections shall be removed and the associated piping repaired and leak tested.
15.34.8.1.4.9
The proper labeling and identification of system outlets/inlets shall be confirmed during the initial tests.
15.34.8.1.5 Initial Pressure Test.
15.34.8.1.5.1
Each section of the piping in dental air systems and copper vacuum systems shall be pressure tested. Plastic vacuum and plastic scavenging piping shall not be pressure tested.
15.34.8.1.5.2
Initial pressure tests shall be conducted as follows:

(1) After installation of station outlet/inlet rough-in assemblies

(2) 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)

15.34.8.1.5.3
The source shutoff valve shall remain closed during the pressure tests.

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15.34.8.1.5.4
The test pressure for dental air piping and copper vacuum piping shall be 1.5 times the system operating pressure but not less than a gauge pressure of 1035 kPa (150 psi).
15.34.8.1.5.5
The test pressure shall be maintained until each joint has been examined for leakage by means of a leak detectant that is safe for use with oxygen and does not contain ammonia.
15.34.8.1.5.6
Any leaks shall be located, repaired (if permitted) or replaced (if required) by the installer, and retested.
15.34.8.1.6 Initial Piping Purge Test.
15.34.8.1.6.1
The outlets in each dental air piping system shall be purged to remove any particulate matter from the distribution piping.
15.34.8.1.6.2
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.
15.34.8.1.6.3
The purging shall be started at the closest outlet to the piping shutoff valve and continue to the furthest outlet from the shutoff valve.
15.34.8.1.7 Standing Pressure Test for Dental Air and Copper Vacuum Piping.
15.34.8.1.7.1
After successful completion of the initial pressure tests in 15.34.8.1, the dental air systems and copper vacuum systems shall be subject to a standing pressure test.
15.34.8.1.7.2
Tests shall be conducted after the final installation of station outlet valve bodies, faceplates, and other distribution system components (e.g., pressure alarm devices, pressure indicators, line pressure relief valves, manufactured assemblies, hoses).
15.34.8.1.7.3
The source valve shall be closed during this test.
15.34.8.1.7.4
The piping systems shall be subjected to 24-hour standing pressure tests using oil-free, dry nitrogen NF.
15.34.8.1.7.5
Test pressures shall be 20 percent above the normal system operating line pressure.
15.34.8.1.7.6
At the conclusion of the tests, there shall be no change in the test pressure, except that attributed to specific changes in ambient temperature.
15.34.8.1.7.7
Any leaks shall be located, repaired (if permitted) or replaced (if required) by the installer, and retested. The piping shall be repurged if necessary.
15.34.8.1.8 Standing Vacuum Test for Plastic Vacuum Piping.
15.34.8.1.8.1
After successful completion of the initial pressure tests in 15.34.8.1, vacuum distribution piping, including scavenging, shall be subjected to a standing vacuum test.
15.34.8.1.8.2
Tests shall be conducted after installation and connection of all components of the vacuum system.
15.34.8.1.8.3
The piping systems shall be subjected to a 24-hour standing vacuum test.
15.34.8.1.8.4
Test pressure shall be between 300 mm (12 in.) HgV and full vacuum.
15.34.8.1.8.5
During the test, the source of test vacuum shall be disconnected from the piping system.
15.34.8.1.8.6
At the conclusion of the test, there shall be no change in the vacuum pressure other than that attributed to changes of ambient temperature.
15.34.8.1.8.7
Any leaks shall be located, repaired (if permitted), or replaced (if required) by the installer, and retested.
15.34.9 Operation and Management.
15.34.9.1 System Shutdowns.
15.34.9.1.1
Gas and vacuum piping systems shall be shut down at the end of each workday.
15.34.9.1.2
Emergency shutoff valves or remote actuators shall not be used for daily shutdown of the systems.
15.34.9.1.3
Cylinder gas valves shall be used for daily shutdowns.
15.34.9.2 Prohibited Interconnections.

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~~Two or more piping systems for different gases or different vacuums shall not be interconnected for testing or any other reason.~~

~~15.3.4.9.3 Manufacturer's Instructions.~~

~~15.3.4.9.3.1~~

~~Piping system components shall be installed, adjusted, operated, and maintained in accordance with the manufacturer's instructions.~~

~~15.3.4.9.3.2~~

~~Copies of the manufacturer's instructions shall be provided to the facility and maintained at the facility.~~

~~15.3.4.9.4 Maintenance.~~

~~15.3.4.9.4.1~~

~~Gas and vacuum system equipment shall be maintained by a qualified person.~~

~~15.3.4.9.4.2~~

~~Every facility shall establish a procedure for manually turning off the gas supply at the cylinder valves of Category 2 dental gas and vacuum systems at the end of each day.~~

~~15.3.4.9.5 Periodic Testing.~~

~~Station outlets for oxygen and nitrous oxide shall be tested for flow and pressure on an approved schedule.~~

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~~15.5 Category 3 Dental Gas and Vacuum Systems.~~

~~15.5.1 General.~~

~~15.5.1.1~~

~~Category 3 dental gas and vacuum systems shall be limited to facilities that perform minimal or no sedation.~~

~~15.5.1.2~~

~~There shall be no medical gases.~~

~~15.5.1.3~~

~~Dental air shall be provided from a dental air source system.~~

~~15.5.1.4~~

~~The vacuum system shall be dental vacuum.~~

~~15.5.2 Category 3 Dental Air and Vacuum Piping Systems.~~

Commented [MC8]: Old category 3 rolled into old 2/new 3

~~Dental vacuum systems shall include dental vacuum and nitrous oxide scavenging.~~

~~15.5.3 Equipment Locations for Dental Air and Vacuum Systems.~~

~~15.5.3.1 General.~~

~~Any of the following systems shall be permitted to be located together in the same room:~~

~~(1) Dental air compressor sources and reserve headers~~

~~(2) Dental vacuum sources~~

~~(3) Any other compressor, vacuum pump, or electrically powered machinery~~

~~15.5.3.2 Cylinders and Containers.~~

~~Cylinders and containers for gases shall be handled in accordance with Chapter 11.~~

~~15.5.3.3 Ventilation for Motor-Driven Equipment.~~

~~The following source locations shall be adequately ventilated to prevent accumulation of heat:~~

~~(1) Dental compressed air sources~~

~~(2) Dental vacuum sources~~

~~15.5.4 Dental Gas and Vacuum Source Equipment.~~

~~15.5.4.1 General.~~

~~15.5.4.1.1~~

~~The capacity of source equipment shall be based on the design requirements for the facility, including the number of gas outlets, vacuum inlets, and other connections, and their individual capacities.~~

~~15.5.4.1.2~~

~~The system design requirements shall be included in the data used for testing and verifying the operation of the gas and vacuum piping systems.~~

~~15.5.4.2 Dental Air.~~

~~15.5.4.2.1 General.~~

~~15.5.4.2.1.1~~

~~Dental air use shall comply with the following:~~

~~(1) Be used for driving dental tools~~

~~(2) Be permitted to be used to supply air-driven equipment~~

~~(3) Be prohibited from being used for respiration~~

~~15.5.4.2.1.2~~

~~Dental air outlets shall not be interchangeable with any other gas outlets, including oxygen, nitrous oxide, medical air, instrument air, and nitrogen.~~

~~15.5.4.2.2 Dental Air Compressor Units.~~

~~15.5.4.2.2.1~~

~~Dental air compressor units shall include dental air compressors, vibration isolation, air receivers, coalescent air filters, adsorption dryers, exhaust silencer/filters, moisture indicators, and service access manifolds, electrical disconnects, motor wiring, and controls.~~

~~15.5.4.2.2.2~~

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Air compressors shall be scroll dental, reciprocating dental, or the oil-free dental types.

15.5.4.2.2.3

Dental air sources for compressors located inside the building shall meet the following requirements:

(1) Sources shall be located in a space where no chemical-based materials are stored or used.

(2) Sources shall be located in a space that is not used for patient treatment or dental procedures.

(3) Sources shall not be taken from a room or space in which there is an open or semi-open discharge from a dental vacuum or dental scavenging system.

(4) When the compressor is located in a room with an open or semi-open discharge from a dental vacuum or dental scavenging system, the air shall be drawn from a remote location such as the building return air system.

15.5.4.3 Dental Vacuum.

15.5.4.3.1 General.

15.5.4.3.1.1

Dental vacuum shall be used for oral evacuation and nitrous oxide scavenging.

15.5.4.3.1.2

Dental vacuum inlets shall not be interchangeable with any other vacuum inlets, including dental–surgical vacuum.

15.5.4.3.2 Dental Vacuum Units.

15.5.4.3.2.1

Dental vacuum units shall include dental vacuum pumps, vibration isolation, separation tanks, vacuum inlet, vacuum exhaust, condensate drain, motor wiring, and controls.

15.5.4.3.2.2

Dental vacuum pumps shall be dental dry vacuum or dental liquid (wet) ring pumps. Pumps shall be oil-free or oil-lubricated and suitable for nitrous oxide scavenging.

15.5.4.3.2.3

Dental vacuum exhaust shall comply with one of the following:

(1) Dental vacuum shall be exhausted to the outdoors in accordance with the manufacturer's recommendations.

(2) Dental vacuum exhaust shall be filtered and diffused locally with a ULPA filter element capable of retaining 99.99 percent of particulates.

(3) Dental vacuum exhaust shall discharge outdoors if used for nitrous oxide scavenging.

15.5.4.3.2.4

Dental vacuum system piping shall comply with all of the following:

(1) Horizontal piping in dental vacuum systems shall be sloped a minimum of 7 mm per 3.05 m (~~1/4~~ in. per 10 ft) toward the vacuum source equipment.

(2) Horizontal piping shall include no sags or low points that would permit fluid or debris to accumulate in the piping.

(3) Voids in the vacuum piping shall be avoided to prevent buildup and obstructions.

(4) Accessible cleanouts shall be permitted to be installed in the vertical downflow pipe to clear obstructions, where necessary.

(5) Dental vacuum cleanouts shall not to be installed on horizontal piping.

(6) Dental vacuum inlets shall be capable of 283 L/min (10 SCFM) or greater flow capacity.

15.5.5 Piping for Category 3 Dental Gas and Vacuum Systems.

15.5.5.1 General.

15.5.5.1.1

Piping for dental air systems shall comply with 15.5.5.2.

15.5.5.1.2

Piping for dental vacuum systems and scavenging systems shall comply with 15.5.5.3.

15.5.5.2 Piping for Dental Air Systems.

15.5.5.2.1 General.

Pipe, fittings, and joints in piping for dental compressed air systems shall be in accordance with 15.5.5.2.2 through 15.5.5.2.4.

15.5.5.2.2 Pipe.

Piping materials for dental air systems shall comply with one of the following:

(1) ASTM B88, *Standard Specification for Seamless Copper Water Tube,* Type L or K

(2) ASTM B819, *Standard Specification for Seamless Copper Tube for Medical Gas Systems,* Type L or K

(3) ASTM B280, *Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service*, ACR tube (O.D. size)

(4) ASTM B103/B103M, *Standard Specification for Phosphor Bronze Plate, Sheet, Strip, and Rolled Bar,* listed corrugated medical tubing (CMT) fabricated from copper alloy No. 51000 strip, as follows:

(a) Having a design margin of 3.5

(b) Externally coated with a nonmetallic sheath marked with the manufacturer's marking

(c) Listing includes testing to demonstrate that CMT systems can be consistently gas purged with results equivalent to comparable medical gas copper tubing

15.5.5.2.2.1

Copper tube shall be hard temper or annealed (soft temper).

15.5.5.2.3 Fittings.

Fittings for dental air piping systems shall be permitted to be any of the following acceptable joining methods:

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(1) Brazed or soldered fittings complying with ASME B16.22, *Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings*
(2) Brazed fittings complying with ANSI/ASME B16.50, *Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings*
(3) Brazed fittings complying with ASME B16.22, with socket depths equal to or greater than braze-joint pressure fittings complying with ANSI/ASME B16.50
(4) Flared fittings complying with ASME B16.26, *Cast Copper Alloy Fittings for Flared Copper Tubes*
(5) Compression fittings (3/4 in. maximum size)
(6) Axially swaged fittings complying with 5.1.10.7

15.5.5.2.4 Joints.

Joints for piping under 15.5.5.2 shall comply with the following:
(1) Joints shall be brazed, soldered, threaded, flared, or the compression type.
(2) Where joints are brazed, they shall comply with the requirements of 15.4.6.
(3) Soldered joints shall be made in accordance with ASTM B828, *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 B32, *Standard Specification for Solder Metal*.

15.5.5.3 Piping for Dental Vacuum Systems and Scavenging Systems.

15.5.5.3.1 General.

Piping for dental vacuum systems and scavenging systems shall be copper, PVC plastic, or CPVC plastic.

15.5.5.3.2 Copper Piping.

Copper piping under 15.5.5.3 shall be in accordance with 15.5.5.3.2.1 through 15.5.5.3.2.3.

15.5.5.3.2.1 Copper Tube.

Copper tubing shall be hard temper or annealed (soft temper) and comply with the following:
(1) ASTM B819, *Standard Specification for Seamless Copper Tube for Medical Gas Systems*, Type L or K
(2) ASTM B88, *Standard Specification for Seamless Copper Water Tube*, Type L or K
(3) ASTM B280, *Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service*, ACR tube (O.D. size)

15.5.5.3.2.2 Copper Fittings.

Copper fittings shall comply with the following:
(1) Brazed or soldered fittings conforming to ASME B16.22, *Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings*
(2) Brazed fittings conforming to ANSI/ASME B16.50, *Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings*
(3) Brazed fittings conforming to ASME B16.22 with socket depths equal to or greater than braze-joint pressure fittings conforming to ANSI/ASME B16.50
(4) Flared fittings conforming to ASME B16.26, *Cast Copper Alloy Fittings for Flared Copper Tubes*
(5) Compression fittings (3/4 in. maximum size)

15.5.5.3.2.3 Joints for Copper Piping.

Joints in copper tubing shall be in accordance with the following:
(1) Joints shall be brazed, soldered, threaded, flared, or the compression type.
(2) Where joints are brazed, they shall comply with the requirements of 15.4.6.
(3) Soldered joints shall be made in accordance with ASTM B828, *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 B32, *Standard Specification for Solder Metal*.

15.5.5.3.3 PVC Plastic Piping.

PVC plastic piping for dental vacuum systems and scavenging systems shall be in accordance with the following:
(1) PVC plastic pipe shall be Schedule 40 or Schedule 80 and comply with ASTM D1785, *Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120*.
(2) PVC plastic fittings shall be Schedule 40 or Schedule 80 to match the pipe and comply with ASTM D2466, *Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40*; ASTM D2467, *Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80*; or ASTM D2665, *Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings*.
(3) Joints in PVC plastic piping shall be solvent-cemented in accordance with ASTM D2672, *Standard Specification for Joints for IPS PVC Pipe Using Solvent Cement*.

15.5.5.3.4 CPVC Plastic Piping.

CPVC plastic piping under 15.5.5.3 shall be in accordance with the following:
(1) CPVC IPS plastic pipe shall be Schedule 40 or Schedule 80, conforming to ASTM F441/F441M, *Standard Specification for 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, conforming to ASTM F438, *Standard Specification for Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40*, or ASTM F439, *Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80*.
(3) CPVC CTS plastic pipe and fittings 1/2 in. through 2 in. size shall be SDR 11, conforming to ASTM D2846/D2846M, *Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems*.

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(4) Solvent cement for joints in CPVC plastic piping shall comply with ASTM F493, *Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings*.

15.5.6 Installation of Dental Air and Vacuum Piping.

15.5.6.1 General.

15.5.6.1.1

Dental air and vacuum piping systems shall be as listed in 15.5.2.

15.5.6.1.2

Piping materials shall be as listed in 15.5.5.

15.5.6.2 Pipe Sizing.

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

15.5.6.3 Protection of Piping.

15.5.6.3.1

Piping shall be protected against freezing, corrosion, and physical damage.

15.5.6.3.2

Piping exposed in corridors and other locations where subject to physical damage from the movement of equipment shall be protected.

15.5.6.4 Pipe Support.

15.5.6.4.1

Piping shall be supported from the building structure.

15.5.6.4.2

Hangers and supports shall comply with and be installed in accordance with MSS SP-58, *Pipe Hangers and Supports — Materials, Design, Manufacture, Selection, Application, and Installation*.

15.5.6.4.3

Hangers and supports shall be sized for the tube or pipe being supported.

15.5.6.4.4

The maximum support spacing for copper tube shall be in accordance with Table 15.5.6.4.4.

Table 15.5.6.4.4 Maximum Copper Tube Support Spacing

	Hanger Spacing	
Pipe Size	**mm**	**ft**
DN8 (NPS 1/4) (3/8 in. O.D.)	1520	5
DN10 (NPS 3/8) (1/2 in. O.D.)	1830	6
DN15 (NPS 1/2) (5/8 in. O.D.)	1830	6
DN20 (NPS 3/4) (7/8 in. O.D.)	2130	7
DN25 (NPS 1) (1 1/8 in. O.D.)	2440	8
DN32 (NPS 1 1/4) (1 3/8 in. O.D.)	2740	9
DN40 (NPS 1 1/2) (1 5/8 in. O.D.) and larger	3050	10
Vertical risers, all sizes, every floor, but not to exceed	4570	15

15.5.6.4.5

The maximum support spacing for plastic pipe shall be in accordance with Table 15.5.6.4.5.

Table 15.5.6.4.5 Maximum Plastic Pipe Support Spacing

	Hanger Spacing	
Pipe Size	**mm**	**ft**
DN15 (NPS 1/2) (5/8 in. O.D.)	1220	4
DN20 (NPS 3/4) (7/8 in. O.D.)	1220	4
DN25 (NPS 1) (1 1/8 in. O.D.)	1320	4.33
DN32 (NPS 1 1/4) (1 3/8 in. O.D.)	1320	4.33
DN40 (NPS 1 1/2) (1 5/8 in. O.D.)	1420	4.66
DN50 (NPS 2) (2 3/8 in. O.D.)	1420	4.66
DN65 (NPS 2 1/2) (2 3/8 in. O.D.) and larger	1520	5
Vertical risers, all sizes, every floor, but not to exceed	3040	10

15.5.6.5 Underground Piping Outside of Buildings.

15.5.6.5.1

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

15.5.6.5.2

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~~The installation procedure for underground piping shall prevent physical damage to the piping while being back-filled.~~

~~**15.5.6.5.3**~~

~~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.~~

~~**15.5.6.5.4**~~

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

~~**15.5.6.5.5**~~

~~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.~~

~~**15.5.6.5.6**~~

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

~~**15.5.6.5.7**~~

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

~~**15.5.6.5.8**~~

~~A continuous warning tape or marker shall be placed immediately above the piping or its enclosure to clearly identify the pipeline by specific name.~~

~~**15.5.6.5.9**~~

~~A continuous warning means shall also be placed above the pipeline at approximately one-half the depth of burial.~~

~~**15.5.6.5.10**~~

~~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.~~

~~**15.5.6.6 Underground Piping Within Buildings.**~~

~~**15.5.6.6.1**~~

~~The installation procedure for underground piping shall prevent physical damage to the piping while being back-filled.~~

~~**15.5.6.6.2**~~

~~The piping shall be backfilled with clean sand or gravel.~~

~~**15.5.6.7 Piping Within Floor Slabs Prohibited.**~~

~~Dental gas and vacuum piping shall not be installed within floor slabs.~~

~~**15.5.7 Performance Criteria and Testing (Dental Air and Vacuum).**~~

~~**15.5.7.1 Dental Air and Vacuum Systems Testing.**~~

~~**15.5.7.1.1 General.**~~

~~**15.5.7.1.1.1**~~

~~Inspection and testing shall be performed on all new piped dental gas and vacuum systems, additions, renovations, temporary installations, or repaired systems to ensure, by a documented procedure, that the following have been completed:~~

~~(1) All applicable requirements of this code have been followed.~~

~~(2) System integrity has been achieved or maintained.~~

~~(3) Piping systems are ready for testing and verification.~~

~~(4) Piping systems are performing in accordance with their design requirements.~~

~~**15.5.7.1.1.2**~~

~~The inspection and testing reports shall be submitted directly to the party that contracted for the testing, who then submits the reports through channels to the responsible facility authority and any others that are required.~~

~~**15.5.7.1.1.3**~~

~~Reports shall contain detailed listings of all findings and results.~~

~~**15.5.7.1.1.4**~~

~~The responsible facility authority shall review the inspection and testing records prior to the use of any systems to ensure that all findings and results of the inspection and testing have been successfully completed before use.~~

~~**15.5.7.1.1.5**~~

~~All documentation pertaining to inspections and testing shall be maintained on-site within the facility.~~

~~**15.5.7.1.2 Required Testing.**~~

~~**15.5.7.1.2.1**~~

~~All Category 3 dental gas and vacuum piping systems indicated in 15.5.2 shall be initially tested in accordance with 15.5.7.1.3.~~

~~**15.5.7.1.2.2**~~

~~Dental air, vacuum, and scavenging systems shall be final tested in accordance with 15.5.7.1.3.4 and 15.5.7.1.3.5.~~

~~**15.5.7.1.3 Initial Testing of Piping Systems.**~~

~~**15.5.7.1.3.1 General.**~~

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~~(A)~~
~~Where plastic vacuum and plastic scavenging piping systems are installed, they shall be visually inspected for cross-connections to oxygen and nitrous oxide systems before applying positive test pressures to the copper piping systems.~~
~~(B)~~
~~During the process of initial testing, the identification and labeling of the dental gas and vacuum piping shall be checked.~~
~~**15.5.7.1.3.2 Initial Pressure Test.**~~
~~(A)~~
~~Each section of the piping in dental air systems and copper vacuum systems shall be pressure tested. Plastic vacuum and plastic scavenging piping shall not be pressure tested.~~
~~(B)~~
~~Initial pressure tests shall be conducted as follows:~~
~~(1) After installation of station outlet/inlet rough-in assemblies~~
~~(2) 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 valve shall remain closed during the pressure tests.~~
~~(D)~~
~~The test pressure for dental air piping and copper vacuum piping shall be 1.5 times the system operating 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 a leak detectant that is safe for use with oxygen and does not contain ammonia.~~
~~(F)~~
~~Any leaks shall be located, repaired (if permitted) or replaced (if required) by the installer, and retested.~~
~~**15.5.7.1.3.3 Initial Piping Purge Test.**~~
~~(A)~~
~~The outlets in each dental air piping system shall be purged to remove any particulate matter from the distribution piping.~~
~~(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 closest outlet to the piping shutoff valve and continue to the furthest outlet from the shutoff valve.~~
~~**15.5.7.1.3.4 Standing Pressure Test for Dental Air and Copper Vacuum Piping.**~~
~~(A)~~
~~After successful completion of the initial pressure tests in 15.5.7.1.3.2, the dental air systems and copper vacuum systems shall be subject to a standing pressure test.~~
~~(B)~~
~~Tests shall be conducted after the final installation of station outlet valve bodies, faceplates, and other distribution system components (e.g., pressure alarm devices, pressure indicators, line pressure relief valves, manufactured assemblies, and hoses).~~
~~(C)~~
~~The source valve shall be closed during this test.~~
~~(D)~~
~~The piping systems shall be subjected to 24-hour standing pressure tests using oil-free, dry nitrogen NF.~~
~~(E)~~
~~Test pressures shall be 20 percent above the normal system operating line pressure.~~
~~(F)~~
~~At the conclusion of the tests, there shall be no change in the test pressure except that attributed to specific changes in ambient temperature.~~
~~(G)~~
~~Any leaks shall be located, repaired (if permitted) or replaced (if required) by the installer, and retested. The piping shall be repurged if necessary.~~
~~**15.5.7.1.3.5 Standing Vacuum Test for Plastic Vacuum Piping.**~~
~~(A)~~
~~After successful completion of the initial pressure tests in 15.5.7.1.3.2, vacuum distribution piping, including scavenging, shall be subjected to a standing vacuum test.~~
~~(B)~~
~~Tests shall be conducted after installation and connection of all components of the vacuum system.~~
~~(C)~~
~~The piping systems shall be subjected to a 24-hour standing vacuum test.~~
~~(D)~~

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~~Test pressure shall be between 300 mm (12 in.) HgV and full vacuum.~~

~~**(E)**~~

~~During the test, the source of test vacuum shall be disconnected from the piping system.~~

~~**(F)**~~

~~At the conclusion of the test, there shall be no change in the vacuum pressure other than that attributed to changes of ambient temperature.~~

~~**(G)**~~

~~Any leaks shall be located, repaired (if permitted) or replaced (if required) by the installer, and retested.~~

~~**15.5.8 Operation and Management.**~~

~~**15.5.8.1 System Shutdowns.**~~

~~Gas and vacuum piping systems shall be shut down at the end of each workday.~~

~~**15.5.8.2 Manufacturer's Instructions.**~~

~~**15.5.8.2.1**~~

~~Piping system components shall be installed, adjusted, operated, and maintained in accordance with the manufacturer's instructions.~~

~~**15.5.8.2.2**~~

~~Copies of the manufacturer's instructions shall be provided to the facility and maintained at the facility.~~

~~**15.5.8.3 Maintenance.**~~

~~Dental air and vacuum system equipment shall be maintained by a qualified representative of the equipment manufacturer.~~

Commented [MC9]: Duplicated text, see 15.2.3
Old category 3 rolled into old 2/new 3

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Chapter 15 Dental Gas and Vacuum Systems

15.1 Applicability.

This chapter shall apply to dental health care facilities that qualify to install dental gas and vacuum piping systems.

15.1.1

This chapter shall also apply to the altered, renovated, or modernized portions of existing systems or individual components.

15.1.1.1

Where the terms medical gas or medical support gas occur, the provisions shall apply to all piped systems for oxygen, nitrous oxide, medical air, carbon dioxide, helium, nitrogen, instrument air, and mixtures thereof. Wherever the name of a specific gas service occurs, the provision shall apply only to that gas.

15.1.1.2

An existing system that is not in strict compliance with the requirements of this code shall be permitted to continue in use unless the authority having jurisdiction has determined that such use constitutes a distinct hazard to life.

15.1.2 System Category Criteria.*

The dental health care facility's governing body shall designate the building system risk categories, in accordance with Sections 4.1 and 4.2.

A.15.1.2 Sample Risk Assessment Chart for Dental Facilities.

This sample risk assessment chart shows the types of treatments, sedation, and patient risk considerations that may be part of a facility specific risk assessment.

Reference	Sedation Levels	Risk of loss of piped gases presuming no user intervention*	Surgical / Procedural Risks - Range of Clinical Procedures*	American Society of Anesthesiologists (ASA) Physical Status (PS)*
Chpt 15 Cat 1 **Chpt 5 Cat 1**	General/Deep, Moderate, Minimal	Likely to cause major injury or death.	All levels of surgical risk (Chapter 5 patients considers both emergent and elective procedures). Would include dental procedures such as head and neck procedures such as orthognathic surgery, reconstructive (nonprosthetic) surgery, major cancer resections involving significant portions of the jaw or oropharyngeal structures, and open reduction and internal fixation of complex fractures of the face. May also include certain anesthesia procedures where neuromuscular blockade is used without immediate reversal agents such as suggamadex.	All levels of physical status. ASA PS 1-5 including PS 1E-5E
Chpt 15 Cat 2	General/Deep, moderate, minimal	Likely to cause minor injury.	Elective Surgery only, not emergent. Dentoalveolar procedures and superficial maxillofacial surgical procedures that carry very low surgical risk of death or loss of limb or function.	ASA PS 1-3

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			Might exclude head and neck procedures such as orthognathic surgery, reconstructive (nonprosthetic) surgery, major cancer resections involving significant portions of the jaw or oropharyngeal structures, and open reduction and internal fixation of complex fractures of the face. May also exclude certain anesthesia procedures where neuromuscular blockade is used without immediate reversal agents such as suggamadex.	
Chpt 15 Cat 3	Moderate/ Minimal or No Sedation	Not likely to cause injury. May cause discomfort.	Elective or Low Risk Procedures Dentoalveolar procedures and superficial surgical procedures that carry very low surgical risk of death or loss of limb or function	ASA PS 1-2, medically optimized 3 ASA 3, not medically optimized, or ASA IV for low-risk surgery (dental care) with either local anesthesia and/ or nitrous oxide only.

15.1.2.1

The category of risk applied to each dental gas and vacuum system serving a space shall be independent of the category of risk applied to other systems serving that same space.

15.1.2.2

Category 1 piped gas and vacuum system requirements shall be applied in dental facilities where Category 1 Risk is determined in Section 15.1.2 in accordance with section 4.2.

15.1.2.2.1
Category 1 piped gas and vacuum system requirements shall comply with Chapter 5 Section 5.1.

15.1.2.3

Category 2 piped gas and vacuum system requirements shall be applied in dental facilities where Category 2 Risk is determined in Section 15.1.2 in accordance with section 4.2.

15.1.2.4

Category 3 piped gas and vacuum system requirements shall be applied in dental facilities where Category 3 Risk is determined in Section 15.1.2 in accordance with section 4.2 and only moderate, minimal or no sedation is performed.

15.1.2.4.1
Deep sedation and general anesthesia shall not be permitted.

15.1.2.4.2*

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Facilities in this category may elect to have no medical gases as defined in 15.3.1.2. If piped medical gases are incorporated, such systems shall meet the requirements in this category.

A.15.1.2.4.2
Facilities performing moderate sedation normally incorporate medical gases. Facilities performing minimal or no sedation do not normally utilize medical gases. If they choose to incorporate piped systems, such systems would need to comply with the requirements within Category 3 dental gas systems.

15.1.3
A single facility shall be permitted to include dental gas and vacuum systems for more than one category of dental piped gas and vacuum systems.
15.1.4
This chapter shall apply to new facilities as specified by Section 1.3 unless otherwise specified by 15.1.5, and 15.1.6.
15.1.5
The requirements for Category 1 dental gas and vacuum systems for the operation, management, and maintenance of gas and vacuum piping systems shall apply to both new and existing facilities within the scope of this chapter and in accordance with 5.1.1.5.
15.1.6
The following sections of this chapter shall apply to the operation, management, and maintenance of Category 3 dental gas and vacuum systems in both new and existing facilities:

(1) 15.1.1.2

(2) 15.1.9

(3) 15.3.2.3.3

(4) 15.3.2.3.6

(5) 15.3.2.3.12

(6) 15.3.2.14.16

(7) 15.3.2.5.5

(8) 15.3.2.9

(9) 15.2.3.10

15.1.7
Where the term *responsible facility authority* is used, that entity shall follow the requirements of 5.1.14.1.

15.1.8 Nature of Hazards of Gas and Vacuum Systems.
Potential fire and explosion hazards associated with positive-pressure dental gas systems and vacuum systems shall be considered in the design, installation, testing, operation, and maintenance of these systems.

15.2 Category 2 Dental Gas and Vacuum Systems.
15.2.1 General.
Facilities that perform deep sedation and general anesthesia associated with dental treatment and where Category 2 Risk or lower is determined per Chapter 4 shall meet the requirements for Category 2 dental gas and vacuum systems.

15.2.2 Category 2 Medical Gas Systems (Dental).
15.2.2.1 Medical Gas and Vacuum Sources.
15.2.2.1.1 Central Supply System Identification and Labeling.
Category 2 systems shall comply with 5.1.3.1.

15.2.2.1.2 Central Supply Operations.
Category 2 systems shall comply with 5.1.3.2.

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15.2.2.1.3 Central Supply System Locations.
Category 2 systems shall comply with 5.1.3.3.

15.2.2.1.4 Central Supply Systems.
Category 2 systems shall comply with 5.1.3.5.

15.2.2.1.5 Medical Air Supply Systems.
Category 2 systems shall comply with 5.1.3.6, except as follows:

(1) Medical air compressors, dryers, aftercoolers, filters, and regulators shall be permitted to be simplex.

(2) The facility staff shall develop an emergency plan to deal with the loss of medical air.

15.2.2.1.6 Oxygen Supply Systems Using Concentrators.
Category 2 systems shall comply with 5.1.3.9, except as follows:

(1) Oxygen supply systems using concentrators shall be permitted to consist of two sources, one of which being a cylinder header with sufficient cylinder connections for an average day's supply.

15.2.2.1.7 Dental–Surgical Vacuum Systems.
Category 2 systems shall comply with 5.1.3.7, except as follows:

(1) Dental–surgical vacuum systems shall be permitted to be simplex.

(2) The facility staff shall develop an emergency plan to deal with the loss of dental–surgical vacuum.

15.2.2.1.8 WAGD Systems.
Category 2 systems shall comply with 5.1.3.8, except as follows:

(1) WAGD pumps shall be permitted to be simplex.

(2) The facility staff shall develop an emergency plan to deal with the loss of WAGD.

15.2.2.2 Valves.
Category 2 systems shall comply with 5.1.4.

15.2.2.3 Station Outlets and Inlets.
Category 2 systems shall comply with 5.1.5.

15.2.2.4 Manufactured Assemblies.
Category 2 systems shall comply with 5.1.6.

15.2.2.5 Surface-Mounted Medical Gas Rails.
Category 2 systems shall comply with 5.1.7.

15.2.2.6 Pressure and Vacuum Indicators.
Category 2 systems shall comply with 5.1.8.

15.2.2.7 Warning Systems.
Warning systems associated with Category 2 systems shall provide the master, area, and local alarm functions of a Category 1 system as required in 5.1.9, except as follows:

(1) Warning systems shall be permitted to be a single alarm panel.

(2) The alarm panel shall be located in an area of continuous surveillance while the facility is in operation.

(3) Pressure and vacuum switches/sensors shall be mounted at the source equipment with a pressure indicator at the master alarm panel.

15.2.2.8 Medical Gas Distribution.
Category 2 systems shall comply with 5.1.10.

15.2.2.9 Labeling and Identification.
Category 2 systems shall comply with 5.1.11.

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15.2.2.10 Performance Criteria and Testing for Medical Gas, Medical–Surgical Vacuum, and WAGD systems.
Category 2 systems shall comply with 5.1.12.

15.2.2.11 Support Gases.
Category 2 systems shall comply with 5.1.13, except as follows:

(1) Nitrogen source equipment shall be permitted to be installed in enclosures for Category 3 medical gases or in a mechanical room.

(2) Nitrogen source equipment shall include the following:

(a) One or more cylinders of nitrogen NF, sufficient for at least one average day's supply

(b) A manifold, if primary and secondary cylinders are provided

(c) A line pressure regulating valve

(d) A check valve downstream from the pressure regulating valve

(e) A pressure relief valve set at 50 percent above the normal line pressure and located downstream from the check valve

(f) A pressure relief valve discharge piped to the outdoors at a point that will not create a probable hazard and that is turned down to prevent the entry of rain or snow

15.2.2.12 Medical Gas and Vacuum Operation and Management.
Category 2 systems shall comply with 5.1.14.

15.2.3 Category 2 Dental Air and Vacuum Piping Systems.
15.2.3.1 General.
15.2.3.1.1
Dental vacuum systems shall include dental vacuum and nitrous oxide scavenging.

15.2.3.3.1.2
Dental vacuum and nitrous oxide scavenging systems as defined in Chapter 3 are independent of Medical-Surgical Vacuum and WAGD Systems.

15.2.3.3.1.2.1
Dental vacuum and nitrous oxide scavenging systems shall not be used for WAGD service.

15.2.3.3.1.3
Dental Air systems as defined in Chapter 3 are independent of Medical Air and all other medical gas systems.

15.2.3.3.1.3.1
Dental Air shall not be used for Medical Air purposes.

15.2.3.2 Equipment Locations for Dental Air and Vacuum Systems.
15.2.3.2.1 General.
Any of the following systems shall be permitted to be located together in the same room:

(1) Medical air compressor supply sources

(2) Dental air compressor sources and reserve headers

(3) Dental–surgical vacuum sources

(4) Dental vacuum sources

(5) WAGD sources

(6) Any other compressor, vacuum pump, or electrically powered machinery

15.2.3.2.2 Cylinders and Containers.
Cylinders and containers for gases shall be handled in accordance with Chapter 11.
15.2.3.2.3 Ventilation.
The following source locations for motor-driven equipment shall be adequately ventilated to prevent accumulation of heat:

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(1) Medical air sources

(2) Instrument air sources

(3) Dental compressed air sources

(4) Dental–surgical vacuum sources

(5) Dental vacuum sources

(6) WAGD sources

15.2.3.3 Dental Gas and Dental Vacuum Source Equipment.
15.2.3.3.1
The capacity of source equipment shall be based on the design requirements for the facility, including the number of gas outlets, vacuum inlets, and other connections, and their individual capacities.

15.2.3.3.2
The system design requirements shall be included in the data used for testing and verifying the operation of the gas and vacuum piping systems.

15.2.3.4* Dental Air.
15.2.3.4.1 General.
15.2.3.4.1.1
Dental air use shall be used for purposes congruent with the following:

(1) Dental air shall be used for driving dental tools.

(2) Dental air shall be permitted to be used to supply air-driven equipment.

(3) Dental compressed air shall not be permitted to be used for respiration.

15.2.3.4.1.2
Dental air outlets shall not be interchangeable with any other gas outlets including but not limited to oxygen, nitrous oxide, medical air, instrument air, and nitrogen.

15.2.3.4.2 Dental Air Compressor Units.
15.2.3.4.2.1
Dental air compressor units shall include dental air compressors, vibration isolation, air receivers, coalescent air filters, adsorption dryers, exhaust silencer/filters, moisture indicators, and service access manifolds, electrical disconnects, motor wiring, and controls.

15.2.3.4.2.2
Air compressors shall be scroll dental, reciprocating dental, or the oil-free dental types.

15.2.3.4.2.3
Dental air sources for compressors located inside the building shall meet the following requirements:

(1) Be located in a space where no chemical-based materials are stored or used

(2) Be located in a space that is not used for patient treatment or dental procedures

(3) Be taken from a room or space in which there is no open or semi-open discharge from a dental vacuum or dental scavenging system

(4) Drawn from a remote location, such as the building return air system, when the compressor is located in a room with an open or semi-open discharge from a dental vacuum or dental scavenging system

15.2.3.5* Dental Vacuum.
15.2.3.5.1 General.
15.2.3.5.1.1
Dental vacuum shall be used for oral evacuation and nitrous oxide scavenging.

15.2.3.5.1.2
Dental vacuum inlets shall not be interchangeable with any other vacuum inlets, including dental–surgical vacuum.

15.2.3.5.2 Dental Vacuum Units.
15.2.3.5.2.1

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Dental vacuum pumps shall comply with both of the following:

(1) Pumps shall be dental dry vacuum or dental liquid (wet) ring pumps.

(2) Pumps shall be oil-free or oil-lubricated and suitable for nitrous oxide scavenging.

15.2.3.5.2.2
Dental vacuum exhaust shall comply with one of the following requirements:

(1) Be exhausted to the outdoors in accordance with the manufacturer's recommendations

(2) Be filtered and diffused locally with a ULPA filter element capable of retaining 99.99 percent of particulates

(3) Discharge outdoors if used for nitrous oxide scavenging

15.2.3.5.2.3
Dental vacuum system piping shall comply with all of the following:

(1) Horizontal piping in dental vacuum systems shall be sloped a minimum of 7 mm per 3.05 m (1/4 in. per 10 ft) toward the vacuum source equipment.

(2) Horizontal piping shall include no sags or low points that would permit fluid or debris to accumulate in the piping.

(3) Voids in the vacuum piping shall be avoided to prevent buildup and obstructions.

(4) Accessible cleanouts shall be permitted to be installed in the vertical downflow pipe to clear obstructions, where necessary.

(5) Dental vacuum cleanouts shall not to be installed on horizontal piping.

(6) Dental vacuum inlets shall be capable of 283 L/min (10 SCFM) or greater flow capacity.

15.2.3.6 Nitrous Oxide Scavenging.
15.2.3.6.1 General.
15.2.3.6.1.1
The use of scavenging shall be limited to portions of dental facilities where moderate or minimal sedation is administered. WAGD shall be provided where the dental treatment involves general anesthesia or deep sedation.

15.2.3.6.1.2
Active nitrous oxide scavenging shall include the use of a nasal mask on the patient. The nasal mask shall be connected to a scavenging inlet in the dental vacuum system through a flow-limiting adapter.

15.2.3.6.1.3
Nitrous oxide scavenging inlets shall not be interchangeable with any other vacuum inlets, including medical–surgical vacuum, dental vacuum, and WAGD.

15.2.3.6.2 Connection to Dental Vacuum.
Scavenging connections to the dental vacuum system shall be a direct high-volume evacuation (HVE) connection to a high-volume vacuum port with a capacity of 45 L/min (1.6 cfm).

15.2.3.7 Piping for Dental Air and Vacuum Systems.
15.2.3.7.1 General.
15.2.3.7.1.1
Piping for dental compressed air systems shall comply with 15.2.3.7.2.

15.2.3.7.1.2
Piping for dental vacuum systems and scavenging systems shall comply with 15.2.3.7.3.

15.2.3.7.2 Piping for Dental Air Systems.
15.2.3.7.2.1 General.
Pipe, fittings, and joints in piping for dental compressed air systems shall be in accordance with 15.2.3.7.2.2 through 15.2.3.7.2.5.

15.2.3.7.2.2 Pipe.
Piping materials for dental air systems shall comply with one of the following:
(1) ASTM B88, *Standard Specification for Seamless Copper Water Tube,* Type L or K

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(2) ASTM B819, *Standard Specification for Seamless Copper Tube for Medical Gas Systems,* Type L or K
(3) ASTM B280, *Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service*, ACR tube (O.D. size)
(4) ASTM B103/B103M, *Standard Specification for Phosphor Bronze Plate, Sheet, Strip, and Rolled Bar*, listed corrugated medical tubing (CMT) fabricated from copper alloy No. 51000 strip, as follows:
(a) Having a design margin of 3.5
(b) Externally coated with a nonmetallic sheath marked with the manufacturer's marking
(c) Listing includes testing to demonstrate that CMT systems can be consistently gas-purged with results equivalent to comparable medical gas copper tubing

15.2.3.7.2.3 Copper Tube.
Copper tube shall be hard temper or annealed (soft temper).

15.2.3.7.2.4 Fittings.
Fittings for dental air piping systems shall be permitted to be any of the following acceptable joining methods:

(1) Brazed or soldered fittings complying with ASME B16.22, *Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings*

(2) Brazed fittings complying with ANSI/ASME B16.50, *Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings*

(3) Brazed fittings complying with ASME B16.22, with socket depths equal to or greater than braze-joint pressure fittings complying with ANSI/ASME B16.50

(4) Flared fittings complying with ASME B16.26, *Cast Copper Alloy Fittings for Flared Copper Tubes*

(5) Compression fittings (3/4 in. maximum size)

(6) Axially swaged fittings shall include metal-to-metal seats, shall be rated for not less than 538°C (1000°F) and 2070 kPa (300 psi), and provide permanent, nonseparable joints. Fittings shall be installed by qualified technicians in accordance with the manufacturer's instructions.

15.2.3.7.2.5 Joints.
Joints for piping under 15.2.3.7.2 shall comply with the following:

(1) Joints shall be brazed, soldered, threaded, flared, or the compression type.

(2) Where joints are brazed, they shall comply with the requirements of 15.2.3.8.10.

(3) Soldered joints shall be made in accordance with ASTM B828, *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 B32, *Standard Specification for Solder Metal*.

15.2.3.7.3 Piping for Dental Vacuum Systems and Scavenging Systems.
15.2.3.7.3.1 General.
Piping for dental vacuum systems and scavenging systems shall be copper, PVC plastic, or CPVC plastic.

15.2.3.7.3.2 Copper Piping.
Copper piping under 15.2.3.7.3 shall be in accordance with 15.2.3.7.3.2.1 through 15.2.3.7.3.2.3.

15.2.3.7.3.2.1 Copper Tube.
Copper tubing shall be hard temper or annealed (soft temper) and comply with the following:

(1) ASTM B88, *Standard Specification for Seamless Copper Water Tube,* Type L or K

(2) ASTM B819, *Standard Specification for Seamless Copper Tube for Medical Gas Systems,* Type L or K

(3) ASTM B280, *Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service*, ACR tube (O.D. size)

15.2.3.7.3.2.2 Copper Fittings.
Copper fittings shall comply 15.2.3.7.2.4(1)- 15.2.3.7.2.4(5).

15.2.3.7.3.2.3 Joints for Copper Piping.
Joints in copper tubing shall comply 15.2.3.7.2.5.

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15.2.3.7.3.3 PVC Plastic Piping.
PVC plastic piping under 15.2.3.7.3 shall comply with the following:

(1) PVC plastic pipe shall be Schedule 40 or Schedule 80, conforming to ASTM D1785, *Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120*.

(2) PVC plastic fittings shall be Schedule 40 or Schedule 80 to match the pipe, conforming to ASTM D2466, *Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40*, or ASTM D2467, *Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80*.

(3) Joints in PVC plastic piping shall be solvent-cemented in accordance with ASTM D2672, *Standard Specification for Joints for IPS PVC Pipe Using Solvent Cement*.

15.2.3.7.3.4 CPVC Plastic Piping.
CPVC plastic piping under 15.2.3.7.3 shall comply with the following:

(1) CPVC IPS plastic pipe shall be Schedule 40 or Schedule 80, conforming to ASTM F441/F441M, *Standard Specification for 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, conforming to ASTM F438, *Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40*, or ASTM F439, *Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80*.

(3) CPVC CTS plastic pipe and fittings ½ in. through 2 in. nominal size shall be SDR 11, conforming to ASTM D2846/D2846M, *Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems*.

(4) Solvent cement for joints in CPVC plastic piping shall comply with ASTM F493, *Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride)(CPVC) Plastic Pipe and Fittings*.

15.2.3.8 Installation of Dental Air, and Dental Vacuum Piping.
15.2.3.8.1 General.
15.2.3.8.1.1
Dental Gas and dental vacuum piping systems shall be as listed in Section 15.2.

15.2.3.8.1.2
Piping materials shall be as listed in 15.2.3.7.

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

15.2.3.8.3 Location of Piping.

Piping shall not be located where subject to contact with oil.

15.2.3.8.4 Protection of Piping.
15.2.3.8.4.1
Piping shall be protected against freezing, corrosion, and physical damage.

15.2.3.8.4.2
Piping exposed in corridors and other locations where subject to physical damage from the movement of equipment shall be protected.

15.2.3.8.5 Pipe Support.
Piping shall be supported from the building structure.

15.2.3.8.5.1
Hangers and supports shall comply with and be installed in accordance with MSS SP-58, *Pipe Hangers and Supports — Materials, Design, Manufacture, Selection, Application, and Installation*.

15.2.3.8.5.2
Hangers and supports shall be sized for the tube or pipe being supported.

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15.2.3.8.5.3
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.

15.2.3.8.5.4
The maximum support spacing for copper tube shall be in accordance with Table 15.3.5.6.5.

Table 15.3.5.6.5 Maximum Copper Tube Support Spacing

Pipe Size	Hanger Spacing	
	mm	ft
DN8 (NPS 1/4) (3/8 in. O.D.)	1520	5
DN10 (NPS 3/8) (1/2 in. O.D.)	1830	6
DN15 (NPS 1/2) (5/8 in. O.D.)	1830	6
DN20 (NPS 3/4) (7/8 in. O.D.)	2130	7
DN25 (NPS 1) (1 1/8 in. O.D.)	2440	8
DN32 (NPS 1 1/4) (1 3/8 in. O.D.)	2740	9
DN40 (NPS 1 1/2) (1 5/8 in. O.D.) and larger	3050	10
Vertical risers, all sizes, every floor, but not to exceed	4570	15

15.2.3.8.5
The maximum support spacing for plastic pipe shall be in accordance with Table 15.4.5.6.6.

Table 15.3.5.6.6 Maximum Plastic Pipe Support Spacing

Pipe Size	Hanger Spacing	
	mm	ft
DN15 (NPS 1/2) (5/8 in. O.D.)	1220	4
DN20 (NPS 3/4) (7/8 in. O.D.)	1220	4
DN25 (NPS 1) (1 1/8 in. O.D.)	1320	4.33
DN32 (NPS 1 1/4) (1 3/8 in. O.D.)	1320	4.33
DN40 (NPS 1 1/2) (1 5/8 in. O.D.)	1420	4.66
DN50 (NPS 2) (2 3/8 in. O.D.)	1420	4.66
DN65 (NPS 2 1/2) (2 7/8 in. O.D.) and larger	1520	5
Vertical risers, all sizes, every floor, but not to exceed	3040	10

15.2.3.8.6 Underground Piping Outside of Buildings.

15.2.3.8.6.1
Buried piping outside of buildings shall be installed below the local level of frost penetration.

15.2.3.8.6.2
The installation procedure for underground piping shall prevent physical damage to the piping while being back-filled.

15.2.3.8.6.3
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.

15.2.3.8.6.4
Buried piping that is subject to surface loads shall be buried at a depth that will protect the piping, its enclosure, or both, from excessive stresses.

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15.2.3.8.6.5
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.

15.2.3.8.6.6
Trenches shall be excavated so that the piping or its enclosure has firm, substantially continuous bearing on the bottom of the trench.

15.2.3.8.6.7
Backfill shall be clean, free from material that can damage the pipe, and compacted.

15.2.3.8.6.8
A continuous warning tape or marker shall be placed immediately above the piping or its enclosure to clearly identify the pipeline by specific name.

15.2.3.8.6.9
A continuous warning means shall also be placed above the pipeline at approximately one-half the depth of burial.

15.2.3.8.6.10
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.

15.2.3.8.7 Underground Piping Within Buildings.

15.2.3.8.7.1
The installation procedure for underground piping shall prevent physical damage to the piping while being back-filled.

15.2.3.8.7.2
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.

15.2.3.8.7.3
The piping shall be backfilled with clean sand or gravel.

15.2.3.8.8 Piping Within Floor Slabs Prohibited.
Dental gas and vacuum piping shall not be installed within floor slabs.

15.2.3.8.9 Hose and Flexible Connectors.
15.2.3.8.9.1
Hose and flexible connectors, both metallic and nonmetallic, shall be no longer than necessary nor penetrate or be concealed in walls, floors, ceilings, or partitions.

15.2.3.8.9.2
Hose and flexible connectors, metallic or nonmetallic, shall have a minimum burst gauge pressure of 6895 kPa (1000 psi).

15.2.3.8.9.3
Medical gas hose and flexible connectors shall be oxygen compatible.

15.2.3.8.9.4
Hose and flexible connectors shall be clearly identified as to the gas content.

15.2.3.8.9.5
Hose and flexible connectors for dental medical gases shall be gas-specific and not be permitted to conduct any other gas, gas mixture, or liquid.

15.2.3.8.10 Brazing Copper Tubing.
15.2.3.8.10.1 Qualification of Brazing Procedures and Brazers.

15.2.3.8.10.1.1

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Brazing procedures and brazer performance for the installation of dental piping shall be in accordance with either Section IX, "Welding and Brazing Qualifications," of the ASME *Boiler and Pressure Vessel Code,* or AWS B2.2/B2.2M, *Specification for Brazing Procedure and Performance Qualification*, both as modified by 15.2.3.8.10.

15.2.3.8.10.1.2
Brazers shall be qualified by visual examination of the test coupons followed by sectioning.

15.2.3.8.10.1.3
The brazing procedure specification shall address cleaning, joint clearance, overlap, internal purge gas, purge gas flow rate, and filler metal.

15.2.3.8.10.1.4
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.

15.2.3.8.10.1.5
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 record 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.

15.2.3.8.10.1.6
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.

15.2.3.8.10.1.7
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.

15.2.3.8.10.2 Brazed Joints.

15.2.3.8.10.2.1
Brazed tube joints shall be of the socket type.

15.2.3.8.10.2.2
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.

15.2.3.8.10.2.3
Filler metals shall bond with and be metallurgically compatible with the base metal being joined.

15.2.3.8.10.2.4
Filler metals shall comply with ANSI/AWS A5.8M/A5.8, *Specification for Filler Metals for Brazing and Braze Welding*.

15.2.3.8.10.2.5
Copper-to-copper joints shall be brazed using a copper-phosphorus or copper-phosphorus-silver brazing filler metal (i.e., BCuP series) without flux.

15.2.3.8.10.2.6

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

15.2.3.8.10.3 Cutting Tube Ends.

15.2.3.8.10.3.1
Tube ends shall be cut square using a sharp tubing cutter to avoid deforming the tube.

15.2.3.8.10.3.2
The cutting wheels on tubing cutters shall be free from grease, oil, or other lubricants not recommended for oxygen service.

15.2.3.8.10.3.3
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.

15.2.3.8.10.4 Cleaning Joints for Brazing.

15.2.3.8.10.4.1
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.

15.2.3.8.10.4.2
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.

15.2.3.8.10.4.3
Nonabrasive pads shall be used to clean the exterior surfaces of tube ends.

15.2.3.8.10.4.4
The use of steel wool, sand cloth, or wire brushes shall be prohibited.

15.2.3.8.10.4.5
The cleaning process shall not result in grooving the surfaces to be joined.

15.2.3.8.10.4.6
After being abraded, the surfaces shall be wiped using a clean, lint-free white cloth.

15.2.3.8.10.4.7
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.

15.2.3.8.10.4.8
Material that has become contaminated internally and is not clean for oxygen service shall not be installed.

15.2.3.8.10.4.9
Joints shall be brazed within 8 hours after being cleaned for brazing.

15.2.3.8.10.5 Brazing Dissimilar Metals.

15.2.3.8.10.5.1
Flux shall only be used when brazing dissimilar metals, such as copper and bronze or brass, using a silver brazing filler metal (i.e., BAg series).

15.2.3.8.10.5.2
Cast metals shall not be field brazed.

15.2.3.8.10.5.3
Surfaces shall be cleaned for brazing in accordance with 15.2.3.8.10.4.

15.2.3.8.10.5.4
Flux shall be applied sparingly to minimize contamination of the inside of the tube with flux.

15.2.3.8.10.5.5

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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.

15.2.3.8.10.5.6
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.

15.2.3.8.10.5.7
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.

15.2.3.8.10.6 Nitrogen Purge.

15.2.3.8.10.6.1
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.

15.2.3.8.10.6.2
The source of the nitrogen purge gas shall be monitored, and the installer shall be audibly alerted when the content is low.

15.2.3.8.10.6.3
The nitrogen purge gas flow rate shall not be high enough to produce a positive pressure in the piping system.

15.2.3.8.10.6.4
The nitrogen purge gas flow shall be controlled by the use of both a pressure regulator and a flowmeter or a combination thereof.

15.2.3.8.10.6.5
Pressure regulators alone shall not be used to control nitrogen purge gas flow rates.

15.2.3.8.10.6.6
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.

15.2.3.8.10.6.7
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.

15.2.3.8.10.6.8
The flow of nitrogen purge gas shall be maintained until the joint is cool to the touch.

15.2.3.8.10.6.9
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.

15.2.3.8.10.7 Assembling and Heating Brazed Joints.

15.2.3.8.10.7.1
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 (i.e., overlap) specified in ANSI/ASME B16.50, *Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings*.

15.2.3.8.10.7.2
Where flux is permitted, joints shall be heated slowly until the flux has liquefied.

15.2.3.8.10.7.3
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.

15.2.3.8.10.7.4
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 VIII, "Brazed Joints," in the CDA *Copper Tube Handbook*.

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15.2.3.8.10.8 Inspection of Brazed Joints.

15.2.3.8.10.8.1
After brazing, the outside of all joints shall be cleaned by washing with water and a wire brush to remove any residue and allow clear visual inspection of the joint.

15.2.3.8.10.8.2
Where flux has been used, the wash water shall be hot.

15.2.3.8.10.8.3
Each joint shall be visually inspected after cleaning the outside surfaces.

15.2.3.8.10.8.4
Joints exhibiting the following conditions shall not be permitted:

(1) Flux or flux residue (where 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 *(see 15.2.3.9.5)* and standing pressure test *(see 15.2.3.9.7)*

15.2.3.8.10.8.5
Joints that are identified as defective under conditions specified in 15.2.3.8.10.8.4 (2) or 15.2.3.8.10.8.4 (5) shall be replaced.

15.2.3.8.10.8.6
Joints that are found to be defective under conditions specified in 15.2.3.8.10.8.4 (1), 15.2.3.8.10.8.4 (3), 15.2.3.8.10.8.4 (4), 15.2.3.8.10.8.4 (6), or 15.2.3.8.10.8.4 (7) shall be permitted to be repaired, except that no joint shall be reheated more than once before being replaced.

15.2.3.9 Dental Air and Vacuum Systems Testing.
15.2.3.9.1 General.
15.2.3.9.1.1
Inspection and testing shall be performed on all new piped dental gas and vacuum systems, additions, renovations, temporary installations, or repaired systems to ensure, by a documented procedure, that the following have been completed:

(1) All applicable requirements of this code have been followed.

(2) System integrity has been achieved or maintained.

(3) Piping systems are ready for testing and verification.

(4) Piping systems are performing in accordance with their design requirements.

15.2.3.9.1.2
The inspection and testing reports shall be submitted directly to the party that contracted for the testing, who then submits the reports through channels to the responsible facility authority and any others that are required.

15.2.3.9.1.3
Reports shall contain detailed listings of all findings and results.

15.2.3.9.1.4
The responsible facility authority shall review the inspection and testing records prior to the use of any systems to ensure that all findings and results of the inspection and testing have been successfully completed before use.

15.2.3.9.1.5

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All documentation pertaining to inspections and testing shall be maintained on-site within the facility.

15.2.3.9.2 Category 2 Dental Air and Vacuum Systems.
15.2.3.9.2.1
All Category 2 dental air and vacuum piping systems indicated in 15.2.3 shall be initially tested in accordance with 15.2.3.9.3.

15.2.3.9.2.2
Dental air, vacuum, and scavenging systems shall be final tested in accordance with 15.2.3.9.3.5 and 15.2.3.9.3.6.

15.2.3.9.3 Initial Testing of Piping Systems.
15.2.3.9.3.1
Where plastic vacuum and plastic scavenging piping systems are installed, they shall be visually inspected for cross-connections to oxygen and nitrous oxide systems before applying positive test pressures to the copper piping systems.

15.2.3.9.3.2 During the process of initial testing, the identification and labeling of the dental gas and vacuum piping shall be checked.

15.2.3.9.4 Initial Cross-Connection Test for Plastic Vacuum and Plastic Scavenging Piping Systems.
15.2.3.9.4.1
Plastic piping shall be tested before copper piping.

15.2.3.9.4.2
Tests shall be conducted to determine that no cross-connections exist between any plastic vacuum piping systems or plastic scavenging piping systems and any copper piping systems.

15.2.3.9.4.3
The vacuum or scavenging source shutoff valves for the vacuum or scavenging piping systems shall remain closed during the tests, unless they are being used for the cross-connection test vacuum source.

15.2.3.9.4.4
The cross-connection test vacuum shall be a minimum of 300 mm (12 in.) HgV.

15.2.3.9.4.5
The source of test vacuum shall be connected only to the vacuum or scavenging piping system being tested.

15.2.3.9.4.6
All individual gas system outlets and vacuum or scavenging system inlets shall be checked to determine that the test vacuum is only present in the vacuum or scavenging piping system being tested.

15.2.3.9.4.7
The cross-connection tests shall be repeated for each installed vacuum and scavenging system with plastic piping.

15.2.3.9.4.8
Any cross-connections shall be removed and the associated piping repaired and leak tested.

15.2.3.9.4.9
The proper labeling and identification of system outlets/inlets shall be confirmed during the initial tests.

15.2.3.9.5 Initial Pressure Test.
15.2.3.9.5.1
Each section of the piping in dental air systems and copper vacuum systems shall be pressure tested. Plastic vacuum and plastic scavenging piping shall not be pressure tested.

15.2.3.9.5.2
Initial pressure tests shall be conducted as follows:

(1) After installation of station outlet/inlet rough-in asselies

(2) Prior to the installation of components of the distribution piping system that would be damaged by the test pressure (e.g., pressure/vacuum alar devices, pressure/vacuum indicators, line pressure relief valves)

15.2.3.9.5.3 The source shutoff valve shall remain closed during the pressure tests.

15.2.3.9.5.4

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The test pressure for dental air piping and copper vacuum piping shall be 1.5 times the system operating pressure but not less than a gauge pressure of 1035 kPa (150 psi).

15.2.3.9.5.5
The test pressure shall be maintained until each joint has been examined for leakage by means of a leak detectant that is safe for use with oxygen and does not contain ammonia.

15.2.3.9.5.6
Any leaks shall be located, repaired (if permitted) or replaced (if required) by the installer, and retested.

15.2.3.9.6 Initial Piping Purge Test.
15.2.3.8.6.1
The outlets in each dental air piping system shall be purged to remove any particulate matter from the distribution piping.

15.2.3.9.6.2
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.

15.2.3.9.6.3
The purging shall be started at the closest outlet to the piping shutoff valve and continue to the furthest outlet from the shutoff valve.

15.2.3.9.7 Standing Pressure Test for Dental Air and Copper Vacuum Piping.
15.2.3.9.7.1
After successful completion of the initial pressure tests in 15.2.8.1, the dental air systems and copper vacuum systems shall be subject to a standing pressure test.

15.2.3.9.7.2
Tests shall be conducted after the final installation of station outlet valve bodies, faceplates, and other distribution system components (e.g., pressure alarm devices, pressure indicators, line pressure relief valves, manufactured assemblies, hoses).

15.2.3.9.7.3
The source valve shall be closed during this test.

15.2.3.9.7.4
The piping systems shall be subjected to 24-hour standing pressure tests using oil-free, dry nitrogen NF.

15.2.3.9.7.5
Test pressures shall be 20 percent above the normal system operating line pressure.

15.2.3.9.7.6
At the conclusion of the tests, there shall be no change in the test pressure except that attributed to specific changes in ambient temperature.

15.2.3.9.7.7
Any leaks shall be located, repaired (if permitted) or replaced (if required) by the installer, and retested. The piping shall be repurged if necessary.

15.2.3.9.8 Standing Vacuum Test for Plastic Vacuum Piping.
15.2.3.9.8.1
After successful completion of the initial pressure tests in 15.4.8.1, vacuum distribution piping, including scavenging, shall be subjected to a standing vacuum test.

15.2.3.9.8.2
Tests shall be conducted after installation and connection of all components of the vacuum system.

15.2.3.9.8.3
The piping systems shall be subjected to a 24-hour standing vacuum test.

15.2.3.9.8.4
Test pressure shall be between 300 mm (12 in.) HgV and full vacuum.

15.2.3.9.8.5

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During the test, the source of test vacuum shall be disconnected from the piping system.

15.2.3.9.8.6
At the conclusion of the test, there shall be no change in the vacuum pressure other than that attributed to changes of ambient temperature.

15.2.3.9.8.7
Any leaks shall be located, repaired (if permitted) or replaced (if required) by the installer, and retested.

15.2.3.10 Operation and Management.
15.2.3.10.1 System Shutdowns.
15.2.3.10.1.1
Dental Gas and dental vacuum piping systems shall be shut down at the end of each workday.

15.2.3.10.1.2
Emergency shutoff valves or remote actuators shall not be used for daily shutdown of the systems.

15.2.3.10.1.3
If cylinders for dental gas are used, cylinder gas valves shall be used for daily shutdowns.

15.2.3.10.2 Prohibited Interconnections.
Two or more piping systems for different gases or different vacuums shall not be interconnected for testing or any other reason.

15.2.3.10.3 Manufacturer's Instructions.
15.2.3.10.3.1
Piping system components shall be installed, adjusted, operated, and maintained in accordance with the manufacturer's instructions.

15.2.3.10.3.2
Copies of the manufacturer's instructions shall be provided to and maintained at the facility.

15.2.3.10.4 Maintenance.
15.2.3.10.4.1
Gas and vacuum system equipment shall be maintained by a qualified person.

15.2.3.10.4.2
Every facility shall establish a procedure for manually turning off the gas supply at the cylinder valves of Category 2 dental gas and vacuum systems at the end of each day.

15.2.3.10.5 Periodic Testing.
Station outlets for oxygen and nitrous oxide shall be tested for flow and pressure on an approved schedule.

15.3 Category 3 Dental Gas and Vacuum Systems.
15.3.1 General.
15.3.1.1
Category 3 dental gas and vacuum system shall be limited to facilities that provide no greater than moderate sedation and where Risk Category 3 or lower is determined per 15.1.2.

15.3.1.2
The medical gases shall be limited to oxygen and nitrous oxide.

15.3.1.3
Dental air shall be provided from a dental air source system.

15.3.1.4
The dental vacuum systems shall be dental vacuum and nitrous oxide scavenging.

15.3.1.5
All connections within Category 3 medical gas (oxygen and nitrous oxide) shall be gas-specific to prevent cross-connections with other piping systems, including dental vacuum, water, and dental air.

15.3.2 Category 3 Medical Gas Systems (Dental Oxygen and Nitrous Oxide).

15.3.2.1 Central Supply System Identification and Labeling.

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15.3.2.1.1
Cylinders, containers, and tanks shall be designed, fabricated, tested, and marked (i.e., stamped) in accordance with Department of Transportation (DOT) regulations, Transport Canada's (TC) *Transportation of Dangerous Goods Regulations*, or the ASME *Boiler and Pressure Vessel Code*. [**55:**7.1.5.1]

15.3.2.1.2
Cylinder contents shall be identified by attached labels or stencils naming the contents in accordance with the mandatory requirements of CGA C-7, *Guide to Classification and Labeling of Compressed Gases*.

15.3.2.1.3
Liquid containers shall have additional product identification visible from all directions with a minimum of 51 mm (2 in.) high letters, such as a 360-degree wraparound tape for medical liquid containers.

15.3.2.1.4
Cryogenic liquid containers shall be provided with gas-specific outlet connections in accordance with the mandatory requirements of CGA V-5, *Standard for Diameter Index Safety System (Noninterchangeable Low Pressure Connections for Medical Gas Applications)*, or CGA V-1, *Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections*.

15.3.2.1.5
Cylinder and cryogenic liquid container outlet connections shall be affixed in such a manner as to be integral to the valve(s), unremovable with ordinary tools, or so designed as to render the attachment point unusable when removed.

15.3.2.1.6
The contents of cylinders and cryogenic liquid containers shall be verified prior to use.

15.3.2.1.7
Labels shall not be defaced, altered, or removed, and connecting fittings shall not be modified.

15.3.2.1.8
Source locations containing positive-pressure gases other than oxygen and medical air shall be provided with signage located on or immediately adjacent to the door that is visible upon entering the space as follows :

Positive-Pressure Gases
NO Smoking or Open Flame
Room May Have Insufficient Oxygen
Open Door and Allow Room to Ventilate Before Entering

15.3.2.1.9
Locations containing central supply systems or cylinders containing only oxygen or medical air shall have their door(s) labeled as follows:

Medical Gases
NO Smoking or Open Flame

15.3.2.2 Central Supply Operations.

15.3.2.2.1
The use of adapters or conversion fittings to adapt one gas-specific fitting to another shall be prohibited.

15.3.2.2.2
Cylinders and containers shall be handled in strict accordance with 11.6.2.

15.3.2.2.3
Only gas cylinders, reusable shipping containers, and their accessories shall be permitted to be stored in rooms containing central supply systems or gas cylinders.

15.3.2.2.4
No flammable materials, cylinders containing flammable gases, or containers containing flammable liquids shall be stored in rooms with gas cylinders.

15.3.2.2.5
If cylinders are wrapped when received, the wrappers shall be removed prior to storage.

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15.3.2.2.6
Cylinders without correct markings or whose markings and gas-specific fittings do not match shall not be used.

15.3.2.2.7
Cryogenic liquid storage units intended to supply gas to the facility shall not be used to transfill other liquid storage vessels.

15.3.2.2.8
Care shall be exercised when handling cylinders that have been exposed to freezing temperatures or containers that contain cryogenic liquids to prevent injury to the skin.

15.3.2.2.9
Cylinders containing compressed gases and containers for volatile liquids shall be kept away from radiators, steam piping, and like sources of heat.

15.3.2.2.10
Where cylinder valve protection caps are supplied, they shall be secured tightly in place unless the cylinder is connected for use.

15.3.2.2.11
Containers shall not be stored in a tightly closed space.

15.3.2.2.12
Cylinders in use and in storage shall be prevented from reaching temperatures in excess of 52°C (125°F).

15.3.2.2.13
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 never be lower than −7°C (20°F) or greater than 52°C (125°F).

15.3.2.3 Central Supply System Locations.

15.3.2.3.1
Gas storage locations in facilities with Category 3 medical gas systems with a total of all gases in cylinders or containers, except nitrogen, connected and in storage at one time that does not exceed 85 m^3 (3000 ft^3) at standard temperature and pressure (STP), or 142 m^3 (5000 ft^3) STP if oxygen is stored in a DOT specification 4 L (cryogenic liquid) container shall comply with 15.4.2.4.3 through 15.4.2.4.15.

15.3.2.3.2*
Gas storage locations in facilities with Category 3 medical gas systems with a total of all gases in cylinders or containers exceeding quantities listed in 15.3.2.3.1 shall comply with 5.1.3.3.

15.3.2.3.3
Enclosures shall serve no purpose other than to contain the medical gas source equipment (oxygen and nitrous oxide), except that nitrogen source equipment and compressed air cylinders shall be permitted in the enclosure.

15.3.2.3.4
Natural or mechanical ventilation for oxygen and nitrous oxide manifold locations shall be in accordance with 9.3.6.5.

15.3.2.3.5
Storage of full or empty gas cylinders, or both, shall be permitted in the same enclosure.

15.3.2.3.6
Air compressors, vacuum pumps, and other equipment shall not be located in enclosures for medical gas cylinders (oxygen and nitrous oxide source equipment).

15.3.2.3.7*
If enclosures are outdoors or remote from the treatment facilities that they serve, they shall be kept locked.

15.3.2.3.8

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Cylinders in use and in storage shall be prevented from reaching temperatures in excess of 52°C (125°F). Nitrous oxide cylinders shall be prevented from reaching temperatures lower than −7°C (20°F).

15.3.2.3.9
Indoor enclosures shall not communicate directly with medical gas (oxygen and nitrous oxide) use points or storage locations for flammable materials or gases.

15.3.2.3.10
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).

15.3.2.3.11
Enclosures for medical gas (oxygen and nitrous oxide) source equipment shall be provided with doors or gates.

15.3.2.3.12
Cylinders in use or in storage shall be individually secured and located to prevent falling or being knocked over.

15.3.2.3.13
Locations containing positive-pressure gases or cylinders containing oxygen, nitrous oxide, or both shall be separated from the rest of the building by walls and floors having a 1-hour fire resistance rating with doors and other opening projective having a ¾-hour fire protection rating.

15.3.2.3.14
Locations containing positive-pressure gases or cylinders containing positive-pressure gases shall be provided with an automatic sprinkler system in accordance with NFPA 13.

15.3.2.4 Central Supply Systems.

15.3.2.4.1 Medical Gas Source Equipment (Oxygen and Nitrous Oxide).
15.3.2.4.2
Mechanical means shall be provided to ensure that the medical gas source equipment is connected to the correct medical gas distribution piping system.

15.3.2.4.3
Cylinder valve outlets for oxygen and nitrous oxide shall comply with CGA V-1, *Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections*.

15.3.2.4.4
Threaded connections to manifolds shall comply with CGA V-5, *Standard for Diameter Index Safety System (Noninterchangeable Low Pressure Connections for Medical Gas Applications)*.

15.3.2.4.5
A check valve shall be provided downstream of each pressure regulator.

15.3.2.4.6
A pressure relief valve set at 50 percent above the normal line pressure shall be located downstream of the check valve in 15.3.3.1.4.5.

15.3.2.4.7
Pressure relief valves shall be brass, bronze, or stainless steel and designed for oxygen service.

15.3.2.4.8
Hose and flexible connectors shall have a gauge pressure rating not less than 6895 kPa (1000 psi).

15.3.2.4.9
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 3000 kPa (435 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.

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(4) If intended for outdoor installation, materials shall be installed in accordance with the manufacturer's requirements.

15.3.2.4.10
Nonmetallic hoses and flexible connectors shall not exceed 1.52 m (5 ft) in length nor be concealed or penetrate walls, floors, ceilings, or partitions.

15.3.2.4.11
Source equipment shall not be connected to the piping system through flexible connectors.

15.3.2.4.12
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 one average day's supply.

15.3.2.4.13
The two banks of each medical gas source shall be manifolded so that either bank can supply its distribution piping system.

15.3.2.4.14
Where the source equipment is remote from a single treatment facility and an in-use bank is unable to supply the system, the manifold shall automatically switch to the secondary bank.

15.3.2.4.15
Where the source equipment serves multiple treatment facilities and an in-use bank is unable to supply the system, the manifold shall automatically switch to the secondary bank.

15.3.2.4.16
Where the source equipment is not remote and is accessible from a single treatment facility served and an in-use bank is unable to supply the system, the manifold shall be manually or automatically switched to the secondary bank..

15.3.2.5 Valves.
15.3.2.5.1 Emergency Shutoff Valves (Oxygen and Nitrous Oxide).
15.3.2.5.2*
All Category 3 medical gas systems shall have an emergency shutoff valve accessible from all use-point locations in an emergency.

15.3.2.5.3
Where a central medical gas supply system supplies two treatment facilities, each facility shall be provided with an emergency shutoff valve located in that treatment facility accessible from all use-point locations in an emergency.

15.3.2.5.4
Each emergency shutoff valve shall be labeled to indicate the gas it controls and shut off only the gas to the treatment facility that it serves.

15.3.2.5.5
A remotely activated shutoff valve at a gas supply manifold shall not be used for emergency shutoff.

15.3.2.5.5.1
For clinical purposes, a remote valve actuator shall not fail-close in the event of loss of electric power.

15.3.2.5.5.2
Where remote actuators are the type that fail-open, cylinder shutoff valves shall be closed whenever the system is not in-use.

15.3.2.5.6
Emergency shutoff valves shall be located to meet the following requirements:

(1) Be readily operable from a standing position

(2) Be installed where visible and accessible at all times

(3) Be installed where they will not be hidden from plain view, such as not behind normally open or normally closed doors

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(4) Be installed in the egress pathway near the exit from the treatment area that will be used in an emergency

(5) Be installed in rooms, areas, or closets that are not capable of being closed or locked

15.3.2.6 Station Outlets and Risers (Oxygen and Nitrous Oxide).

15.3.2.6.1
Each gas outlet shall be gas specific.

15.3.2.6.2
Gas outlets shall consist of a primary and a secondary valve or assembly.

15.3.2.6.3
Each gas outlet shall be legibly identified.

15.3.2.6.4
Threaded outlets shall be noninterchangeable connections complying with the mandatory requirements of CGA V-5, *Standard for Diameter Index Safety System (Noninterchangeable Low Pressure Connections for Medical Gas Applications)*.

15.3.2.6.5
Factory-installed copper inlet tubes on station outlets extending no further than 205 mm (8 in.) from the body of the terminal shall be not less than DN8 (NPS 1/4) (3/8 in. O.D.) size, with 8 mm (0.3 in.) minimum inside diameter.

15.3.2.7 Manufactured Assemblies.
Category 3 systems shall comply with 5.1.6.

15.3.2.8 Surface-Mounted Medical Gas Rails.
Category 3 systems shall comply with 5.1.7.

15.3.2.9 Pressure and Vacuum Indicators.
Category 3 systems shall comply with 5.1.8.

15.3.2.10 Warning Systems (Oxygen and Nitrous Oxide).
15.3.2.10.1 Warning Systems (Oxygen and Nitrous Oxide).
Category 3 warning systems shall comply with 5.2.9, except as follows:

(1) Warning systems shall be permitted to be a single alarm panel.

(2) The alarm panel shall be located in an area of continuous surveillance while the facility is in operation.

(3) Pressure and vacuum switches/sensors shall be mounted at the source equipment with a pressure indicator at the master alarm panel.

(4) Warning systems for medical gas systems shall provide the following alarms:

(a) Oxygen main line pressure low

(b) Oxygen main line pressure high

(c) Oxygen changeover to secondary bank or about to changeover (if automatic)

(d) Nitrous oxide main line pressure low

(e) Nitrous oxide main line pressure high

(f) Nitrous oxide changeover to secondary bank or about to changeover (if automatic)

(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.
(6) Visual indications shall remain until the situation that caused the alarm is resolved.
(7) Pressure switches/sensors shall be installed downstream of any emergency shutoff valves and any other shutoff valves in the system and cause an alarm for the medical gas if the pressure decreases or increases 20 percent from the normal operating pressure.

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(8) A cancelable audible indication of each alarm condition that produces a sound at the alarm panel shall reinitiate the audible signal if another alarm condition occurs while the audible signal is silenced.

15.3.2.11 Piping for Oxygen and Nitrous Oxide Systems.

15.3.2.11.1 Cleaning for Oxygen Service.

15.3.2.11.1.1
For oxygen and nitrous oxide, the pipe, fittings, valves, gas/vacuum outlets/inlets, and other piping components shall be cleaned for oxygen by the manufacturer prior to installation in accordance with CGA G-4.1, *Cleaning Equipment for Oxygen Service*.

15.3.2.11.1.2
Fittings shall be permitted to be cleaned by a supplier or agency other than the manufacturer.

15.3.2.11.2 Pipe.
Piping materials for oxygen and nitrous oxide shall be one of the following:

(1) Hard-drawn seamless copper in accordance with ASTM B819, *Standard Specification for Seamless Copper Tube for Medical Gas Systems,* medical gas tube, Type L or Type K

(2) Listed corrugated medical tubing (CMT) fabricated from copper alloy No. 51000 strip, meeting ASTM B103/B103M, *Standard Specification for Phosphor Bronze Plate, Sheet, Strip, and Rolled Bar*, as follows:

(a) Having a design margin of 3.5

(b) Externally coated with a nonmetallic sheath marked with the manufacturer's marking

(c) Listing includes testing to demonstrate that CMT systems can be consistently gas-purged with results equivalent to comparable medical gas copper tubing

15.3.2.11.2.1
CMT shall have a flame spread index of 25 or less and a smoke developed index of 50 or less as determined by ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*.

15.3.2.11.2
CMT shall be identified by the manufacturer as suitable for oxygen service at a minimum of every 0.92 m (3 ft).

15.3.2.11.3 Fittings.
15.3.2.11.3.1
Fittings shall be brazed, memory metal, or axially swaged.

15.3.2.11.3.2
Brazed fittings shall be the wrought copper capillary type complying with the following:

(1) ASME B16.22, *Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings*

(2) ANSI/ASME B16.50, *Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings*

(3) ASME B16.22 with socket depths equal to or greater than brazed joint pressure fittings in accordance with ANSI/ASME B16.50

15.3.2.11.3.3
Cast copper alloy fittings shall not be used with field-brazed joints.

15.3.2.11.3.4
Memory metal fittings shall be rated for not less than 538°C (1000°F) and 2070 kPa (300 psi) and be installed by qualified technicians in accordance with the manufacturer's instructions.

15.3.2.11.3.5
Axially swaged fittings shall comply with 15.2.3.7.2.4 (6).

15.3.2.11.4 Joints.
15.3.2.11.4.1 Brazed.

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Brazing of copper joints shall be in accordance with 15.2.3.8.10 .

15.3.2.11.4.2 Threaded.
Threaded joints shall be limited to connections to pressure indicators, alarm devices, and source equipment and shall comply with the following:

(1) Threads shall be tapered complying with ASME B1.20.1, *Pipe Threads, General Purpose, Inch*.

(2) Threads shall be made up with polytetrafluoroethylene (PTFE) tape or other thread sealant recommended for oxygen service, with the sealant applied to the male threads only.

15.3.2.11.4.3 Prohibited Joints.
The following joints shall be prohibited under 15.3.2.11.4 :

(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

(4) Pipe crimping tools used to permanently stop the flow of medical gas and vacuum piping

15.3.2.11.5 Pipe sizing

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

15.3.2.11.5.2 Minimum Pipe Sizes

The minimum size of the following piping shall be as follows:

(1) Category 3 oxygen piping shall be not less than DN10 (NPS 3/8 in.) (1/2 in. O.D.) size.

(2) Category 3 nitrous oxide piping shall be not less than DN8 (NPS 1/4 in.) (3/8 in. O.D.) size.

(3) Category 3 oxygen piping shall be at least 1 size larger than piping for nitrous oxide

15.3.2.12 Labeling and Identification.
Category 3 systems shall comply with 5.1.11.

15.3.2.13 Performance Criteria and Testing (Oxygen and Nitrous Oxide).
15.3.2.13.1 Testing and Verification.
15.3.2.13.1.1 General.
15.3.2.13.1.1.1
Inspection and testing shall be performed on all new piped oxygen and nitrous oxide systems, additions, renovations, temporary installations, or repaired systems to ensure, by a documented procedure, that the following have been completed:

(1) All applicable requirements of this code have been followed.

(2) System integrity has been achieved or maintained.

(3) Piping systems are ready for testing and verification.

(4) Piping systems are performing in accordance with their design requirements.

15.3.2.13.1.1.2
The inspection and testing reports shall be submitted directly to the party that contracted for the testing, who then submits the reports through channels to the responsible facility authority and any others that are required.

15.3.2.13.1.1.3
Reports shall contain detailed listings of all findings and results.

15.3.2.13.1.1.4
The responsible facility authority shall review the inspection and testing records prior to the use of any systems to ensure that all findings and results of the inspection and testing have been successfully completed before use.

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15.3.2.13.1.1.5
All documentation pertaining to inspections and testing shall be maintained on-site within the facility.

15.3.2.13.2 Required Testing and Verification.
15.3.2.13.2.1 Category 2 Medical Gas Systems (Oxygen and Nitrous Oxide).
All Category 2 oxygen and nitrous oxide piping systems indicated in 15.4.2 shall be initially tested in accordance with 15.3.2.13.4.

15.3.2.13.2.2
The oxygen and nitrous oxide piping systems shall be verified in accordance with 15.3.2.13.5.

15.3.2.13.3 Qualification of System Testers and Verifiers (Oxygen and Nitrous Oxide).
15.3.2.13.3.1
Individuals who perform the initial and final tests of the oxygen and nitrous oxide piping systems shall be certified to ASSE 6010, *Professional Qualifications Standard for Medical Gas Systems Installers*, or verifiers who comply with 15.3.2.13.3.2.

15.3.2.13.3.2
Individuals who verify the oxygen and nitrous oxide piping systems shall be certified to ASSE 6030, *Professional Qualifications Standard for Medical Gas Systems Verifiers*.

15.3.2.13.4 Initial Testing of Piping Systems (Oxygen and Nitrous Oxide).
15.3.2.13.4.1 General.
15.3.2.13.4.1.1
The initial tests required by 15.3.2.13.4 shall be performed prior to either the final tests or the verification tests listed in 15.3.2.13.5.

15.3.2.13.4.1.2
The test gas for gas piping systems shall be oil-free, dry nitrogen NF.

15.3.2.13.4.1.3
Where manufactured assemblies are to be installed, the initial tests required by 15.3.2.13.4 shall be performed as follows:

(1) After completion of the distribution piping but before the standing pressure test

(2) Prior to installation of manufactured assemblies supplied through flexible hose or flexible tubing

(3) For all station outlets/inlets on installed manufactured assemblies supplied through copper tubing

15.3.2.13.4.1.4
Where plastic vacuum and plastic scavenging piping systems are installed, they shall be visually inspected for cross-connections to positive-pressure systems before applying positive test pressures to the copper piping systems.

15.3.2.13.4.1.5
Where brazed joints in copper tubing are found to be defective, they shall be repaired if permitted by 15.4.6.8.6 or replaced if required by 15.4.6.8.5, and retested. The piping shall be repurged if necessary.

15.3.2.13.4.1.6
During the process of initial testing, the identification and labeling of the medical gas and vacuum piping shall be checked.

15.3.2.13.4.2 Initial Piping Blowdown (Oxygen and Nitrous Oxide).
Piping in dental air 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 outlet/inlet rough-in assemblies and other system components (e.g., pressure/vacuum alarm devices, pressure/vacuum indicators, pressure relief valves, manifolds, and source equipment).

15.3.2.13.4.3 Initial Cross-Connection Test for Copper Piping Systems.
15.3.2.13.4.3.1
Copper piping shall not be tested before any plastic piping.

15.3.2.13.4.3.2
It shall be determined that no cross-connections exist between the various medical gas and vacuum piping systems.

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15.3.2.13.4.3.3
All piping systems shall be reduced to atmospheric pressure.

15.3.2.13.4.3.4
Sources of test gas shall be disconnected from all piping systems except for the one system being tested.

15.3.2.13.4.3.5
The system under test shall be charged with oil-free, dry nitrogen NF to a gauge pressure of 345 kPa (50 psi).

15.3.2.13.4.3.6
After the installation of the individual faceplates with appropriate adapters matching outlet/inlet labels, each individual outlet/inlet in each installed medical gas and vacuum piping system shall be checked to determine that the test gas is dispensed only from the piping system tested.

15.3.2.13.4.3.7
The initial cross-connection test in 15.3.2.13.4.3 shall be repeated for each installed medical gas and vacuum piping system with copper piping.

15.3.2.13.4.3.8
Any cross-connections shall be removed and the associated piping repaired and leak tested.

15.3.2.13.4.3.9
The proper labeling and identification of system outlets/inlets shall be confirmed during these tests.

15.3.2.13.4.4 Initial Pressure Test.
15.3.2.13.4.4.1
Each section of the piping in positive-pressure gas systems and copper vacuum systems shall be pressure tested. Plastic vacuum and plastic scavenging piping shall not be pressure tested.

15.3.2.13.4.4.2
Initial pressure tests shall be conducted as follows:

(1) After blowdown of the distribution piping

(2) After installation of station outlet/inlet rough-in assemblies

(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, and line pressure relief valves)

15.3.2.13.4.4.3
The source shutoff valve shall remain closed during the pressure tests.

15.3.2.13.4.4.4
The test pressure for oxygen and nitrous oxide piping shall be 1.5 times the system operating pressure but not less than a gauge pressure of 1035 kPa (150 psi).

15.3.2.13.4.4.5*
The test pressure shall be maintained until each joint has been examined for leakage by means of a leak detectant that is safe for use with oxygen and does not contain ammonia.

15.3.2.13.4.4.6
Any leaks shall be located, repaired (if permitted), or replaced (if required) by the installer, and retested.

15.3.2.13.4.5 Initial Piping Purge Test.
15.3.2.13.4.5.1
The outlets in each oxygen and nitrous oxide piping system shall be purged to remove any particulate matter from the distribution piping.
15.3.2.13.4.5.2
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.

15.3.2.13.4.5.3
The purging shall be started at the closest outlet to the piping shutoff valve and continue to the furthest outlet from the shutoff valve.

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15.3.2.13.4.6 Standing Pressure Test for Oxygen and Nitrous Oxide Piping.

15.3.2.13.4.6.1
After successful completion of the initial pressure tests in 15.3.2.13.4.4, the gas distribution piping shall be subject to a standing pressure test.

15.3.2.13.4.6.2
Tests shall be conducted after the final installation of station outlet valve bodies, faceplates, and other distribution system components (e.g., pressure alarm devices, pressure indicators, line pressure relief valves, manufactured assemblies, and hoses).

15.3.2.13.4.6.3
The source valve shall be closed during this test.

15.3.2.13.4.6.4
The piping systems shall be subjected to 24-hour standing pressure tests using oil-free, dry nitrogen NF.

15.3.2.13.4.6.5
Test pressures shall be 20 percent above the normal system operating line pressure.

15.3.2.13.4.6.6
At the conclusion of the tests, there shall be no change in the test pressure except that attributed to specific changes in ambient temperature.

15.3.2.13.4.6.7
Any leaks shall be located, repaired (if permitted), or replaced (if required) by the installer, and retested. The piping shall be repurged if necessary.

15.3.2.13.4.6.8
The 24-hour standing pressure tests shall be witnessed by the authority having jurisdiction or its designee. A form indicating that these tests have been performed and witnessed shall be provided to the verifier at the start of the verification tests in 15.3.2.13.5.

15.3.2.13.5 Verification of Piping Systems (Oxygen and Nitrous Oxide).

15.3.2.13.5.1 General.

15.3.2.13.5.1.1
The oxygen and nitrous oxide piping systems requiring initial testing and verification shall be as indicated in 15.3.2.13.2 for the different dental facilities.

15.3.2.13.5.1.2
Required verification of oxygen and nitrous oxide piping systems shall be performed only after all initial tests required in 15.3.2.13.4 have been completed.

15.3.2.13.5.1.3
The test gas shall be oil-free, dry nitrogen NF or the system gas or vacuum where permitted.

15.3.2.13.5.1.4
Verification shall be conducted by a party technically competent and experienced in the field of medical gas and vacuum piping system testing and certified for ASSE 6030, *Professional Qualifications Standard for Medical Gas Systems Verifiers*.

15.3.2.13.5.1.5
Verification shall be performed by a party other than the installing contractor.

15.3.2.13.5.1.6
All required verification tests shall be performed after installation of any manufactured assemblies supplied through tubing or flexible hose.

15.3.2.13.5.1.7
Where there are multiple possible connection points for terminals, each possible position shall be tested independently.

15.3.2.13.5.1.8
Where brazed joints in copper tubing are found to be defective, they shall be repaired if permitted by 15.4.6.8.6 or replaced if required by 15.4.6.8.5, and retested. The piping shall be repurged if necessary.

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15.3.2.13.5.1.9
During the process of verification, the presence and proper labeling of source equipment, station outlets/inlets, zone valve boxes, shutoff valves, and alarms shall be checked.

15.3.2.13.5.2 Verifier Standing Pressure Test.
Oxygen and nitrous oxide piping systems requiring verification shall be subjected to a 10-minute standing pressure test at operating line pressure using the following procedure:

(1) After the system is filled with nitrogen or the source gas, the source valve shall be closed.

(2) The piping system shall show no decrease in pressure after not less than 10 minutes.

(3) Any leaks shall be located, repaired (if permitted), or replaced (if required) by the installer, and retested.

15.3.2.13.5.3 Verifier Cross-Connection Test.
The piping systems shall be tested for cross-connections between the systems using the following procedure:

(1) All medical gas and vacuum piping systems shall be reduced to atmospheric pressure.

(2) All sources of test gas for all of the gas and vacuum systems, with the exception of the one system to be checked, shall be disconnected.

(3) The system being checked shall be pressurized to a gauge pressure of 345 kPa (50 psi).

(4) With adapters matching outlet labels, each individual station outlet/inlet of all medical gas and vacuum systems installed shall be checked to determine that test gas is dispensed only from the outlets/inlets of the piping system being tested.

(5) The source of test gas shall be disconnected, and the system that was tested reduced to atmospheric pressure.

(6) Each additional piping system shall be tested until all gas and vacuum piping systems requiring verification are free of cross-connections.

(7) Any cross-connections shall be removed and the associated piping repaired and tested for leaks.

15.3.2.13.5.4 Verifier Piping Purge Test.
15.3.2.13.5.4.1
To remove any traces of particulate matter deposited in the oxygen and nitrous oxide piping during construction, a heavy, intermittent purging of the piping shall be done.

15.3.2.13.5.4.2
The appropriate adapter shall be obtained and high purge rates of at least 225 Nl/min (8 SCFM) shall be put on each outlet.

15.3.2.13.5.4.3
After each 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.

15.3.2.13.5.4.4
To avoid possible damage to the outlet and its components, this test shall not be conducted using any implement other than the proper adapter.

15.3.2.13.5.4.5
No pronounced or objectionable odor shall be discernible from any positive-pressure outlet.

15.3.2.13.5.5 Verifier Piping Particulate Test.
15.3.2.13.5.5.1
For each oxygen and nitrous oxide system, the cleanliness of the piping system shall be verified.
15.3.2.13.5.5.2
The test shall be performed with the use of oil-free, dry nitrogen NF.

15.3.2.13.5.5.3
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 Nl/min (3.5 SCFM).

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15.3.2.13.5.5.4
Twenty five percent of the zones shall be tested at the outlet most remote from the source.

15.3.2.13.5.5.5
The filter shall accrue no more than 0.001 g (1 mg) of matter from any outlet tested.

15.3.2.13.5.5.6
If any outlet fails this test, the most remote outlet in every zone shall be tested.

15.3.2.13.5.6 Verifier Piping Purity Test.
15.3.2.13.5.6.1
For each oxygen and nitrous oxide system, the purity of the piping system shall be verified in accordance with 15.3.2.13.5.6.

15.3.2.13.5.6.2
These tests shall be performed with oil-free, dry nitrogen NF or the system gas.

15.3.2.13.5.6.3
The outlet most remote from the source shall be tested for total nonmethane hydrocarbons and compared to the test of the source gas.

15.3.2.13.5.6.4
If the system gas is used as the source gas, it shall be tested at the source equipment.

15.3.2.13.5.6.5
The difference between the two tests shall in no case exceed 5 ppm of total nonmethane hydrocarbons.

15.3.2.13.5.6.6
The difference between the two tests shall in no case exceed 5 ppm of halogenated hydrocarbons.

15.3.2.13.5.6.7
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).

15.3.2.13.5.7 Verifier Final Tie-in Test.
15.3.2.13.5.7.1
Prior to the connection of any work or any extension or addition to an existing piping system, the verification tests in 15.3.2.13.5 shall be successfully performed on the new work.

15.3.2.13.5.7.2
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 a leak detectant that is safe for use with oxygen and does not contain ammonia.

15.3.2.13.5.7.3
For oxygen and nitrous oxide, immediately after the final brazed connection is made and leak-tested, 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 15.3.2.13.5.4.

15.3.2.13.5.7.4
Before the new work is used for patient care, oxygen and nitrous oxide shall be tested for operational pressure and gas concentration in accordance with 15.3.2.13.5.8 and 15.3.2.13.5.9.

15.3.2.13.5.7.5
Permanent records of these tests shall be maintained.

15.3.2.13.5.8 Verifier Operational Pressure Test.
15.3.2.13.5.8.1
Operational pressure tests shall be performed at each station outlet or terminal where the user makes connections and disconnections.

15.3.2.13.5.8.2
Tests shall be performed with the gas of system designation.

15.3.2.13.5.8.3

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All medical gas outlets with a gauge pressure of 345 kPa (50 psi), including 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).

15.3.2.13.5.9 Verifier Gas Concentration Test.
After purging each system with the gas of system designation, the following shall be performed:

(1) Each pressure gas source and outlet 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

(b) Nitrous oxide ≥99 percent

(c) Other gases ±1 percent unless otherwise specified

15.3.2.14 Support Gases.
Category 3 systems shall comply with 5.1.13, except as follows:

(1) Nitrogen source equipment shall be permitted to be installed in enclosures for Category 3 medical gases or in a mechanical room.

(2) Nitrogen source equipment shall include the following:

(a) One or more cylinders of nitrogen NF, sufficient for at least one average day's supply

(b) A manifold, if primary and secondary cylinders are provided

(c) A line pressure regulating valve

(d) A check valve downstream from the pressure regulating valve

(e) A pressure relief valve set at 50 percent above the normal line pressure and located downstream from the check valve

(f) A pressure relief valve discharge piped to the outdoors at a point that will not create a probable hazard and that is turned down to prevent the entry of rain or snow

(3) Nitrogen piping shall comply with 15.3.2.11.

15.3.2.15 Medical Gas and Vacuum Operation and Management.
Category 3 systems shall comply with 5.1.14.

15.3.3 Category 3 Dental Air and Vacuum Piping Systems.
Category 3 Dental air and vacuum systems shall comply with section 15.2.3

Public Input No. 13-NFPA 99-2024 [Section No. 15.1]

15.1 Applicability.

This chapter shall apply to dental health care facilities that qualify to install dental gas and vacuum piping systems.

15.1.1

Category 1 dental piped gas and piped vacuum system requirements shall be applied in facilities where general anesthesia and deep sedation is performed, as defined in 3.3.70.1 and 3.3.70.2.

15.1.2

Category 2 dental piped gas and piped vacuum system requirements shall be applied in facilities where only moderate and minimal sedation is performed, as defined in 3.3.70.3 and 3.3.70.4.

15.1.3

Category 3 dental piped gas and piped vacuum system requirements shall be applied in facilities where minimal or no sedation is performed, as defined in 3.3.70.4.

15.1.4

A single facility shall be permitted to include dental gas and vacuum systems for more than one category of dental piped gas and vacuum systems.

15.1.5

An existing system that is not in strict compliance with the requirements of this code shall be permitted to continue in use unless the authority having jurisdiction has determined that such use constitutes a distinct hazard to life.

15.1.6

This chapter shall apply to new health care facilities as specified by Section 1.3 unless otherwise specified by 15.1.7, 15.1.8, or 15.1.9.

15.1.7

The requirements for Category 1 dental gas and vacuum systems for the operation, management, and maintenance of gas and vacuum piping systems shall apply to both new and existing health care facilities within the scope of this chapter and in accordance with 5.1.1.5.

15.1.8

The following sections of this chapter shall apply to the operation, management, and maintenance of Category 2 dental gas and vacuum systems in both new and existing health care facilities:

(1) 15.1.5

(2) Section 15.2

(3) 15.4.2.4.3

(4) 15.4.2.4.6

(5) 15.4.2.4.12

(6) 15.4.2.5.14

(7) 15.4.2.6.4

(8) 15.4.2.9

15.1.9

The following sections of this chapter shall apply to the operation, management, and maintenance of Category 3 dental gas and vacuum systems in both new and existing health care facilities:

(1) 15.1.5

(2) Section 15.2

(3) 15.5.8

15.1.10

Where the term *responsible facility authority* is used, that entity shall follow the requirements of 5.1.14.1.

Statement of Problem and Substantiation for Public Input

The term "health care " is added for clarity and to correlate with similar language at 5.3.1.2, 5.2.1.2, 6.1.3, 11.1, 12.1 and 13.1.

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Public Input No. 327-NFPA 99-2024 [Section No. 15.1]

15.1 Applicability.

This chapter shall apply to dental health care facilities that qualify to install dental gas and vacuum piping systems.

15.1.1

Category 1 dental piped gas and piped vacuum system requirements shall be applied in facilities where general anesthesia and deep sedation is performed, as defined in 3.3.70.1 and 3.3.70.2 and where Category 2 Risk has been determined per the required risk assessment defined in 4 . 2 .

15.1. 1.1 Where Category 1 Risk has been determined per the required risk assessment defined in 4. 2 , the dental piped gas and piped vacuum system shall meet the requirements of 5.1.

15.1.2

Category 2 dental piped gas and piped vacuum system requirements shall be applied in facilities where only moderate and minimal sedation is performed, as defined in 3.3.70.3 and 3.3.70.4 and where Category 3 Risk has been determined per the required risk assessment defined in 4. 2 ..

15.1.3

Category 3 dental piped gas and piped vacuum system requirements shall be applied in facilities where minimal or no sedation is performed, as defined in 3.3.70.4 and where Category 3 Risk has been deterimined per the required risk assessment defined in 4 . 2 .

15.1.4

A single facility shall be permitted to include dental gas and vacuum systems for more than one category of dental piped gas and vacuum systems.

15.1.5

An existing system that is not in strict compliance with the requirements of this code shall be permitted to continue in use unless the authority having jurisdiction has determined that such use constitutes a distinct hazard to life.

15.1.6

This chapter shall apply to new health care facilities as specified by Section 1.3 unless otherwise specified by 15.1.7, 15.1.8, or 15.1.9.

15.1.7

The requirements for Category 1 dental gas and vacuum systems for the operation, management, and maintenance of gas and vacuum piping systems shall apply to both new and existing facilities within the scope of this chapter and in accordance with 5.1.1.5.

15.1.8

The following sections of this chapter shall apply to the operation, management, and maintenance of Category 2 dental gas and vacuum systems in both new and existing facilities:

(1) 15.1.5

(2) Section 15.2

(3) 15.4.2.4.3

(4) 15.4.2.4.6

(5) 15.4.2.4.12

(6) 15.4.2.5.14

(7) 15.4.2.6.4

(8) 15.4.2.9

15.1.9

The following sections of this chapter shall apply to the operation, management, and maintenance of Category 3 dental gas and vacuum systems in both new and existing facilities:

(1) 15.1.5

(2) Section 15.2

(3) 15.5.8

15.1.10

Where the term *responsible facility authority* is used, that entity shall follow the requirements of 5.1.14.1.

Statement of Problem and Substantiation for Public Input

This proposal is an alternative to the Chapter 15 Task Group Proposal for complete restructuring. This proposal minimally addresses 2 important deficits in the code. First, chapter 15 appears to only base the Category determination on the level of sedation which is inconsistent with Chapter 4 which requires that categories be determined by a risk assessment. Chapter 15 appears to ignore the fact that patient risk can not be solely determined by the level of sedation. Range of patient treatment and patient ASA classification are significant factors that would normally be considered in a risk assessment. Second, current chapter 15 risk numbers do not align with risk numbering in chapters 4 and 5. This is apparent from the fact that the technical requirements in Chapter 15, Cat 1 are essentially Chapter 5 Category 2 requirements. This proposal would link the correct Chapter 4 risk categories. It also adds a reference back to Chapter 5 Category 1 where a true Category 1 risk has been determined. This is essential to address the full range of patient treatment.

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Public Input No. 278-NFPA 99-2024 [New Section after 15.3.3.3.2]

15.3.3.3.3 Dental Gas and Vacuum Systems.

15.3.3.3.3.1 Dental Gas and Vacuum Installer Qualifications.

15.3.3.3.3.1.1

Installers of dental gas and vacuum systems shall be certified in accordance with ASSE/IAPMO/ANSI 6010, Professional Qualifications Standard for Medical Gas Systems Installers, regardless of the capacity

15.3.3.3.3.1.2

Installers of medical gas systems shall not use their certification to oversee installation by noncertified personnel.

15.3.3.3.3.1.3

Brazing of medical gas piping systems shall be performed by individuals who are qualified in accordance with 15.4.6.1.

15.3.3.3.3.1.4

Prior to any installation work involving brazing, the installer of the medical gas piping systems shall provide documentation required by 15.4.6.1 for the qualifications of the brazing procedures and individual brazers.

Re-number remaining sections

Statement of Problem and Substantiation for Public Input

This adds the requirement that an ASSE 6010 certified installer installs the dental gas and vacuum system. Often in facilities that only have dental gas (dental air) and dental vacuum the argument is made that because a certified installer is not required, the code does not apply. While it is clear that NFPA 99 does apply to regular users of the code, this proposal adds to the requirement that all personnel installing these systems have proper training and certifications. This is also going to provide proper training and credentialing for those installers to use appropriate materials. Because we are currently allowing for non credentialed or trained people to install the systems, we have a large number of the systems being installed incorrectly with the incorrect materials. This proposal to require training will help get the installations done correctly.
Additionally we require a dental facility testing documents to be reviewed by a responsible facility authority (ASSE 6000 certified) so if we require that person who reviews the system testing documents to have a certification, we probably should require all individuals installing all of the systems to have proper training and certifications

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 279-NFPA 99-2024 [New Section after 15.4.3.2.2]	
Public Input No. 280-NFPA 99-2024 [New Section after 15.5.4.1.2]	

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Committee: HEA-PIP

Public Input No. 465-NFPA 99-2024 [Section No. 15.3.3.4.2.1]

15.3.3.4.2.1

Dental air compressor

~~units shall include dental air compressors, vibration isolation, air receivers, coalescent air filters, adsorption dryers, exhaust silencer/filters, moisture indicators, and service access manifolds, electrical disconnects, motor wiring, and controls.~~
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, 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 a manual or automatic drain

(10) Shutoff valves

(11) Compressor discharge check valve(s) (for multiple compressors)

(12) Air dryer(s) that maintains a minimum of 40 percent relative humidity at operating pressure and temperature

(13) In-line final particulate/coalescing filters rated at 0.01 µ, with filter status indicator to ensure the delivery of dental air with a maximum allowable 0.05 ppm liquid oil

(14) Pressure regulator(s)

(15) Pressure relief valve

(16) Pressure indicator

(17) Moisture indicator

15.3.3.4.2.1.1 Receivers.

Receivers shall have the following:

(1) The capacity to prevent short cycling of the compressor(s)

(2) Compliance with Section VIII, “Unfired Pressure Vessels,” of the ASME Boiler and Pressure Vessel Code

15.3.3.4.2.1 .2 Moisture Indicator.

Moisture indicators shall have the following:

(1) A location in the active airstream prior to, or after, the receiver and upstream of any system pressure regulators

(2) The ability to indicate (e.g., by color change, digital readout, or other method understood by the user) when the relative humidity of the dental air exceeds 40 percent at line

pressure and temperature

5.3.3.6.1.4 Pressure Relief Valve Discharge.

Pressure relief valves for dental air systems having less than 84,950 L (3000 ft3) at STP shall be permitted to discharge locally indoors in a safe manner that will not restrict the flow.

Statement of Problem and Substantiation for Public Input

When Chapter 15 was created the individual requirements including but not limited to the filtration and moisture requirements were not moved into the new chapter. This proposal restores the requirements.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 466-NFPA 99-2024 [Section No. 15.4.3.3.2.2(A)]	
Public Input No. 467-NFPA 99-2024 [Section No. 15.5.4.2.2.1]	

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Public Input No. 201-NFPA 99-2024 [Section No. 15.3.3.5.2.4]

15.3.3.5.2.4

Dental vacuum system piping shall comply with all of the following:

(1) Horizontal piping in dental vacuum systems shall be sloped a minimum of 7 mm per 3.05 m (¼ in. per 10 ft) toward the vacuum source equipment.

(2) Horizontal piping shall include no sags or low points that would permit fluid or debris to accumulate in the piping.

(3) Voids in the vacuum piping shall be avoided to prevent buildup and obstructions.

(4) Accessible cleanouts shall be permitted to be installed in the vertical downflow pipe to clear obstructions, where necessary.

(5) Dental vacuum cleanouts shall not to be installed on horizontal piping.

(6) Dental vacuum inlets shall be capable of 283 L/min (10 SCFM) or greater flow capacity during simultaneous use .

Statement of Problem and Substantiation for Public Input

The current requirement does not clearly indicate if this is a single inlet requirement (similar to a Chapter 5 Operational Flow Test) or if this is a piping design requirement that all inlets must meet simultaneously. It is presumed this is intended to be a design requirement so for the highest category system the phrase for simultaneous use is proposed. Section 15.4.3.3.3.2(D)(6) should also be edited in a similar manner.

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Public Input No. 247-NFPA 99-2024 [Section No. 15.3.3.6.1.3]

15.3.3.6.1.3

Nitrous oxide scavenging inlets shall not be interchangeable with any other vacuum inlets, including medical–surgical vacuum, dental-surgical vacuum, dental vacuum, and WAGD.

Statement of Problem and Substantiation for Public Input

This creates consistency with the dental-surgical vacuum used in Chapter 15, and also covers the possible use of a medical-surgical vacuum as defined in Chapter 5 if it were to be installed in a dental office.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 248-NFPA 99-2024 [Section No. 15.4.3.3.4.1(C)]	

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Public Input No. 221-NFPA 99-2024 [Section No. 15.3.3.7.3.2(B)]

(B) Copper Fittings.

Copper fittings shall comply with the following:

(1) Brazed or soldered fittings conforming to ASME B16.22, *Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings*

(2) Brazed fittings conforming to ANSI/ASME B16.50, *Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings*

(3) Brazed fittings conforming to ASME B16.22 with socket depths equal to or greater than braze-joint pressure fittings conforming to ANSI/ASME B16.50

(4) Flared fittings conforming to ASME B16.26, *Cast Copper Alloy Fittings for Flared Copper Tubes*

(5) Compression fittings (¾ in. maximum size)

(6) Axial swaged fittings complying with 5.1.10.7

Statement of Problem and Substantiation for Public Input

Adding in accepted technology (axial swaged) to valves for joint connection. Appears to be inadvertently not included in the past version.

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Public Input No. 428-NFPA 99-2024 [Section No. 15.4.2.4.15]

~~15.4.2.4.15~~ –

~~Locations containing positive-pressure gases or cylinders containing positive-pressure gases shall be provided with an automatic sprinkler system in accordance with NFPA 13.~~

Statement of Problem and Substantiation for Public Input

This code was new in 2024. Chapter 5 allows up to 10,000 cubic feet without a sprinkler system. Why is a Dental facility being treated differently where the typical dental office has below 3000 cubic feet? Normal tank room is 2 H cylinders for each gas - which is negligible compared to a hospital or surgery center. Requiring a dental facility to put in a sprinkler system is cost prohibitive and restrictive. Dentists will cease piping medical gas in their office.

Additional issue with the code as it is currently written it applies to "any" positive pressure cylinder. If an office has an E cylinder of O2 - they now need a sprinkler system?

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Submittal Date: Tue Jun 04 11:49:14 EDT 2024
Committee: HEA-PIP

Public Input No. 279-NFPA 99-2024 [New Section after 15.4.3.2.2]

15.4.3.3.2 Dental Gas and Vacuum Systems.

15.4.3.3.2.1 Dental Gas and Vacuum Installer Qualifications.

15.4.3.3.2.1.1

Installers of dental gas and vacuum systems shall be certified in accordance with ASSE/IAPMO/ANSI 6010, Professional Qualifications Standard for Medical Gas Systems Installers, regardless of the capacity

15.4.3.3.2.1.2

Installers of medical gas systems shall not use their certification to oversee installation by noncertified personnel.

15.4.3.3.2.1.3

Brazing of medical gas piping systems shall be performed by individuals who are qualified in accordance with 15.4.6.1.

15.4.3.3.2.1.4

Prior to any installation work involving brazing, the installer of the medical gas piping systems shall provide documentation required by 15.4.6.1 for the qualifications of the brazing procedures and individual brazers.

Re-number remaining sections

Statement of Problem and Substantiation for Public Input

This adds the requirement that an ASSE 6010 certified installer installs the dental gas and vacuum system. Often in facilities that only have dental gas (dental air) and dental vacuum the argument is made that because a certified installer is not required, the code does not apply. While it is clear that NFPA 99 does apply to regular users of the code, this proposal adds to the requirement that all personnel installing these systems have proper training and certifications. This is also going to provide proper training and credentialing for those installers to use appropriate materials. Because we are currently allowing for non credentialed or trained people to install the systems, we have a large number of the systems being installed incorrectly with the incorrect materials. This proposal to require training will help get the installations done correctly.
Additionally we require a dental facility testing documents to be reviewed by a responsible facility authority (ASSE 6000 certified) so if we require that person who reviews the system testing documents to have a certification, we probably should require all individuals installing all of the systems to have proper training and certifications.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 278-NFPA 99-2024 [New Section after 15.3.3.3.2]	Same proposal for Cat 2

Submitter Information Verification

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Submittal Date:	Wed May 29 12:46:55 EDT 2024
Committee:	HEA-PIP

Public Input No. 466-NFPA 99-2024 [Section No. 15.4.3.3.2.2(A)]

(A)–

~~Dental~~

D ental air compressor

~~units shall include dental air compressors, vibration isolation, air receivers, coalescent air filters, adsorption dryers, exhaust silencer/filters, moisture indicators, service access manifolds, electrical disconnects, motor wiring, and controls.~~

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, 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 a manual or automatic drain

(10) Shutoff valves

(11) Compressor discharge check valve(s) (for multiple compressors)

(12) Air dryer(s) that maintains a minimum of 40 percent relative humidity at operating pressure and temperature

(13) In-line final particulate/coalescing filters rated at 0.01 µ, with filter status indicator to ensure the delivery of dental air with a maximum allowable 0.05 ppm liquid oil

(14) Pressure regulator(s)

(15) Pressure relief valve

(16) Pressure indicator

(17) Moisture indicator

(B) Receivers shall have the following:

(1) The capacity to prevent short cycling of the compressor(s)

(2) Compliance with Section VIII, “Unfired Pressure Vessels,” of the ASME Boiler and Pressure Vessel Code

(C) Moisture indicators shall have the following:

(1) A location in the active airstream prior to, or after, the receiver and upstream of any system pressure regulators

(2) The ability to indicate (e.g., by color change, digital readout, or other method understood by the user) when the relative humidity of the dental air exceeds 40 percent at line pressure and temperature

(D) Pressure Relief Valve Discharge.

Pressure relief valves for dental air systems having less than 84,950 L (3000 ft3) at STP shall be permitted to discharge locally indoors in a safe manner that will not restrict the flow.

Re Number Remaining Sections

Statement of Problem and Substantiation for Public Input

When Chapter 15 was created the individual requirements including but not limited to the filtration and moisture requirements were not moved into the new chapter. This proposal restores the requirements.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 465-NFPA 99-2024 [Section No. 15.3.3.4.2.1]	Adding requirement in Cat 2 to match Cat 1

Submitter Information Verification

Submitter Full Name: Mathis Carlson
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Submittal Date: Tue Jun 04 16:30:28 EDT 2024
Committee: HEA-PIP

Public Input No. 423-NFPA 99-2024 [Section No. 15.4.3.3.3.1(B)]

(B)

Dental vacuum inlets shall not be interchangeable with any other vacuum inlets, including ~~dental–surgical~~ medical–surgical vacuum. Dental High Volume Evacuation (HVE) may be used for nitrous oxide scavenging and may be interchangeable.

Statement of Problem and Substantiation for Public Input

Suggestion for Dental Surgical Suction - this term does not resinate for a Cat 2 minimal to moderate sedation office. There is medical surgical suction and standard dental suction - which is what is used day to day for normal dental procedures.

Standard dental offices all use High Volume Evacuation (HVE) for dental suction and scavenging. There is normally a dental delivery arm that has the handpiece (drill), air, water, and suction. The suction is used for oral suction in the mouth. When using nitrous oxide the dentist will add a second HVE port and the breathing circuit scavenging line connects directly. These connections are uniform and interchangeable. 85% of dental offices use HVE for scavenging vs Outlets. The current code is causing confusion where some believe that you can't scavenge through HVE because its not a dedicated or specific connection for scavenging.

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Submittal Date: Tue Jun 04 09:29:58 EDT 2024
Committee: HEA-PIP

Public Input No. 248-NFPA 99-2024 [Section No. 15.4.3.3.4.1(C)]

(C)

Nitrous oxide scavenging inlets shall not be interchangeable with any other vacuum inlets, including medical–surgical vacuum, dental-surgical vacuum, dental vacuum, and WAGD.

Statement of Problem and Substantiation for Public Input

In 2024, we introduced Dental-Surgical Vacuum to be distinct from Medical-Surgical Vacuum in Chapter 5. These medical-surgical vacuum references remained, but should state that nitrous oxide scavenging shall not connect to either of these two systems - medical-surgical vacuum, or dental-surgical vacuum. These are allowed to handle WAGD though.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 247-NFPA 99-2024 [Section No. 15.3.3.6.1.3]	Same rationale and issue with medical vs dental surgical vacuums

Submitter Information Verification

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Submittal Date: Sun May 26 14:57:35 EDT 2024
Committee: HEA-PIP

Public Input No. 231-NFPA 99-2024 [Section No. 15.4.3.4]

~~**15.4.3.4** – Category 2 Warning Systems (Oxygen and Nitrous Oxide).~~

~~**15.4.3.4.1** – General.~~

~~**15.4.3.4.1.1** –~~

~~The warning systems in Category 2 dental gas and vacuum systems shall comply with applicable requirements of 5.2.9 and 15.4.3.4.2 through 15.4.3.4.4 .~~

~~**15.4.3.4.1.2** –~~

~~The master, area, and local alarm functions shall be permitted to be provided by a single alarm panel, as indicated in 5.2.9 .~~

~~**15.4.3.4.2** – Master Alarm Panels.~~

~~**15.4.3.4.2.1** –~~

~~A master alarm panel shall be located in the facility at a point of continuous surveillance when the facility is in operation.~~

~~**15.4.3.4.2.2** –~~

~~The master alarm panel shall indicate the following:~~

(1) ~~Oxygen supply pressure ±20 percent from normal~~

(2) ~~Nitrous oxide supply pressure ±20 percent from normal~~

(3) ~~Changeover of oxygen supply source~~

(4) ~~Changeover of nitrous oxide supply source~~

~~**15.4.3.4.3** – Area Alarm Panels.~~

~~**15.4.3.4.3.1** –~~

~~An area alarm panel shall be centrally located where two or more treatment areas are supplied from the same zoned dental gas and vacuum piping.~~

~~**15.4.3.4.3.2** –~~

~~Area alarm panels shall indicate the following:~~

(1) ~~Oxygen supply pressure ±20 percent from normal~~

(2) ~~Nitrous oxide supply pressure ±20 percent from normal~~

~~**15.4.3.4.4** – Local Alarms.~~

~~**15.4.3.4.4.1** –~~

~~Local alarms shall be located in source equipment control panels or separate control panels in the equipment rooms for source equipment.~~

Statement of Problem and Substantiation for Public Input

Section 15.4.3.4 is essentially a duplication of 15.4.2.10, both sections applicable to Category 2 Oxygen and Nitrous Oxide systems. It appears that 15.4.3.4 can be deleted.

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Submittal Date: Thu May 23 13:42:54 EDT 2024
Committee: HEA-PIP

Public Input No. 267-NFPA 99-2024 [Section No. 15.4.5.3]

15.4.5.3 Minimum Pipe Sizes.

The minimum size of the following piping shall be as follows:

(1) Category 2 oxygen piping shall be not less than DN10 (NPS ⅜ in.) (½ in. O.D.) size.

(2) Category 2 nitrous oxide piping shall be not less than DN8 (NPS ¼ in.) (⅜ in. O.D.) size.

(3) ~~Category 2 oxygen piping shall be at least 1 size larger than piping for nitrous oxide.~~

Additional Proposed Changes

File Name	Description	Approved
Dental_Pictures_Submission.pdf	15.4.5.3 Diagrams	

Statement of Problem and Substantiation for Public Input

This requirement of having different pipe sizes for Nitrous and Oxygen is unnecessary when a system is properly installed, tested, inspected, and verified as presently required by the code. Mandating that the oxygen line be one pipe size larger than the Nitrous oxide could lead to additional cost of construction and provide a false sense of security against cross connections.

As shown in the attached/ submitted picture of a combination Oxygen/Nitrous Oxide wall outlet that is supplied and used by multiple major dental equipment manufacturers, the two pipe sizes is not a guarantee that a cross connection will not occur. Both the Oxygen and Nitrous Oxide outlet supply lines are supplied from the manufacture with 3/8” NPS pipe stubs. If we are running the minimum size lines, the Oxygen line will require a 3/8” coupling and the Nitrous a 3/8”x1/4” reducer. There is no mechanism stopping the two different pipe sizes from being connected to the opposite outlets. Figures 1 & 2 show a correctly piped configuration and figures 3 & 4 show one that is incorrect or a cross connection. Both configurations were made with the exact same components.

The code already requires Nitrous and Oxygen lines to be installed by ASSE 6010 Medical Gas Installers, The same requirement for Dental Cat. 1 system and all Ch. 5 systems. There isn’t a “dental” 6010 or a different training requirement, so the installers all have the same training. The 6010 installers are also required to complete a cross connection test prior to a system verification. A system verification is also required to be completed by an ASSSE 6030 verifier including a cross connection test, no different than Ch. 15 Cat. 1 or any Ch. 5 system. Requiring two different pipe sizes for different gasses only in a dental Cat. 2 system is assuming that the medical gas installer has ignored the 6010-training requirement, ignored the cross-connection test, ignored the verification, and associated cross connection test but has decided to follow the requirement of two different pipe sizes.

In the past the reasoning for adding the different pipe sizes requirement was to prevent cross connections between gasses, as cross connections are “the number one problem found”. By that reasoning this requirement should apply to all medical gas systems including those found in Chapter 5. As a standard that is looking to be a minimum standard requiring two different pipe sizes is outside of that charge. There have been cases of cross connections occurring even with two different pipe sizes being installed.

Having installers/verifiers/inspectors/AHJ’s/Owner’s looking for different pipe sizes as a cross connection prevention tactic will ultimately lead to those same individuals skipping or not doing as complete of a job in their testing, verifying, and commissioning process such as the cross-connection tests that are already required. There will be groups that simply skip the required tests because they have depended on the two different sizes catching any problems.

Requiring the two different pipe sizes is done under the assumption that Oxygen will be 3/8” NPS tube and Nitrous ¼” NPS tube. That assumption comes from the way that some dental equipment suppliers have supplied their equipment such as outlets in the past. While many small clinics can use the minimum required pipe sizes to meet flow requirements, this is not always the case. In most larger

offices (more than 3-4 chairs) it is highly likely that the pipe sizes will be increased from the minimum required. More and more large-scale offices are being built where the minimum pipe sizes are not large enough and larger pipe sizes are being used. For example, a larger system requiring a 3/4" NPS Nitrous Oxide Line when properly sized, the code would now require that the Oxygen be increased to 1" NPS, even if a 3/4" NPS Oxygen line would meet the engineering and flow requirements. This would add additional construction costs and exceeds a “minimum standard”.

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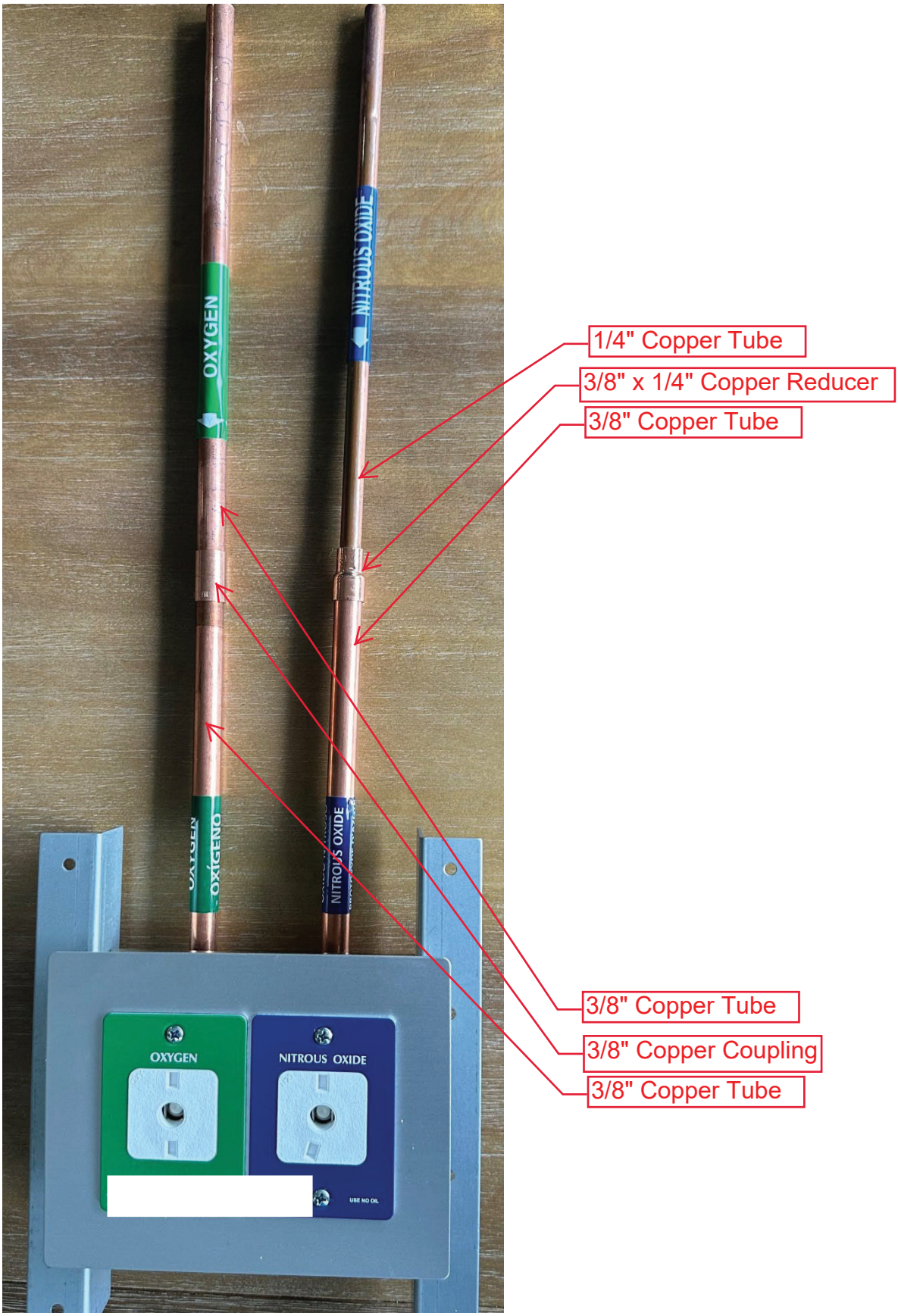
Committee: HEA-PIP

Figure 1



Common Dental Wall Outlet

Figure 2

Common Dental Wall Outlet

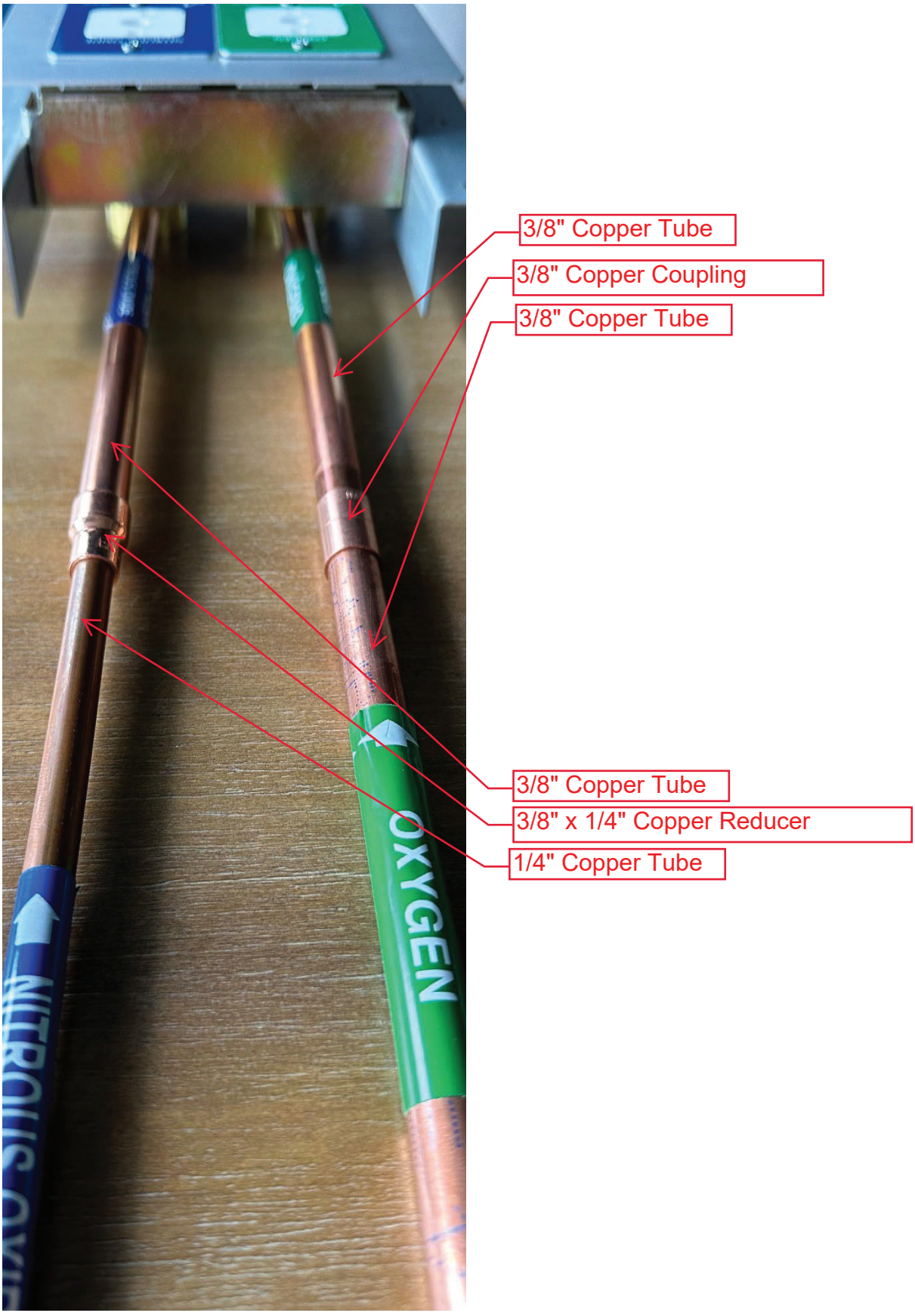
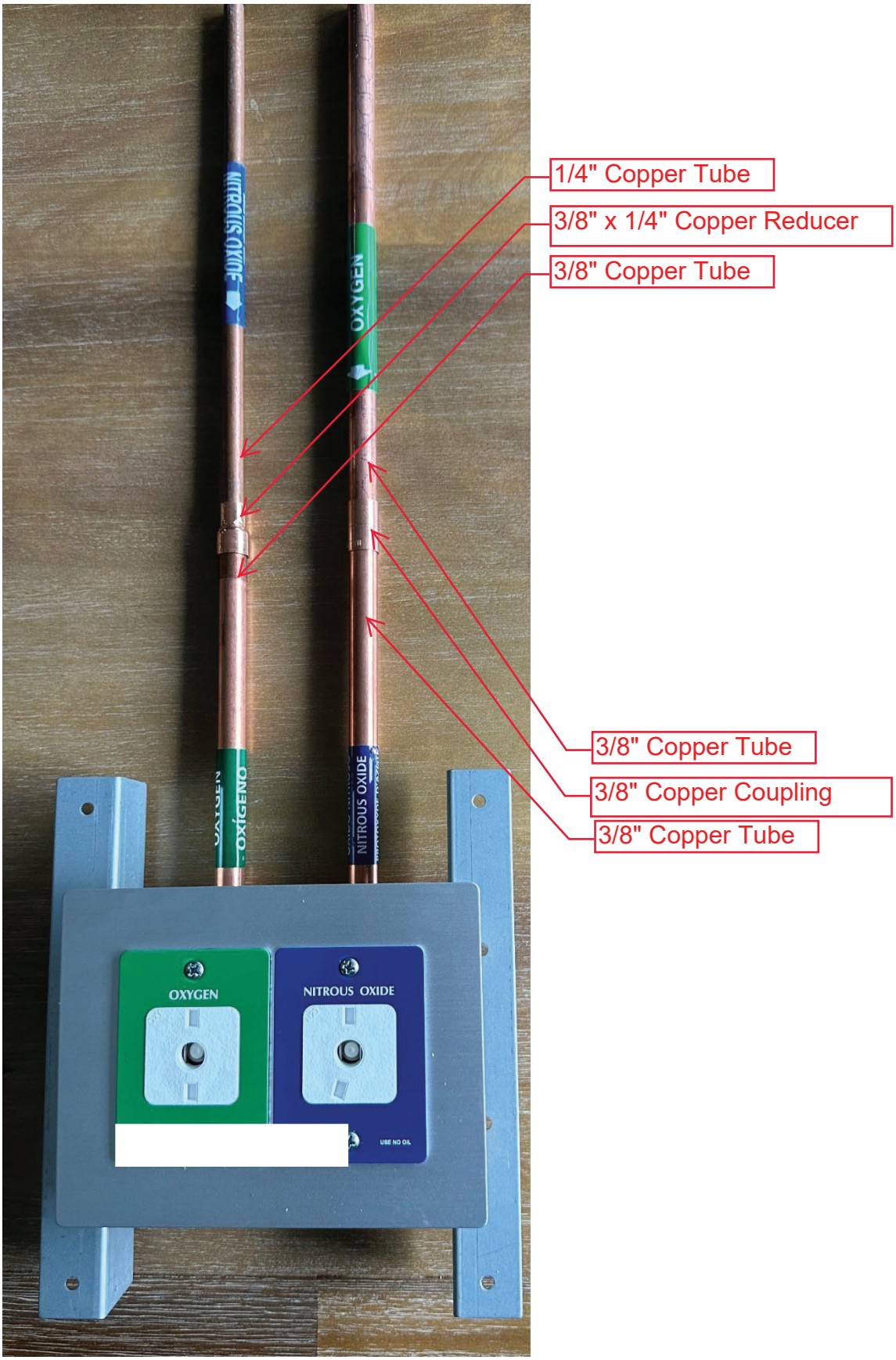


Figure 3



Common Dental Wall Outlet

Figure 4

Common Dental Wall Outlet

Public Input No. 294-NFPA 99-2024 [Section No. 15.4.7.5.8.3]

15.4.7.5.8.3

~~All~~ Each medical gas ~~outlets with~~ outlet with a gauge pressure of 345 kPa (50 psi), including 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) when tested individually .

Statement of Problem and Substantiation for Public Input

The current wording can be interpreted as a design requirement for all outlets to be capable of 50 slpm when flowed simultaneously. It is understood that this paragraph is only intended as an individual outlet test to verify that no supply piping has been damaged (e.g. dented) during construction. The revised wording reflects this intent.

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Committee: HEA-PIP

Public Input No. 280-NFPA 99-2024 [New Section after 15.5.4.1.2]

15.5.4.1.3 Dental Gas and Vacuum Systems.

15. 5.4.1.3.1 Dental Gas and Vacuum Installer Qualifications.

15. 5.4.1.3.1.1

Installers of dental gas and vacuum systems shall be certified in accordance with ASSE/IAPMO/ANSI 6010, Professional Qualifications Standard for Medical Gas Systems Installers, regardless of the capacity

15. 5.4.1.3.1.2

Installers of medical gas systems shall not use their certification to oversee installation by noncertified personnel.

15. 5.4.1.3.1.3

Brazing of medical gas piping systems shall be performed by individuals who are qualified in accordance with 15.4.6.1.

15. 5.4.1.3.1.4

Prior to any installation work involving brazing, the installer of the medical gas piping systems shall provide documentation required by 15.4.6.1 for the qualifications of the brazing procedures and individual brazers.

Re-number remaining sections

Statement of Problem and Substantiation for Public Input

This adds the requirement that an ASSE 6010 certified installer installs the dental gas and vacuum system. Often in facilities that only have dental gas (dental air) and dental vacuum the argument is made that because a certified installer is not required, the code does not apply. While it is clear that NFPA 99 does apply to regular users of the code, this proposal adds to the requirement that all personnel installing these systems have proper training and certifications. This is also going to provide proper training and credentialing for those installers to use appropriate materials. Because we are currently allowing for non credentialed or trained people to install the systems, we have a large number of the systems being installed incorrectly with the incorrect materials. This proposal to require training will help get the installations done correctly.
Additionally we require a dental facility testing documents to be reviewed by a responsible facility authority (ASSE 6000 certified) so if we require that person who reviews the system testing documents to have a certification, we probably should require all individuals installing all of the systems to have proper training and certifications.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 278-NFPA 99-2024 [New Section after 15.3.3.3.2]	Same proposal for Cat 3

Submitter Information Verification

Submitter Full Name: Mathis Carlson

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Submittal Date:	Wed May 29 12:48:45 EDT 2024
Committee:	HEA-PIP

Public Input No. 467-NFPA 99-2024 [Section No. 15.5.4.2.2.1]

15.5.4.2.2.1

Dental air compressor

~~units shall include dental air compressors, vibration isolation, air receivers, coalescent air filters, adsorption dryers, exhaust silencer/filters, moisture indicators, and service access manifolds, electrical disconnects, motor wiring, and controls.~~
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, 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 a manual or automatic drain

(10) Shutoff valves

(11) Compressor discharge check valve(s) (for multiple compressors)

(12) Air dryer(s) that maintains a minimum of 40 percent relative humidity at operating pressure and temperature

(13) In-line final particulate/coalescing filters rated at 0.01 µ, with filter status indicator to ensure the delivery of dental air with a maximum allowable 0.05 ppm liquid oil

(14) Pressure regulator(s)

(15) Pressure relief valve

(16) Pressure indicator

(17) Moisture indicator

15.5.4.2.2.1.1 Receivers.

Receivers shall have the following:

(1) The capacity to prevent short cycling of the compressor(s)

(2) Compliance with Section VIII, “Unfired Pressure Vessels,” of the ASME Boiler and Pressure Vessel Code

15.5.4.2.2.1 .2 Moisture Indicator.

Moisture indicators shall have the following:

(1) A location in the active airstream prior to, or after, the receiver and upstream of any system pressure regulators

(2) The ability to indicate (e.g., by color change, digital readout, or other method understood by the user) when the relative humidity of the dental air exceeds 40 percent at line

pressure and temperature

5.3.3.6.1.4 Pressure Relief Valve Discharge.

Pressure relief valves for dental air systems having less than 84,950 L (3000 ft3) at STP shall be permitted to discharge locally indoors in a safe manner that will not restrict the flow.

Statement of Problem and Substantiation for Public Input

When Chapter 15 was created the individual requirements including but not limited to the filtration and moisture requirements were not moved into the new chapter. This proposal restores the requirements.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 465-NFPA 99-2024 [Section No. 15.3.3.4.2.1]	Adds matching requirement in Cat 3

Submitter Information Verification

Submitter Full Name: Mathis Carlson
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Submittal Date: Tue Jun 04 16:33:54 EDT 2024
Committee: HEA-PIP

Public Input No. 244-NFPA 99-2024 [Section No. A.5.1.1.1]

~~A.5.1.1.1~~ —

~~Category 1 piped gas or piped vacuum system requirements should be applied where any of the following criteria is met:~~

(1) ~~General anesthesia, as defined in~~ 3.3.70.1 ~~, or deep sedation, as defined in~~ 3.3.70.2 ~~, is performed.~~

(2) ~~The loss of the piped gas or piped vacuum systems is likely to cause major injury or death of patients, staff, or visitors.~~

Statement of Problem and Substantiation for Public Input

This verbiage was removed from Chapter 5 of the Code in the 2024 edition. The intent was to make the "triggering" requirement based solely on the risk assessment in Chapter 4. Although the annex material is not code, its existence here implies that the activity of deep sedation and / or general anesthesia still automatically mandates a Category 1 system.

We should be consistent in our application throughout the code, including the annex materials.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 245-NFPA 99-2024 [Section No. A.5.2.1.1]	
Public Input No. 246-NFPA 99-2024 [Section No. A.5.3.1.1]	

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Committee: HEA-PIP

Public Input No. 86-NFPA 99-2024 [Section No. A.5.1.14.3.4]

A.5.1.14.3.4

Other examples of prohibited use of medical–surgical vacuum would be scope cleaning, decontamination, ~~and laser plume~~ and condensate return .

Statement of Problem and Substantiation for Public Input

moving the parenthetical references to the annex to include condensate return. Deleting "laser plume" since that term is not defined and isn't consistent with the other types of prohibited examples and also conflicts with 9.3.8.1.

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Committee: HEA-PIP

Public Input No. 245-NFPA 99-2024 [Section No. A.5.2.1.1]

~~**A.5.2.1.1** —~~

~~Category 2 piped gas or piped vacuum system requirements should be applied when all of the following criteria are met:~~

(1) ~~Only moderate sedation *(as defined in 3.3.70.3)* , minimal sedation *(as defined in 3.3.70.4)* , or no sedation is performed. Deep sedation and general anesthesia are not permitted.~~

(2) ~~The loss of the piped gas or piped vacuum systems is likely to cause minor injury to patients, staff, or visitors.~~

(3) ~~The facility piped gas or piped vacuum systems are intended for Category 2 patient care spacesin accordance with 3.3.146.2 .~~

Statement of Problem and Substantiation for Public Input

This verbiage was removed from Chapter 5 of the Code in the 2024 edition. The intent was to make the "triggering" requirement based solely on the risk assessment in Chapter 4. Although the annex material is not code, its existence here implies that the activity of moderate sedation requires at minimum a Category 2 system.

Additionally, if we were to strictly adhere to the non-intervention and strictly system / equipment approach in Annex A.4.1 and the definition of moderate sedation in 3.3.70.3 which states that "No interventions are required to maintain a patient airway and spontaneous ventilation is adequate," then the failure of the system should have little to no impact on the patient at least in terms of the activity of providing moderate sedation.

We should be consistent in our application throughout the code, including the annex materials.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 242-NFPA 99-2024 [Section No. A.4.1]	Annex material requiring a strict system / equipment approach with no intervention by others
Public Input No. 244-NFPA 99-2024 [Section No. A.5.1.1.1]	Same issue, only dealing with Category 1
Public Input No. 246-NFPA 99-2024 [Section No. A.5.3.1.1]	

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Committee: HEA-PIP

Public Input No. 246-NFPA 99-2024 [Section No. A.5.3.1.1]

~~A.5.3.1.1~~ —

~~Category 3 piped gas or piped vacuum system requirements should be applied when all of the following criteria are met:~~

(1) ~~Only minimal sedation, as defined in 3.3.70.4 , or no sedation is performed. Deep sedation, moderate sedation, and general anesthesia are not permitted.~~

(2) ~~The loss of the piped gas or piped vacuum systems is not likely to cause injury to patients, staff, or visitors but can cause discomfort.~~

(3) ~~The facility piped gas or piped vacuum systems are intended for Category 3 patient care spaces in accordance with 3.3.146.3 .~~

Statement of Problem and Substantiation for Public Input

This verbiage was removed from Chapter 5 of the Code in the 2024 edition. The intent was to make the "triggering" requirement based solely on the risk assessment in Chapter 4. Although the annex material is not code, its existence here implies that the activity of moderate sedation requires at minimum a Category 2 system.

If we were to strictly adhere to the non-intervention and strictly system / equipment approach in Annex A.4.1 and the definition of moderate sedation in 3.3.70.3 which states that "No interventions are required to maintain a patient airway and spontaneous ventilation is adequate," then the failure of the system should have little to no impact on the patient at least in terms of the activity of providing moderate sedation. This would provide an argument under Chapter 4 that both moderate and minimal sedation could be provided in a Category 3 space.

We should be consistent in our application throughout the code, including the annex materials. If the intent was to base the Categories solely on Chapter 4 prescribed risk assessment, then this material should be removed.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 244-NFPA 99-2024 [Section No. A.5.1.1.1]	Same issue and rationale
Public Input No. 245-NFPA 99-2024 [Section No. A.5.2.1.1]	Same issue and Rationale

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Zip:
Submittal Date: Sun May 26 14:21:37 EDT 2024
Committee: HEA-PIP

From: O'Connor, Brian
To: Harrington, Greg
Subject: NFPA 99 Inconsistency
Date: Friday, December 15, 2023 11:55:43 AM
Attachments: image002.png
image003.png

Hey Greg,

I hope you're having a nice holiday season. I'm reviewing the MedGas OLL and noticed an inconsistency in what is considered standard gauge pressure in NFPA 99. First Revision 1055 changed table 5.1.11 to say that the standard gauge pressure for nitrogen and instrument air is 0-300psi but in section 5.1.11.2.2, 5.1.11.3.2 and 5.1.11.4.3 it says that the standard gauge pressure for nitrogen and instrument air is 160-185psi. This would lead to potentially the alarm panel, valves, and station outlets being labeled as non-standard pressure, but the piping would be labeled as standard pressure. It's not the end of the world but it seems like there should be more consistency with the labeling and thought it might be worth bringing up to the committee.

5.1.11.2.2

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 or instrument air, the valve identification shall also include the nonstandard operating pressure.

5.1.11* Labeling, Identification, and Operating Pressure.

Color and pressure requirements shall be in accordance with Table 5.1.11.

Table 5.1.11 Standard Designation Colors and Operating Pressures for Gas and Vacuum Systems

Gas Service	Abbreviated Name	Colors (Background/Text)	Standard Gauge Pressure	
			kPa	psi
Medical air	Med air	Yellow/black	345–380	50–55
Carbon dioxide	CO_2	Gray/black or gray/white	345–380	50–55
Helium	He	Brown/white	345–380	50–55
Nitrogen	N_2	Black/white	~~345–1275~~ 0–2070	~~55–185~~ 0–300
Nitrous oxide	N_2O	Blue/white	345–380	50–55
Oxygen	O_2	Green/white or white/green	345–380	50–55
Oxygen/carbon dioxide mixtures	$O_2/CO_2 n\%$ (n = % of CO_2)	Green/white	345–380	50–55
Medical–surgical vacuum	Med vac	White/black	380 mm to 760 mm (15 in. to 30 in.) HgV	
Waste anesthetic gas disposal	WAGD	Violet/white	Varies with system type	
Medical–surgical vacuum/WAGD combination	Med–surg/WAGD	White/black and violet/white	380 mm to 760 mm (15 in. to 30 in.) HgV	
Other mixtures	Gas A%/Gas B%	Colors as above	None	
		Major gas for background/minor gas for text		
Nonmedical air and dental air	—	Yellow and white diagonal stripe/black	None	
Nonmedical vacuum and dental vacuum	—	White and black diagonal stripe/black boxed	None	
Laboratory air	—	Yellow and white checkerboard/black	None	
Laboratory vacuum	—	White and black checkerboard/black boxed	None	
Instrument air	—	Red/white	~~345–1275~~ 0–2070	~~50–185~~ 0–300

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From: Harrington, Greg
To: Harrington, Greg
Subject: Conversion in NFPA 99 - 5.1.3.6.1(5)
Date: Monday, June 10, 2024 4:37:21 PM

From: Harrington, Greg <gharrington@NFPA.org>
Sent: Thursday, January 11, 2024 3:10 PM
To: Ing, Alexander <AIng@nfpa.org>
Cc: Harrington, Greg <gharrington@NFPA.org>
Subject: RE: NFPA 99 IAPMO Extract Question

The conversion in 5.1.3.6.1(5) goes back to the 2012 edition. In the prior 2005 edition, the value was 5 mg/m^3 with no conversion. The change to 1 mg/m^3 is documented in the A2009 ROP, but no conversion was given. I agree that the correct conversion should be 1.686 x 10^{-6} lb/yd^3. The conversion is shown as 1.685 x 10^{-6} lb/yd^3 in 5.1.3.9.1.2. I'll flag this for the Piping Committee for the next cycle.

Let me know if you have any other questions.

-Greg

From: Ing, Alexander <AIng@nfpa.org>
Sent: Wednesday, January 10, 2024 11:33 AM
To: Harrington, Greg <gharrington@NFPA.org>
Subject: NFPA 99 IAPMO Extract Question

Hi Greg,
I am reviewing IAMPO UPC extracts and they have the following note on one of the extracted sections below. Are you aware this might be an incorrect conversion? I checked online and it seems the 1.686 x10^{-6} number might be correct but I haven't dug into the history of the change. Do you have any thoughts on this?

The below unit conversion (6.85 x 10^{-7} lb/yd^3) for Section 1310.1 (NFPA 99:5.1.6.1) seems to be incorrect in the 2021 and 2024 NFPA 99 documents. For now, we will keep the value shown in the UPC with the appropriate conversions as shown in Section 1310.1.

"(5) It shall have equal to or less than ~~1.686 x 10^{-6} pounds per cubic yard (~~1 mg/m^3~~)~~ (6.85 × 10^{-7} lb/yd^3) of permanent particulates sized 1 micron or larger in the air at normal atmospheric pressure."

1310.1 Quality of Medical Air. Medical air shall be required to have the following characteristics:
(1) It shall be supplied from cylinders, bulk containers, or medical air compressor sources, or it shall be reconstituted from oxygen USP and oil-free, dry nitrogen NF.
(2) It shall meet the requirements of medical air USP.
(3) It shall have no detectable liquid hydrocarbons.

(4) It shall have less than 25 ppm gaseous hydrocarbons.
(5) It shall have equal to or less than 1.686 x 10-6 pounds per cubic yard (1 mg/m3) of permanent particulates sized 1 micron or larger in the air at normal atmospheric pressure. [NFPA 99:5.1.3.6.1]

Thank you,

Alex Ing, PE
Engineer | **NFPA**

From: Harrington, Greg
To: Harrington, Greg
Subject: FW: NFPA Technical Question Response
Date: Monday, June 10, 2024 4:40:50 PM

From: NFPA Life Safety <techquesbfpls@nfpa.org>
Sent: Monday, April 22, 2024 4:39 PM
Subject: NFPA Technical Question Response ref# [ref:!00D50077Vx.!500Uc08w45D:ref]

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Thank you for your question on NFPA 99, *Health Care Facilities Code*, 2024 edition.

It is the intent of 5.1.3.7.7.7 to limit vacuum exhaust piping to the materials and joining methods permitted by 5.1.10.2 and 5.1.10.3. This requirement was added for the 2015 edition with the following committee statement:

2012 Log CP2 99-219 inadvertently took out the exhaust piping section. the NFPA 99, 2012 does not have a section for exhaust piping materials or joining techniques (The NFPA 99, 2005 edition section " 5.1.3.6.7.4 The exhaust shall be piped of materials approved for medical–surgical vacuum piping under 5.1.10.2."

I will flag this to the technical committee for clarification for the 2027 edition. Thank you for bringing this to our attention.

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Gregory Harrington, PE
Principal Engineer
NFPA

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Create Date: 4/19/2024

Document Number: 99
Edition: 2024
Section:
Subject: NFPA Website Submission
Question for NFPA: Is it the intent of the TC to allow other materials or joining methods other than those listed in 5.1.10.2 and 5.1.10.3 by using the wording "shall be permitted" for this tubing?

5.1.3.7.7.7

Vacuum exhaust piping shall be permitted to be made of materials and use a joining technique as permitted under 5.1.10.2 and 5.1.10.3.

ref:!00D50077Vx.!500Uc08w45D:ref