Committee Input No. 1131-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~~

* , and medical support gas systems serving Category 1 spaces .

Submitter Information Verification

Committee: HEA-PIP

Submittal Date: Wed Aug 07 10:42:18 EDT 2024

Committee Statement

Committee Statement: The CI is intended to solicit Public Comments and is based on PI-164, the substantiation for which follows:

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advent of injectable anesthesia, where no gas machine may be connected or even present in the room, this assumption is no longer valid.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)

Response Message: CI-1131-NFPA 99-2024

Public Input No. 164-NFPA 99-2024 [Section No. 5.1.9.4 [Excluding any Sub-Sections]]

Committee Input No. 1132-NFPA 99-2024 [Section No. 5.1.9.4.4]

5.1.9.4.4*

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~~

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Submitter Information Verification

Committee: HEA-PIP

Submittal Date: Wed Aug 07 11:19:38 EDT 2024

Committee Statement

Committee Statement: The CI is intended to solicit Public Comments and is based on PI-165, the substantiation for which follows (see also PI-164):

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)

Response Message: CI-1132-NFPA 99-2024

Public Input No. 165-NFPA 99-2024 [Section No. 5.1.9.4.4]

Committee Input No. 1139-NFPA 99-2024 [Section No. 5.1.10.4]

~~**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 $\frac{3}{4}$) ($\frac{7}{8}$ in. O.D.) size and smaller, flux-coated brazing rods shall be permitted to be used in lieu of applying flux to the surfaces being joined.

5.1.10.4.5 * – Nitrogen Purge.

A.5.1.10.4.5 –

The intent is to provide an oxygen-free atmosphere within the tubing and to prevent the formation of copper oxide scale during brazing. This is accomplished by filling the piping with a low-volume flow of low-pressure inert gas.

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.

A.5.1.10.4.5.12 –

This is to ensure a quality joint and to prevent the formation of copper oxide on the inside and outside surfaces of the joint.

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.~~

Submitter Information Verification

Committee: HEA-PIP

Submittal Date: Wed Aug 07 14:19:51 EDT 2024

Committee Statement

Committee Statement: The CI is intended to permit a task group to review the NFPA 99 brazing requirements and those of other standards to determine if there are inconsistencies and redundancies and provide recommended revisions at the Second Draft stage via Public Comments.

Response Message: CI-1139-NFPA 99-2024

Public Input No. 404-NFPA 99-2024 [Section No. 5.1.10.4.6.4]

Committee Input No. 1248-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~~ 345–1276	~~0–300~~ 50–185
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~~ 345–1276	~~0–300~~ 50–185

Submitter Information Verification

Committee: HEA-PIP

Submittal Date: Thu Aug 15 11:57:10 EDT 2024

Committee Statement

Committee Statement: Proposed change: Update table for Nitrogen and Instrument Air to reflected values as well as all reflected areas that utilize these values directly as opposed to referring to the table (5.1.11.3.2 & 5.1.11.4.3).

Justification: Multiple locations within NFPA 99 refer to the standard pressure of medical gases. A value of 0-300 psig does not make sense as a standard pressure when applied to the sections that reference this table (e.g.: 5.1.3.5.5.1(1); 5.1.3.5.6.3; 5.1.11.1.1(3); 5.1.11.3.2; 5.1.11.4.3)

CGA DISS fittings are designed for use up to 200 psig

CGA V-5

Standard for Diameter Index Safety System (Noninterchangeable Low Pressure Connections for Medical Gas Applications)

The Diameter Index Safety System defines noninterchangeable removable connections for use with medical gases at pressures of 200 psi (1380 kPa) or less.

CGA M-22

Standard for Medical Gas Quick Connect Adaptors (Formerly SB-43)

This standard excludes gas specific threaded connections including Diameter Index Safety Systems (DISS) that are addressed in CGA V-5, Diameter Index Safety System (Noninterchangeable Low Pressure Connections for Medical Gas Applications), and non-interchangeable screwed-threaded (NIST) connectors addressed in CSA Z5359, Low-Pressure Hose Assemblies for use with Medical Gases.

GENERAL NOTES:

Health care facilities can install wall panels to control and adjust line pressures they need for various applications or they can install inline regulators for specific areas of nitrogen gas need.

Global Chapter Change :

Nitrogen : 50 – 185 psig

Also consider adding:

Hyperbaric Oxygen : 50 – 90 psig

Response Message: CI-1248-NFPA 99-2024

Committee Input No. 1166-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~~

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 :

15.2 – 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.

15.3.1 – General.

Facilities that perform deep sedation and general anesthesia associated with dental treatment shall meet the requirements for Category 1 dental gas and vacuum systems.

15.3.2 – Category 1 Medical Gas Systems (Dental).

15.3.2.1 – Medical Gas and Vacuum Sources.

15.3.2.1.1 – Central Supply System Identification and Labeling.

Category 1 systems shall comply with 5.1.3.1 :

15.3.2.1.2 – Central Supply Operations.

Category 1 systems shall comply with 5.1.3.2 :

15.3.2.1.3 – Central Supply System Locations.

Category 1 systems shall comply with 5.1.3.3 :

15.3.2.1.4 – Central Supply Systems.

Category 1 systems shall comply with 5.1.3.5 :

15.3.2.1.5 – Medical Air Supply Systems.

Category 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.

15.3.2.1.6 – Oxygen Supply Systems Using Concentrators.

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.

15.3.2.1.7 – Dental–Surgical Vacuum Systems.

Category 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.

15.3.2.1.8 – WAGD Systems.

Category 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.

15.3.2.2 – Valves.

Category 1 systems shall comply with 5.1.4 .

15.3.2.3 – Station Outlets and Inlets.

Category 1 systems shall comply with 5.1.5 .

15.3.2.4 – Manufactured Assemblies.

Category 1 systems shall comply with 5.1.6 .

15.3.2.5 – Surface-Mounted Medical Gas Rails.

Category 1 systems shall comply with 5.1.7 .

15.3.2.6 – Pressure and Vacuum Indicators.

Category 1 systems shall comply with 5.1.8 .

15.3.2.7 – Warning Systems.

Warning systems associated with Category 1 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.

15.3.2.8 – Medical Gas Distribution.

Category 1 systems shall comply with 5.1.10 .

15.3.2.9 – Labeling and Identification.

Category 1 systems shall comply with 5.1.11 .

15.3.2.10 – Performance Criteria and Testing (Medical Gas, Medical–Surgical Vacuum, and WAGD).

Category 1 systems shall comply with 5.1.12 .

15.3.2.11 – Support Gases.

Category 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:

(3) One or more cylinders of nitrogen NF, sufficient for at least one average day's supply

(4) A manifold, if primary and secondary cylinders are provided

(5) A line pressure regulating valve

(6) A check valve downstream from the pressure regulating valve

(7) A pressure relief valve set at 50 percent above the normal line pressure and located downstream from the check valve

(8) 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

15.3.2.12 – Medical Gas and Vacuum Operation and Management.

Category 1 systems shall comply with 5.1.14 .

15.3.3 – Category 1 Dental Air and Vacuum Piping Systems.

15.3.3.1 – General.

15.3.3.1.1 –

Dental vacuum systems shall include dental vacuum and nitrous oxide scavenging.

15.3.3.2 – Equipment Locations for Dental Air and Vacuum Systems.

15.3.3.2.1 – 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

15.3.3.2.2 – Cylinders and Containers.

Cylinders and containers for gases shall be handled in accordance with Chapter 11 .

15.3.3.2.3 – 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

15.3.3.3 – Dental Gas and Vacuum Source Equipment.

15.3.3.3.1 –

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.

15.3.3.3.2 –

The system design requirements shall be included in the data used for testing and verifying the operation of the gas and vacuum piping systems.

15.3.3.4 * – Dental Air.

15.3.3.4.1 – General.

15.3.3.4.1.1 –

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.

15.3.3.4.1.2 –

Dental air outlets shall not be interchangeable with any other gas outlets.

15.3.3.4.2 – Dental Air Compressor Units.

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.

15.3.3.4.2.2 –

Air compressors shall be scroll dental, reciprocating dental, or the oil-free dental types.

15.3.3.4.2.3 –

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

15.3.3.5 * – Dental Vacuum.

15.3.3.5.1 – General.

15.3.3.5.1.1 –

Dental vacuum shall be used for oral evacuation and nitrous oxide scavenging.

15.3.3.5.1.2 –

Dental vacuum inlets shall not be interchangeable with any other vacuum inlets, including dental–surgical vacuum.

15.3.3.5.2 – Dental Vacuum Units.

15.3.3.5.2.1 –

Dental vacuum units shall include dental vacuum pumps, vibration isolation, separation tanks, vacuum inlet, vacuum exhaust, condensate drain, motor wiring, and controls.

15.3.3.5.2.2 –

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.

15.3.3.5.2.3 –

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

15.3.3.5.2.4 –

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 ($\frac{1}{4}$ 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.

15.3.3.6 – Nitrous Oxide Scavenging.

15.3.3.6.1 – General.

15.3.3.6.1.1 –

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.

15.3.3.6.1.2 –

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.

15.3.3.6.1.3 –

Nitrous oxide scavenging inlets shall not be interchangeable with any other vacuum inlets, including medical–surgical vacuum, dental vacuum, and WAGD.

15.3.3.6.2 – 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).

15.3.3.7 – Piping for Dental Air and Vacuum Systems.

15.3.3.7.1 – General.

15.3.3.7.1.1 –

Piping for dental compressed air systems shall comply with 15.3.3.7.2 .

15.3.3.7.1.2 –

Piping for dental vacuum systems and scavenging systems shall comply with 15.3.3.7.3 .

15.3.3.7.2 – Piping for Dental Air Systems.

15.3.3.7.2.1 – General.

Pipe, fittings, and joints in piping for dental compressed air systems shall be in accordance with 15.3.3.7.2.2 through 15.3.3.7.2.5 .

15.3.3.7.2.2 – 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:

   (5) Having a design margin of 3.5

   (6) Externally coated with a nonmetallic sheath marked with the manufacturer's marking

   (7) Listing includes testing to demonstrate that CMT systems can be consistently gas-purged with results equivalent to comparable medical gas copper tubing

15.3.3.7.2.3 – Copper Tube.

Copper tube shall be hard temper or annealed (soft temper).

15.3.3.7.2.4 – 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 complying with 5.1.10.7

15.3.3.7.2.5 – Joints.

Joints for piping under 15.3.3.7.2 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 15.4.6 .

(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* .

15.3.3.7.3 – Piping for Dental Vacuum Systems and Scavenging Systems.

15.3.3.7.3.1 – General.

Piping for dental vacuum systems and scavenging systems shall be copper, PVC plastic, or CPVC plastic.

15.3.3.7.3.2 – Copper Piping.

Copper piping under 15.3.3.7.3 shall be in accordance with 15.3.3.7.3.2(A) through 15.3.3.7.3.2(C) .

(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)

(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 ($\frac{3}{4}$ in. maximum size)

(C) – Joints for Copper Piping.

Joints in copper tubing 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* .

15.3.3.7.3.3 – PVC Plastic Piping.

PVC plastic piping under 15.3.3.7.3 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* .

15.3.3.7.3.4 – CPVC Plastic Piping.

CPVC plastic piping under 15.3.3.7.3 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* .

(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. 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* .

15.3.3.7.3.5 – Piping Within Floor Slabs Prohibited.

Dental gas and vacuum piping shall not be installed within floor slabs.

15.3.3.8 – Dental Air and Vacuum Systems Testing.

15.3.3.8.1 – General.

15.3.3.8.1.1 –

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.

15.3.3.8.1.2 –

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.

15.3.3.8.1.3 –

Reports shall contain detailed listings of all findings and results.

15.3.3.8.1.4 –

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.

15.3.3.8.1.5 –

All documentation pertaining to inspections and testing shall be maintained on-site within the facility.

15.3.3.8.2 – Category 1 Dental Air and Vacuum Systems.

15.3.3.8.2.1 –

All Category 1 dental air and vacuum piping systems indicated in 15.3.3 shall be initially tested in accordance with 15.3.3.8.3 .

15.3.3.8.2.2 –

Dental air, vacuum, and scavenging systems shall be final tested in accordance with 15.3.3.8.3.5 and 15.3.3.8.3.6 .

15.3.3.8.3 – Initial Testing of Piping Systems.

15.3.3.8.3.1 – 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.

(B) –

During the process of initial testing, the identification and labeling of the dental gas and vacuum piping shall be checked.

15.3.3.8.3.2 – Initial Cross-Connection Test for Plastic Vacuum and Plastic Scavenging Piping Systems.

(A) –

Plastic piping shall be tested before copper piping.

(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.

(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.

(D) –

The cross-connection test vacuum shall be a minimum of 300 mm (12 in.) HgV.

(E) –

The source of test vacuum shall be connected only to the vacuum or scavenging piping system being tested.

(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.

(G) –

The cross-connection tests shall be repeated for each installed vacuum and scavenging system with plastic piping.

(H) –

Any cross-connections shall be removed and the associated piping repaired and leak tested.

(I) –

The proper labeling and identification of system outlets/inlets shall be confirmed during the initial tests.

15.3.3.8.3.3 – 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.~~

~~**15.3.3.8.3.4**~~ – ~~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.~~

~~**15.3.3.8.3.5**~~ – ~~Standing Pressure Test for Dental Air and Copper Vacuum Piping.~~

~~(A)~~ –

~~After successful completion of the initial pressure tests in~~ ~~15.4.8.1~~ ~~, 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, 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.~~

~~**15.3.3.8.3.6** – Standing Vacuum Test for Plastic Vacuum Piping.~~

~~**(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.~~

~~**(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)** –~~

~~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.~~

~~**15.3.3.8.4** – Operation and Management.~~

~~**15.3.3.8.4.1** – System Shutdowns.~~

~~**(A)** –~~

~~Gas and vacuum piping systems shall be shut down at the end of each workday.~~

~~**(B)** –~~

~~Emergency shutoff valves or remote actuators shall not be used for daily shutdown of the systems.~~

~~**(C)** –~~

~~Cylinder gas valves shall be used for daily shutdowns.~~

~~**15.3.3.8.4.2** – Prohibited Interconnections.~~

~~Two or more piping systems for different gases or different vacuums shall not be interconnected for testing or any other reason.~~

~~**15.3.3.8.4.3** – Manufacturer's Instructions.~~

~~**(A)** –~~

~~Piping system components shall be installed, adjusted, operated, and maintained in accordance with the manufacturer's instructions.~~

~~**(B)** –~~

~~Copies of the manufacturer's instructions shall be provided to and maintained at the facility.~~

~~**15.3.3.8.4.4** – Maintenance.~~

(A) –

Gas and vacuum system equipment shall be maintained by a qualified person.

(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.

15.3.3.8.5 – Periodic Testing.

Station outlets for oxygen and nitrous oxide shall be tested for flow and pressure on an approved schedule.

15.4 – Category 2 Dental Gas and Vacuum Systems.

15.4.1 – General.

15.4.1.1 –

Category 2 dental gas and vacuum system shall be limited to facilities that, at most, provide moderate and minimal sedation.

15.4.1.2 –

The medical gases shall be limited to oxygen and nitrous oxide.

15.4.1.3 –

Dental air shall be provided from a dental air source system.

15.4.1.4 –

The vacuum systems shall be dental vacuum and nitrous oxide scavenging.

15.4.1.5 –

All connections within Category 2 medical gas (oxygen and nitrous oxide) shall be gas-specific to prevent cross-connections with other piping systems, including vacuum, water, and dental air.

15.4.1.6 –

Station outlets and piped outlets for Category 2 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).

15.4.1.7 –

Requirements for Category 2 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 .

15.4.2 – Medical Gas Systems (Oxygen and Nitrous Oxide).

15.4.2.1 – Installer Qualifications (Oxygen and Nitrous Oxide).

15.4.2.1.1 –

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.

15.4.2.1.2 –

Installers of medical gas systems shall not use their certification to oversee installation by noncertified personnel.

15.4.2.1.3 –

Brazing of medical gas piping systems shall be performed by individuals who are qualified in accordance with 15.4.6.1 .

15.4.2.1.4 –

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.

15.4.2.2 – Central Supply System Identification and Labeling (Oxygen and Nitrous Oxide).

15.4.2.2.1 –

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]

15.4.2.2.2 –

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* .

15.4.2.2.3 –

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.

15.4.2.2.4 –

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* .

15.4.2.2.5 –

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.

15.4.2.2.6 –

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

15.4.2.2.7 –

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

15.4.2.2.8 –

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

15.4.2.2.9 –

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

15.4.2.3 – Central Supply System Operations (Oxygen and Nitrous Oxide).

15.4.2.3.1 –

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

15.4.2.3.2 –

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

15.4.2.3.3 –

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

15.4.2.3.4 –

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

15.4.2.3.5 –

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

15.4.2.3.6 –

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

15.4.2.3.7 –

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

15.4.2.3.8 –

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.

15.4.2.3.9 –

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

15.4.2.3.10 –

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

15.4.2.3.11 –

Containers shall not be stored in a tightly closed space.

15.4.2.3.12 –

Cylinders in use and in storage shall be prevented from reaching temperatures in excess of 52°C (125°F).

15.4.2.3.13 –

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).

15.4.2.4 – Locations of Medical Gas Source Equipment (Oxygen and Nitrous Oxide).

15.4.2.4.1 –

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 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 .

15.4.2.4.2 * –

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 .

15.4.2.4.3 –

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.

15.4.2.4.4 –

Natural or mechanical ventilation for oxygen and nitrous oxide manifold locations shall be in accordance with 9.3.6.5 .

15.4.2.4.5 –

Storage of full or empty gas cylinders, or both, shall be permitted in the same enclosure.

15.4.2.4.6 –

Air compressors, vacuum pumps, and other equipment shall not be located in enclosures for medical gas cylinders (oxygen and nitrous oxide source equipment).

15.4.2.4.7 * –

If enclosures are outdoors or remote from the treatment facilities that they serve, they shall be kept locked.

15.4.2.4.8 –

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).

15.4.2.4.9 –

Indoor enclosures shall not communicate directly with medical gas (oxygen and nitrous oxide) use points or storage locations for flammable materials or gases.

15.4.2.4.10 –

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).

15.4.2.4.11 –

Enclosures for medical gas (oxygen and nitrous oxide) source equipment shall be provided with doors or gates.

15.4.2.4.12 –

Cylinders in service or in storage shall be individually secured and located to prevent falling or being knocked over.

15.4.2.4.13 –

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 **3/4** -hour fire protection rating.

15.4.2.4.14 –

Locations containing positive-pressure gases or cylinders containing positive-pressure gases shall be ventilated in accordance with 9.3.6.5 .

15.4.2.4.15 –

Locations containing positive-pressure gases or cylinders containing positive-pressure gases shall be provided with an automatic sprinkler system in accordance with NFPA 13.

15.4.2.5 – Medical Gas Source Equipment (Oxygen and Nitrous Oxide).

15.4.2.5.1 –

Mechanical means shall be provided to ensure that the medical gas source equipment is connected to the correct medical gas distribution piping system.

15.4.2.5.2 –

Cylinder valve outlets for oxygen and nitrous oxide shall comply with CGA V-1, *Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections* .

15.4.2.5.3 –

Threaded connections to manifolds shall comply with CGA V-5, *Standard for Diameter Index Safety System (Noninterchangeable Low Pressure Connections for Medical Gas Applications)* .

15.4.2.5.4 –

A check valve shall be provided downstream of each pressure regulator.

15.4.2.5.5 –

A pressure relief valve set at 50 percent above the normal line pressure shall be located downstream of the check valve in 15.4.2.5.4 .

15.4.2.5.6 –

Pressure relief valves shall be brass, bronze, or stainless steel and designed for oxygen service.

15.4.2.5.7 –

Hose and flexible connectors shall have a gauge pressure rating not less than 6895 kPa (1000 psi).

15.4.2.5.8 –

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.

(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.

15.4.2.5.9 –

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.

15.4.2.5.9.1 –

Source equipment shall not be connected to the piping system through flexible connectors.

15.4.2.5.10 –

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.

15.4.2.5.11 –

The two banks of each medical gas source shall be manifolded so that either bank can supply its distribution piping system.

15.4.2.5.12 –

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.

15.4.2.5.13 –

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.

15.4.2.5.14 –

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.

15.4.2.6 – Emergency Shutoff Valves (Oxygen and Nitrous Oxide).

15.4.2.6.1 * –

All Category 2 medical gas systems shall have an emergency shutoff valve accessible from all use-point locations in an emergency.

15.4.2.6.2 –

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.

15.4.2.6.3 –

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.

15.4.2.6.4 –

A remotely activated shutoff valve at a gas supply manifold shall not be used for emergency shutoff.

15.4.2.6.4.1 –

For clinical purposes, a remote valve actuator shall not fail-close in the event of loss of electric power.

15.4.2.6.4.2 –

Where remote actuators are the type that fail-open, cylinder shutoff valves shall be closed whenever the system is not in-use.

15.4.2.6.4.3 –

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

15.4.2.7 – Station Outlets and Risers (Oxygen and Nitrous Oxide).

15.4.2.7.1 –

Each gas outlet shall be gas specific.

15.4.2.7.2 –

Gas outlets shall consist of a primary and a secondary valve or assembly.

15.4.2.7.3 –

Each gas outlet shall be legibly identified.

15.4.2.7.4 –

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)* .

15.4.2.7.5 –

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.

15.4.2.8 – Manufactured Assemblies (Oxygen and Nitrous Oxide).

Category 2 systems shall comply with 5.1.6 .

15.4.2.9 – Pressure and Vacuum Indicators (Oxygen and Nitrous Oxide).

Category 2 systems shall comply with 5.1.8 .

15.4.2.10 – Warning Systems (Oxygen and Nitrous Oxide).

Category 2 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:

(5) Oxygen main line pressure low

(6) Oxygen main line pressure high

(7) Oxygen changeover to secondary bank or about to changeover (if automatic)

(8) Nitrous oxide main line pressure low

(9) Nitrous oxide main line pressure high

(10) Nitrous oxide changeover to secondary bank or about to changeover (if automatic)

(11) 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.

(12) Visual indications shall remain until the situation that caused the alarm is resolved.

(13) 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.

(14) 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.

15.4.2.11 – Labeling and Identification.

Category 2 systems shall comply with 5.1.11 .

15.4.3 – Category 2 Dental Air and Vacuum Piping Systems.

15.4.3.1 – General.

Dental vacuum systems shall include dental vacuum and nitrous oxide scavenging.

15.4.3.2 – Equipment Locations for Dental Air and Vacuum Systems.

15.4.3.2.1 – 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

15.4.3.2.2 – Cylinders and Containers.

Cylinders and containers for gases shall be handled in accordance with Chapter 11 .

15.4.3.2.3 – Ventilation for Motor-Driven Equipment.

The following source locations 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

15.4.3.3 – Dental Gas and Vacuum Source Equipment.

15.4.3.3.1 – General.

15.4.3.3.1.1 –

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.

15.4.3.3.1.2 –

The system design requirements shall be included in the data used for testing and verifying the operation of the gas and vacuum piping systems.

15.4.3.3.2 – Dental Air.

15.4.3.3.2.1 – 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.

15.4.3.3.2.2 – 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~~

~~**15.4.3.3.3** – Dental Vacuum.~~

~~**15.4.3.3.3.1** – 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.~~

~~**15.4.3.3.3.2** – 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.~~

(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 ($\frac{1}{4}$ 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.

15.4.3.3.4 – Nitrous Oxide Scavenging.

15.4.3.3.4.1 – 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.

15.4.3.3.4.2 – 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).

15.4.3.4 – 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.

15.4.4 – Piping for Category 2 Medical Gas, Dental Air, and Vacuum Systems.

15.4.4.1 – General.

15.4.4.1.1 –

Piping for the following systems shall comply with 15.4.4.2 :

(1) Oxygen

(2) Nitrous oxide

15.4.4.1.2 –

Piping for dental air systems shall comply with 15.4.4.3 .

15.4.4.1.3 –

Piping for dental vacuum systems and scavenging systems shall comply with 15.4.4.4 .

15.4.4.2 – Piping for Oxygen and Nitrous Oxide Systems.

15.4.4.2.1 – Cleaning for Oxygen Service.

15.4.4.2.1.1 –

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* .

15.4.4.2.1.2 –

Fittings shall be permitted to be cleaned by a supplier or agency other than the manufacturer.

15.4.4.2.2 – 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

(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:

(3) Having a design margin of 3.5

(4) Externally coated with a nonmetallic sheath marked with the manufacturer's marking

(5) Listing includes testing to demonstrate that CMT systems can be consistently gas-purged with results equivalent to comparable medical gas copper tubing

15.4.4.2.2.1 –

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* .

15.4.4.2.2.2 –

CMT shall be identified by the manufacturer as suitable for oxygen service at a minimum of every 0.92 m (3 ft).

15.4.4.2.3 – Fittings.

15.4.4.2.3.1 –

Fittings shall be brazed, memory metal, or axially swaged.

15.4.4.2.3.2 –

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

15.4.4.2.3.3 –

Cast copper alloy fittings shall not be used with field-brazed joints.

15.4.4.2.3.4 –

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.

15.4.4.2.3.5 –

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.

15.4.4.2.4 – Joints.

15.4.4.2.4.1 – Brazed.

Brazing of copper joints shall be in accordance with 15.4.6 .

15.4.4.2.4.2 – 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.

15.4.4.2.4.3 – Prohibited Joints.

The following joints shall be prohibited under 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

15.4.4.3 – Piping for Dental Air Systems.

15.4.4.3.1 – General.

Pipe, fittings, and joints in piping for dental compressed air systems shall be in accordance with 15.4.4.3.2 through 15.4.4.3.4 .

15.4.4.3.2 – 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:

(5) Having a design margin of 3.5

(6) Externally coated with a nonmetallic sheath marked with the manufacturer's marking

(7) Listing includes testing to demonstrate that CMT systems can be consistently gas purged with results equivalent to comparable medical gas copper tubing

15.4.4.3.2.1 –

Copper tube shall be hard temper or annealed (soft temper).

15.4.4.3.3 – 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*

(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 15.4.4.2.3.5

15.4.4.3.4 – Joints.

Joints for piping under 15.4.4.3 shall comply with 15.4.4.3.4.1 through 15.4.4.3.4.3 .

15.4.4.3.4.1 –

Joints shall be brazed, soldered, threaded, flared, or the compression type.

15.4.4.3.4.2 –

Where joints are brazed, they shall comply with the requirements of 15.4.6 .

15.4.4.3.4.3 –

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* .

15.4.4.4 – Piping for Dental Vacuum Systems and Scavenging Systems.

15.4.4.4.1 – General.

Piping for dental vacuum systems and scavenging systems shall be copper, PVC plastic, or CPVC plastic.

15.4.4.4.2 – 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 .

15.4.4.4.2.1 – 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)

15.4.4.4.2.2 – 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)

15.4.4.4.2.3 – 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* .

15.4.4.4.3 – 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* .

(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* .

15.4.4.4.4 – 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 1 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* .

(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* .

15.4.4.5 – Piping for Nitrogen.

Nitrogen piping in dental facilities shall comply with 15.4.4.2 , including cleaning for oxygen service.

15.4.5 – Installation of Medical Gas, Dental Air, and Vacuum Piping.

15.4.5.1 – General.

15.4.5.1.1 –

Gas and vacuum piping systems shall be as listed in Section 15.4 .

15.4.5.1.2 –

Piping materials shall be as listed in 15.4.4 .

15.4.5.2 – Pipe Sizing.

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

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 3/8 in.) (1/2 in. O.D.) size.

(2) Category 2 nitrous oxide piping shall be not less than DN8 (NPS 1/4 in.) (3/8 in. O.D.) size.

(3) Category 2 oxygen piping shall be at least 1 size larger than piping for nitrous oxide.

15.4.5.4 – Location of Piping.

Piping shall not be located where subject to contact with oil.

15.4.5.5 – Protection of Piping.

15.4.5.5.1 –

Piping shall be protected against freezing, corrosion, and physical damage.

15.4.5.5.2 –

Piping exposed in corridors and other locations where subject to physical damage from the movement of equipment shall be protected.

15.4.5.6 – Pipe Support.

15.4.5.6.1 –

Piping shall be supported from the building structure.

15.4.5.6.2 –

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* .

15.4.5.6.3 –

Hangers and supports shall be sized for the tube or pipe being supported.

15.4.5.6.4 –

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.

15.4.5.6.5 –

The maximum support spacing for copper tube shall be in accordance with Table 15.4.5.6.5 .

Table 15.4.5.6.5 Maximum Copper Tube Support Spacing

- Hanger Spacing Pipe Size mm ft DN8 (NPS $\frac{1}{4}$) ($\frac{3}{8}$ in. O.D.) 1520 5 DN10 (NPS $\frac{3}{8}$) ($\frac{1}{2}$ in. O.D.) 1830 6 DN15 (NPS $\frac{1}{2}$) ($\frac{5}{8}$ in. O.D.) 1830 6 DN20 (NPS $\frac{3}{4}$) ($\frac{7}{8}$ in. O.D.) 2130 7 DN25 (NPS 1) (1 $\frac{1}{8}$ in. O.D.) 2440 8 DN32 (NPS 1 $\frac{1}{4}$) (1 $\frac{3}{8}$ in. O.D.) 2740 9 DN40 (NPS 1 $\frac{1}{2}$) (1 $\frac{5}{8}$ in. O.D.) and larger 3050 10 Vertical risers, all sizes, every floor, but not to exceed 4570 15

15.4.5.6.6 –

The maximum support spacing for plastic pipe shall be in accordance with Table 15.4.5.6.6 .

Table 15.4.5.6.6 Maximum Plastic Pipe Support Spacing

- Hanger Spacing Pipe Size mm ft DN15 (NPS $\frac{1}{2}$) ($\frac{5}{8}$ in. O.D.) 1220 4 DN20 (NPS $\frac{3}{4}$) ($\frac{7}{8}$ in. O.D.) 1220 4 DN25 (NPS 1) (1 $\frac{1}{8}$ in. O.D.) 1320 4.33 DN32 (NPS 1 $\frac{1}{4}$) (1 $\frac{3}{8}$ in. O.D.) 1320 4.33 DN40 (NPS 1 $\frac{1}{2}$) (1 $\frac{5}{8}$ in. O.D.) 1420 4.66 DN50 (NPS 2) (2 $\frac{3}{8}$ in. O.D.) 1420 4.66 DN65 (NPS 2 $\frac{1}{2}$) (2 $\frac{7}{8}$ in. O.D.) and larger 1520 5 Vertical risers, all sizes, every floor, but not to exceed 3040 10

15.4.5.7 – Underground Piping Outside of Buildings.

15.4.5.7.1 –

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

15.4.5.7.2 –

The installation procedure for underground piping shall prevent physical damage to the piping while being backfilled.

15.4.5.7.3 –

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.

15.4.5.7.4 –

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.

15.4.5.7.5 –

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.

15.4.5.7.6 –

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

15.4.5.7.7 –

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

15.4.5.7.8 –

A continuous warning tape or marker shall be placed immediately above the piping or its enclosure to clearly identify the pipeline by specific name.

15.4.5.7.9 –

A continuous warning means shall also be placed above the pipeline at approximately one-half the depth of burial.

15.4.5.7.10 –

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.

15.4.5.8 – Underground Piping Within Buildings.

15.4.5.8.1 –

The installation procedure for underground piping shall prevent physical damage to the piping while being backfilled.

15.4.5.8.2 –

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.

15.4.5.8.3 –

The piping shall be backfilled with clean sand or gravel.

15.4.5.9 – Piping Within Floor Slabs Prohibited.

Dental gas and vacuum piping shall not be installed within floor slabs.

15.4.5.10 – Hose and Flexible Connectors.

15.4.5.10.1 –

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.

15.4.5.10.2 –

Hose and flexible connectors, metallic or nonmetallic, shall have a minimum burst gauge pressure of 6895 kPa (1000 psi).

15.4.5.10.3 –

Medical gas hose and flexible connectors shall be oxygen compatible.

15.4.5.10.4 –

Hose and flexible connectors shall be clearly identified as to the gas content.

15.4.5.10.5 –

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.

15.4.6 – Brazing Copper Tubing.

15.4.6.1 – Qualification of Brazing Procedures and Brazers.

15.4.6.1.1 –

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 .

15.4.6.1.2 –

Brazers shall be qualified by visual examination of the test coupons followed by sectioning.

15.4.6.1.3 –

The brazing procedure specification shall address cleaning, joint clearance, overlap, internal purge gas, purge gas flow rate, and filler metal.

15.4.6.1.4 –

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.

15.4.6.1.5 –

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.

15.4.6.1.6 –

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.

15.4.6.1.7 –

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.

15.4.6.2 – Brazed Joints.

15.4.6.2.1 –

Brazed tube joints shall be of the socket type.

15.4.6.2.2 –

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.

15.4.6.2.3 –

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

15.4.6.2.4 –

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

15.4.6.2.5 –

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

15.4.6.2.6 –

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

15.4.6.3 – Cutting Tube Ends.

15.4.6.3.1 –

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

15.4.6.3.2 –

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

15.4.6.3.3 –

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.

15.4.6.4 – Cleaning Joints for Brazing.

15.4.6.4.1 –

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.

15.4.6.4.2 –

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.

15.4.6.4.3 –

Nonabrasive pads shall be used to clean the exterior surfaces of tube ends.

15.4.6.4.4 –

The use of steel wool, sand cloth, or wire brushes shall be prohibited.

15.4.6.4.5 –

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

15.4.6.4.6 –

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

15.4.6.4.7 –

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.

15.4.6.4.8 –

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

15.4.6.4.9 –

Joints shall be brazed within 8 hours after being cleaned for brazing.

15.4.6.5 – Brazing Dissimilar Metals.

15.4.6.5.1 –

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).

15.4.6.5.2 –

Cast metals shall not be field brazed.

15.4.6.5.3 –

Surfaces shall be cleaned for brazing in accordance with 15.4.6.4 .

15.4.6.5.4 –

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

15.4.6.5.5 –

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.

15.4.6.5.6 –

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.

15.4.6.5.7 –

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.

15.4.6.6 – Nitrogen Purge.

15.4.6.6.1 –

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.

15.4.6.6.2 –

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

15.4.6.6.3 –

The nitrogen purge gas flow rate shall not be high enough to produce a positive pressure in the piping system.

15.4.6.6.4 –

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

15.4.6.6.5 –

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

15.4.6.6.6 –

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.

15.4.6.6.7 –

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.

15.4.6.6.8 –

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

15.4.6.6.9 –

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.

15.4.6.7 – Assembling and Heating Brazed Joints.

15.4.6.7.1 –

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* .

15.4.6.7.2 –

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

15.4.6.7.3 –

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.

15.4.6.7.4 –

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* .

15.4.6.8 – Inspection of Brazed Joints.

15.4.6.8.1 –

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.

15.4.6.8.2 –

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

15.4.6.8.3 –

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

15.4.6.8.4 –

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 15.4.7.4.4)* and standing pressure test *(see 15.4.7.4.6)*

15.4.6.8.5 –

Joints that are identified as defective under conditions specified in 15.4.6.8.4(2) or 15.4.6.8.4(5) shall be replaced.

15.4.6.8.6 –

Joints that are found to be defective under conditions specified in 15.4.6.8.4(1) , 15.4.6.8.4(3) , 15.4.6.8.4(4) , 15.4.6.8.4(6) , or 15.4.6.8.4(7) shall be permitted to be repaired, except that no joint shall be reheated more than once before being replaced.

15.4.7 – Performance Criteria and Testing (Oxygen and Nitrous Oxide).

15.4.7.1 – Testing and Verification.

15.4.7.1.1 – General.

15.4.7.1.1.1 –

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.

15.4.7.1.1.2 –

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.

15.4.7.1.1.3 –

Reports shall contain detailed listings of all findings and results.

15.4.7.1.1.4 –

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.

15.4.7.1.1.5 –

All documentation pertaining to inspections and testing shall be maintained on-site within the facility.

15.4.7.2 – Required Testing and Verification.

15.4.7.2.1 – 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 15.4.7.4 .

15.4.7.2.2 –

The oxygen and nitrous oxide piping systems shall be verified in accordance with 15.4.7.5 .

15.4.7.3 – Qualification of System Testers and Verifiers (Oxygen and Nitrous Oxide).

15.4.7.3.1 –

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 15.4.7.3.2 .

15.4.7.3.2 –

Individuals who verify the oxygen and nitrous oxide piping systems shall be certified to ASSE 6030, *Professional Qualifications Standard for Medical Gas Systems Verifiers* .

15.4.7.4 – Initial Testing of Piping Systems (Oxygen and Nitrous Oxide).

15.4.7.4.1 – General.

15.4.7.4.1.1 –

The initial tests required by 15.4.7.4 shall be performed prior to either the final tests or the verification tests listed in 15.4.7.5 .

15.4.7.4.1.2 –

The test gas for gas piping systems shall be oil-free, dry nitrogen NF.

15.4.7.4.1.3 –

Where manufactured assemblies are to be installed, the initial tests required by 15.4.7.4 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

15.4.7.4.1.4 –

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.

15.4.7.4.1.5 –

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.

15.4.7.4.1.6 –

During the process of initial testing, the identification and labeling of the medical gas and vacuum piping shall be checked.

15.4.7.4.2 – 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).

15.4.7.4.3 – Initial Cross-Connection Test for Copper Piping Systems.

15.4.7.4.3.1 –

Copper piping shall not be tested before any plastic piping.

15.4.7.4.3.2 –

It shall be determined that no cross-connections exist between the various medical gas and vacuum piping systems.

15.4.7.4.3.3 –

All piping systems shall be reduced to atmospheric pressure.

15.4.7.4.3.4 –

Sources of test gas shall be disconnected from all piping systems except for the one system being tested.

15.4.7.4.3.5 –

The system under test shall be charged with oil-free, dry nitrogen NF to a gauge pressure of 345 kPa (50 psi).

15.4.7.4.3.6 –

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.

15.4.7.4.3.7 –

The initial cross-connection test in 15.4.7.4.3 shall be repeated for each installed medical gas and vacuum piping system with copper piping.

15.4.7.4.3.8 –

Any cross-connections shall be removed and the associated piping repaired and leak tested.

15.4.7.4.3.9 –

The proper labeling and identification of system outlets/inlets shall be confirmed during these tests.

15.4.7.4.4 – Initial Pressure Test.

15.4.7.4.4.1 –

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.

15.4.7.4.4.2 –

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)

15.4.7.4.4.3 –

The source shutoff valve shall remain closed during the pressure tests.

15.4.7.4.4.4 –

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).

15.4.7.4.4.5 * –

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.

15.4.7.4.4.6 –

Any leaks shall be located, repaired (if permitted), or replaced (if required) by the installer, and retested.

15.4.7.4.5 – Initial Piping Purge Test.

15.4.7.4.5.1 –

The outlets in each oxygen and nitrous oxide piping system shall be purged to remove any particulate matter from the distribution piping.

15.4.7.4.5.2 –

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.

15.4.7.4.5.3 –

The purging shall be started at the closest outlet to the piping shutoff valve and continue to the furthest outlet from the shutoff valve.

15.4.7.4.6 – Standing Pressure Test for Oxygen and Nitrous Oxide Piping.

15.4.7.4.6.1 –

After successful completion of the initial pressure tests in 15.4.7.4.4 , the gas distribution piping shall be subject to a standing pressure test.

15.4.7.4.6.2 –

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).

15.4.7.4.6.3 –

The source valve shall be closed during this test.

15.4.7.4.6.4 –

The piping systems shall be subjected to 24-hour standing pressure tests using oil-free, dry nitrogen NF.

15.4.7.4.6.5 –

Test pressures shall be 20 percent above the normal system operating line pressure.

15.4.7.4.6.6 –

At the conclusion of the tests, there shall be no change in the test pressure except that attributed to specific changes in ambient temperature.

15.4.7.4.6.7 –

Any leaks shall be located, repaired (if permitted), or replaced (if required) by the installer, and retested. The piping shall be repurged if necessary.

15.4.7.4.6.8 –

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 .

15.4.7.5 – Verification of Piping Systems (Oxygen and Nitrous Oxide).

15.4.7.5.1 – General.

15.4.7.5.1.1 –

The oxygen and nitrous oxide piping systems requiring initial testing and verification shall be as indicated in 15.4.7.2 for the different dental facilities.

15.4.7.5.1.2 –

Required verification of oxygen and nitrous oxide piping systems shall be performed only after all initial tests required in 15.4.7.4 have been completed.

15.4.7.5.1.3 –

The test gas shall be oil-free, dry nitrogen NF or the system gas or vacuum where permitted.

15.4.7.5.1.4 –

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* .

15.4.7.5.1.5 –

Verification shall be performed by a party other than the installing contractor.

15.4.7.5.1.6 –

All required verification tests shall be performed after installation of any manufactured assemblies supplied through tubing or flexible hose.

15.4.7.5.1.7 –

Where there are multiple possible connection points for terminals, each possible position shall be tested independently.

15.4.7.5.1.8 –

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.

15.4.7.5.1.9 –

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.

15.4.7.5.2 – 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.

15.4.7.5.3 – 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.

15.4.7.5.4 – Verifier Piping Purge Test.

15.4.7.5.4.1 –

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.

15.4.7.5.4.2 –

The appropriate adapter shall be obtained and high purge rates of at least 225 Nl/min (8 SCFM) shall be put on each outlet.

15.4.7.5.4.3 –

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.

15.4.7.5.4.4 –

To avoid possible damage to the outlet and its components, this test shall not be conducted using any implement other than the proper adapter.

15.4.7.5.4.5 –

No pronounced or objectionable odor shall be discernible from any positive-pressure outlet.

15.4.7.5.5 – Verifier Piping Particulate Test.

15.4.7.5.5.1 –

For each oxygen and nitrous oxide system, the cleanliness of the piping system shall be verified.

15.4.7.5.5.2 –

The test shall be performed with the use of oil-free, dry nitrogen NF.

15.4.7.5.5.3 –

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).

15.4.7.5.5.4 –

Twenty five percent of the zones shall be tested at the outlet most remote from the source.

15.4.7.5.5.5 –

The filter shall accrue no more than 0.001 g (1 mg) of matter from any outlet tested.

15.4.7.5.5.6 –

If any outlet fails this test, the most remote outlet in every zone shall be tested.

15.4.7.5.6 – Verifier Piping Purity Test.

15.4.7.5.6.1 –

For each oxygen and nitrous oxide system, the purity of the piping system shall be verified in accordance with 15.4.7.5.6 .

15.4.7.5.6.2 –

These tests shall be performed with oil-free, dry nitrogen NF or the system gas.

15.4.7.5.6.3 –

The outlet most remote from the source shall be tested for total nonmethane hydrocarbons and compared to the test of the source gas.

15.4.7.5.6.4 –

If the system gas is used as the source gas, it shall be tested at the source equipment.

15.4.7.5.6.5 –

The difference between the two tests shall in no case exceed 5 ppm of total nonmethane hydrocarbons.

15.4.7.5.6.6 –

The difference between the two tests shall in no case exceed 5 ppm of halogenated hydrocarbons.

15.4.7.5.6.7 –

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).

15.4.7.5.7 – Verifier Final Tie-in Test.

15.4.7.5.7.1 –

Prior to the connection of any work or any extension or addition to an existing piping system, the verification tests in 15.4.7.5 shall be successfully performed on the new work.

15.4.7.5.7.2 –

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.

15.4.7.5.7.3 –

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 15.4.7.5.4 .

15.4.7.5.7.4 –

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 15.4.7.5.8 and 15.4.7.5.9 .

15.4.7.5.7.5 –

Permanent records of these tests shall be maintained.

15.4.7.5.8 – Verifier Operational Pressure Test.

15.4.7.5.8.1 –

Operational pressure tests shall be performed at each station outlet or terminal where the user makes connections and disconnections.

15.4.7.5.8.2 –

Tests shall be performed with the gas of system designation.

15.4.7.5.8.3 –

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).

15.4.7.5.9 – 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:

(4) Oxygen ≥99 percent

(5) Nitrous oxide ≥99 percent

(6) Other gases ±1 percent unless otherwise specified

15.4.8 – Performance Criteria and Testing (Dental Air and Vacuum).

15.4.8.1 – Dental Air and Vacuum Systems Testing.

15.4.8.1.1 – General.

15.4.8.1.1.1 –

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.

(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.

15.4.8.1.1.2 –

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.

15.4.8.1.1.3 –

Reports shall contain detailed listings of all findings and results.

15.4.8.1.1.4 –

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.

15.4.8.1.1.5 –

All documentation pertaining to inspections and testing shall be maintained on-site within the facility.

15.4.8.1.2 – Category 2 Dental Air and Vacuum Systems.

15.4.8.1.2.1 –

All Category 2 dental air and vacuum piping systems indicated in 15.4.3 shall be initially tested in accordance with 15.4.8.1 .

15.4.8.1.2.2 –

Dental air, vacuum, and scavenging systems shall be final tested in accordance with 15.4.8.1.7 and 15.4.8.1.8 .

15.4.8.1.3 – Initial Testing of Piping Systems.

15.4.8.1.3.1 –

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.

15.4.8.1.3.2 –

During the process of initial testing, the identification and labeling of the dental gas and vacuum piping shall be checked.

15.4.8.1.4 – Initial Cross-Connection Test for Plastic Vacuum and Plastic Scavenging Piping Systems.

15.4.8.1.4.1 –

Plastic piping shall be tested before copper piping.

15.4.8.1.4.2 –

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.

15.4.8.1.4.3 –

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.

15.4.8.1.4.4 –

The cross-connection test vacuum shall be a minimum of 300 mm (12 in.) HgV.

15.4.8.1.4.5 –

The source of test vacuum shall be connected only to the vacuum or scavenging piping system being tested.

15.4.8.1.4.6 –

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.

15.4.8.1.4.7 –

The cross-connection tests shall be repeated for each installed vacuum and scavenging system with plastic piping.

15.4.8.1.4.8 –

Any cross-connections shall be removed and the associated piping repaired and leak tested.

15.4.8.1.4.9 –

The proper labeling and identification of system outlets/inlets shall be confirmed during the initial tests.

15.4.8.1.5 – Initial Pressure Test.

15.4.8.1.5.1 –

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.

15.4.8.1.5.2 –

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)

15.4.8.1.5.3 –

The source shutoff valve shall remain closed during the pressure tests.

15.4.8.1.5.4 –

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).

15.4.8.1.5.5 –

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.

15.4.8.1.5.6 –

Any leaks shall be located, repaired (if permitted) or replaced (if required) by the installer, and retested.

15.4.8.1.6 – Initial Piping Purge Test.

15.4.8.1.6.1 –

The outlets in each dental air piping system shall be purged to remove any particulate matter from the distribution piping.

15.4.8.1.6.2 –

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.

15.4.8.1.6.3 –

The purging shall be started at the closest outlet to the piping shutoff valve and continue to the furthest outlet from the shutoff valve.

15.4.8.1.7 – Standing Pressure Test for Dental Air and Copper Vacuum Piping.

15.4.8.1.7.1 –

After successful completion of the initial pressure tests in 15.4.8.1 , the dental air systems and copper vacuum systems shall be subject to a standing pressure test.

15.4.8.1.7.2 –

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).

15.4.8.1.7.3 –

The source valve shall be closed during this test.

15.4.8.1.7.4 –

The piping systems shall be subjected to 24-hour standing pressure tests using oil-free, dry nitrogen NF.

15.4.8.1.7.5 –

Test pressures shall be 20 percent above the normal system operating line pressure.

15.4.8.1.7.6 –

At the conclusion of the tests, there shall be no change in the test pressure, except that attributed to specific changes in ambient temperature.

15.4.8.1.7.7 –

Any leaks shall be located, repaired (if permitted) or replaced (if required) by the installer, and retested. The piping shall be repurged if necessary.

15.4.8.1.8 – Standing Vacuum Test for Plastic Vacuum Piping.

15.4.8.1.8.1 –

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.

15.4.8.1.8.2 –

Tests shall be conducted after installation and connection of all components of the vacuum system.

15.4.8.1.8.3 –

The piping systems shall be subjected to a 24-hour standing vacuum test.

15.4.8.1.8.4 –

Test pressure shall be between 300 mm (12 in.) HgV and full vacuum.

15.4.8.1.8.5 –

During the test, the source of test vacuum shall be disconnected from the piping system.

15.4.8.1.8.6 –

At the conclusion of the test, there shall be no change in the vacuum pressure other than that attributed to changes of ambient temperature.

15.4.8.1.8.7 –

Any leaks shall be located, repaired (if permitted), or replaced (if required) by the installer, and retested.

15.4.9 – Operation and Management.

15.4.9.1 – System Shutdowns.

15.4.9.1.1 –

Gas and vacuum piping systems shall be shut down at the end of each workday.

15.4.9.1.2 –

Emergency shutoff valves or remote actuators shall not be used for daily shutdown of the systems.

15.4.9.1.3 –

Cylinder gas valves shall be used for daily shutdowns.

15.4.9.2 – Prohibited Interconnections.

Two or more piping systems for different gases or different vacuums shall not be interconnected for testing or any other reason.

15.4.9.3 – Manufacturer's Instructions.

15.4.9.3.1 –

Piping system components shall be installed, adjusted, operated, and maintained in accordance with the manufacturer's instructions.

15.4.9.3.2 –

Copies of the manufacturer's instructions shall be provided to the facility and maintained at the facility.

15.4.9.4 – Maintenance.

15.4.9.4.1 –

Gas and vacuum system equipment shall be maintained by a qualified person.

15.4.9.4.2 –

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.

15.4.9.5 – Periodic Testing.

Station outlets for oxygen and nitrous oxide shall be tested for flow and pressure on an approved schedule.

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.

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 –

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 ($\frac{1}{4}$ 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:

(5) Having a design margin of 3.5

(6) Externally coated with a nonmetallic sheath marked with the manufacturer's marking

(7) 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:

(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 ($\frac{3}{4}$ 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 ($\frac{3}{4}$ 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* .

(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 7/8 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 –

The installation procedure for underground piping shall prevent physical damage to the piping while being backfilled.

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 backfilled.

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.

(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) –

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.~~

[SEE ATTACHED WORD FILE]

Submitter Information Verification

Committee: HEA-PIP

Submittal Date: Thu Aug 08 12:38:42 EDT 2024

Committee Statement

Committee Statement: 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.” It is suggested that individuals who wish to submit Public Comments on the CI do so via Global Public Comments at the second draft stage indicating what in the CI is proposed to be revised.

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.

Response Message: CI-1166-NFPA 99-2024

Public Input No. 327-NFPA 99-2024 [Section No. 15.1]

Public Input No. 342-NFPA 99-2024 [Chapter 15]