

# 2015 UPC CODE -CHAPTER 13

## HEALTH CARE FACILITIES AND MEDICAL GAS AND MEDICAL VACUUM SYSTEMS

### Part I – General Requirements.

#### **1301.0 General.**

**1301.1 Applicability.** This chapter applies to the special fixtures and systems in health care facilities; the special plumbing requirements for such facilities; and the installation, testing, and verification of Categories 1, 2, and 3 medical gas and medical vacuum piping systems, except as otherwise indicated in this chapter, from the central supply system to the station outlets or inlets in hospitals, clinics, and other health care facilities. Other plumbing in such facilities shall comply with other applicable sections of this code. For Category 3 medical gas systems, only oxygen and nitrous oxide shall be used.

**1301.2 Where Not Applicable.** This chapter does not apply to the following except as otherwise addressed in this chapter:

- (1) Cylinder and container management, storage, and reserve requirements
- (2) Bulk supply systems
- (3) Electrical connections and requirements
- (4) Motor requirements and controls
- (5) Systems having nonstandard operating pressures
- (6) Waste anesthetic gas disposal (WAGD) systems
- (7) Surface-mounted medical gas rail systems
- (8) Breathing air replenishment (BAR) systems
- (9) Portable compressed gas systems
- (10) Medical support gas systems
- (11) Gas-powered device supply systems
- (12) Scavenging systems

**1301.3 Conflict of Requirements.** The requirements of this chapter shall not be interpreted to conflict with the requirements of NFPA 99. For requirements of portions of medical gas and medical vacuum systems not addressed in this chapter or medical gas and medical vacuum systems beyond the scope of this chapter refer to NFPA 99.

**1301.4 Terms.** Where the term “medical gas” occurs, the provisions shall apply to piped systems for oxygen, nitrous oxide, medical air, carbon dioxide, helium, nitrogen, instrument air, and mixtures thereof. Where the name of a specific gas service occurs, the provision shall apply to that gas. [NFPA 99:5.1.1.2] Where the term “medical vacuum” occurs, the provisions shall apply to systems for piped medical-surgical vacuum. Where the name of a specific vacuum service occurs, the provision shall apply to that vacuum service. [NFPA 99:5.1.1.3]

**1301.5 Where Required.** Construction and equipment requirements shall be applied to new construction and new equipment, except as otherwise addressed in this chapter. [NFPA 99:1.3.2]

**1301.6 Existing Systems.** The altered, renovated, or modernized portion of an existing system or individual component shall be required to meet the installation and equipment requirements stated in this chapter. Where the alteration, renovation, or modernization adversely impacts existing performance requirements of a system or component, additional upgrading shall be required. An existing system that does not comply with the provisions of this chapter shall be permitted to be continued in use where the Authority Having Jurisdiction has determined that such use does not constitute a distinct hazard to life. [NFPA 99:1.3.2.1 – 1.3.2.3]

## **1302.0 Design Requirements.**

**1302.1 Building System Categories.** Building systems in health care facilities shall be designed in accordance with Category 1 through Category 3 requirements as detailed in this chapter. [NFPA 99:4.1]

**1302.2 Patient Care Rooms.** The governing body of the facility or its designee shall establish the following areas in accordance with the type of patient care anticipated:

- (1) Critical care rooms
- (2) General care rooms
- (3) Basic care rooms [NFPA 99:1.3.4.1]

**1302.3 Anesthetizing Locations.** It shall be the responsibility of the governing body of the health care organization to designate anesthetizing locations. [NFPA 99:1.3.4.2]

*Exception: Deep sedation and general anesthesia shall not be administered where using a Category 3 medical gas system. [NFPA 99:5.3.1.5]*

**1302.4 Wet Procedure Locations.** It shall be the responsibility of the governing body of the health care organization to designate wet procedure locations. [NFPA 99:1.3.4.3]

## **1303.0 Health Care Facilities.**

**1303.1 Drinking Fountain Control Valves.** Drinking fountain control valves shall be flush-mounted or fully recessed where installed in corridors or other areas where patients are transported on a gurney, bed, or wheelchair.

**1303.2 Psychiatric Patient Rooms.** Piping and drain traps in psychiatric patient rooms shall be concealed. Fixtures and fittings shall be resistant to vandalism.

**1303.3 Locations for Ice Storage.** Ice makers or ice storage containers shall be located in nursing stations or similarly supervised areas to minimize potential contamination.

**1303.4 Sterilizers and Bedpan Steamers.** Sterilizers and bedpan steamers shall be installed in accordance with the manufacturer's installation instructions and comply with Section 1303.4.1 and Section 1303.4.2.

**1303.4.1 Drainage Connections.** Sterilizers and bedpan steamers shall be connected to the sanitary drainage system through an air gap in accordance with Section 801.2. The size of indirect waste piping shall be not less than the size of the drain connection on the fixture. Each such indirect waste pipe shall not exceed 15 feet (4572 mm) in length and shall be separately piped to a receptor. Such receptors shall be located in the same room as the equipment served. Except for bedpan steamers, such indirect waste pipes shall not require traps. A trap having a seal of not less than 3 inches (76 mm) shall be provided in the indirect waste pipe for a bedpan steamer.

**1303.4.2 Vapor Vents and Stacks.** Where a sterilizer or bedpan steamer has provision for a vapor vent and such a vent is required by the manufacturer, the vent shall be extended to the outdoors above the roof. Sterilizer and bedpan steamer vapor vents shall be installed in accordance with the manufacturer's installation instructions and shall not be connected to a drainage system vent.

**1303.5 Aspirators.** Provisions for aspirators or other water-supplied suction devices shall be installed with the specific approval of the Authority Having Jurisdiction. Where aspirators are used for removing body fluids, they shall include a collection container to collect liquids and solid particles. Aspirators shall indirectly discharge to the sanitary drainage system through an air gap in accordance with Section 806.1. The potable water supply to an aspirator shall be protected by a vacuum breaker or equivalent backflow protection device in accordance with Section 603.5.9.

**1303.6 Drains.** Drains shall be installed on dryers, after-coolers, separators, and receivers.

**1303.7 Clinical Sinks.** Clinical sinks shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 1303.7.1.

**1303.7.1 Drainage Connection.** Clinical sinks shall be directly connected to the sanitary drainage system, and shall be provided with approved flushing devices installed in accordance with Section 413.1.

**1303.8 Water Supply for Hospitals.** Hospitals shall be provided with not less than two approved potable water sources that are installed in such a manner as to prevent the interruption of water service.

## **1304.0 Medical Gas and Medical Vacuum Piping Systems.**

**1304.1 General.** The installation of medical gas and medical vacuum piping systems shall comply with the requirements of this chapter.

**1304.2 Manufacturer's Instructions.** The installation of individual components shall comply with the manufacturer's installation instructions. Such instructions shall include directions and information deemed by the manufacturer to be adequate for attaining proper operation, testing, and maintenance of the medical gas and medical vacuum systems. Copies of the manufacturer's instructions shall be left with the system owner. [NFPA 99:5.1.10.11.8]

**1304.3 Supply Source.** Medical gas and medical vacuum systems shall be supplied from a central supply source of not less than two units, primary and secondary, consisting of one of the following:

- (1) Two cylinder banks with not less than two cylinders in each bank.
- (2) Not less than two air compressors.
- (3) Not less than two vacuum pumps.
- (4) A proportioning system for medical air USP.

*Exception: A single Category 3 medical gas source system shall not supply more than two adjoining single treatment facilities. [NFPA 99:5.3.1.1.4]*

**1304.4 Certification of Systems.** Certification of medical gas and medical vacuum systems shall comply with the requirements of Section 1320.0.

**1304.5 Construction Documents.** Before a medical gas or medical vacuum system is installed or altered in a hospital, medical facility, or clinic, duplicate construction documents shall be filed

with the Authority Having Jurisdiction. Approval of the plans shall be obtained prior to issuance of a permit by the Authority Having Jurisdiction.

**1304.5.1 Requirements.** Construction documents shall show the following:

- (1) Plot plan of the site, drawn to scale, indicating the location of existing or new cylinder storage areas, property lines, driveways, and existing or proposed buildings.
- (2) Piping layout of the proposed piping system or alteration, including alarms, valves, origin of gases, user outlets, and user inlets. The demand and loading of a piping, existing or future, shall also be indicated.
- (3) Complete specification of materials.

**1304.5.2 Extent of Work.** Construction documents submitted to the Authority Having Jurisdiction shall clearly indicate the nature and extent of the work proposed and shall show in detail that such work will be in accordance with the provisions of this chapter.

**1304.5.3 Record.** A record of as-built plans and valve identification records shall remain on the site.

**1305.0 System Performance.**

**1305.1 Required Operating Pressures.** Medical gas and medical vacuum systems shall be capable of delivering service in the pressure ranges listed in Table 1305.1.

**1305.2 Minimum Flow Rates.** Medical gas and medical vacuum systems shall be capable of supplying the flow rates listed in Table 1305.2.

**1305.3 Minimum Station Outlets and Inlets.** Station outlets and inlets for medical gas and medical vacuum systems shall be provided as listed in Table 1305.3.

**TABLE 1305.1**  
**STANDARD DESIGNATION COLORS AND OPERATING PRESSURES FOR MEDICAL GAS AND MEDICAL VACUUM SYSTEMS**  
**[NFPA 99:TABLE 5.1.11]**

| GAS SERVICE                                     | ABBREVIATED NAME                                               | COLORS (BACKGROUND/TEXT)                                     | STANDARD GAUGE PRESSURE |
|-------------------------------------------------|----------------------------------------------------------------|--------------------------------------------------------------|-------------------------|
| Medical air                                     | Med Air                                                        | Yellow/black                                                 | 50–55 psi               |
| Carbon dioxide                                  | CO <sub>2</sub>                                                | Gray/black or gray/white                                     | 50–55 psi               |
| Helium                                          | He                                                             | Brown/white                                                  | 50–55 psi               |
| Nitrogen                                        | N <sub>2</sub>                                                 | Black/white                                                  | 160–185 psi             |
| Nitrous oxide                                   | N <sub>2</sub> O                                               | Blue/white                                                   | 50–55 psi               |
| Oxygen                                          | O <sub>2</sub>                                                 | Green/white or white/green                                   | 50–55 psi               |
| Oxygen/carbon dioxide mixtures                  | O <sub>2</sub> /CO <sub>2</sub> n% (n = % of CO <sub>2</sub> ) | Green/white                                                  | 50–55 psi               |
| Medical–surgical vacuum                         | Med Vac                                                        | White/black                                                  | 15 inch to 30 inch HgV  |
| Waste anesthetic gas disposal                   | WAGD                                                           | Violet/white                                                 | Varies with system type |
| Other mixtures                                  | Gas A%/ Gas B%                                                 | Colors as above; major gas for background/minor gas for text | None                    |
| Nonmedical air ( Category 3 gas-powered device) | —                                                              | Yellow-and-white diagonal stripe/black                       | None                    |
| Nonmedical and Category 3 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                                                    | 160–185 psi             |

For SI units: 1 pound-force per square inch = 6.8947 kPa, 1 inch of mercury vacuum (HgV) = 3.386 kPa

**TABLE 1305.2**  
**MINIMUM FLOW RATES (cubic feet per minute)**

| MEDICAL SYSTEM         | FLOW RATE                       |
|------------------------|---------------------------------|
| Oxygen                 | .71 CFM per outlet <sup>1</sup> |
| Nitrous Oxide          | .71 CFM per outlet <sup>1</sup> |
| Medical Compressed Air | .71 CFM per outlet <sup>1</sup> |
| Nitrogen               | 15 CFM free air per outlet      |
| Vacuum                 | 1 SCFM per inlet <sup>2</sup>   |
| Carbon Dioxide         | .71 CFM per outlet <sup>1</sup> |
| Helium                 | .71 CFM per outlet              |

For SI units: 1 cubic foot per minute (CFM) = 0.47 L/s

**Notes:**

<sup>1</sup> A room designed for a permanently located respiratory ventilator or anesthesia machine shall have an outlet capable of a flow rate of 6.36 CFM (3.0 L/s) at the station outlet.

<sup>2</sup> For testing and certification purposes, individual station inlets shall be capable of a flow rate of 3 SCFM, while maintaining a system pressure of not less than 12 inches of mercury (41 kPa) at the nearest adjacent vacuum inlet.

## **1306.0 Qualifications of Installers.**

**1306.1 General.** The installation of medical gas and medical vacuum systems shall be made by qualified, competent technicians who are experienced in performing such installations. Installers of medical gas and medical vacuum piped distribution systems, appurtenant piping supporting pump and compressor source systems, and appurtenant piping supporting source gas manifold

systems not including permanently installed bulk source systems, shall be certified in accordance with ASSE 6010. [NFPA 99:5.1.10.11.10.1, 5.1.10.11.10.2]

**1306.2 Brazing.** Brazing shall be performed by individuals who are qualified in accordance with Section 1307.0. [NFPA 99:5.1.10.11.10.4]

**1306.2.1 Documentation.** Prior to installation work, the installer of medical gas and medical vacuum piping shall provide and maintain documentation on the job site for the qualification of brazing procedures and individual brazers that are required in accordance with Section 1307.0. [NFPA 99:5.1.10.11.10.5]

**TABLE 1305.3  
MINIMUM OUTLETS AND INLETS PER STATION**

| LOCATION                                                         | OXYGEN          | MEDICAL VACUUM               | MEDICAL AIR     | NITROUS OXIDE | NITROGEN | HELIUM | CARBON DIOXIDE |
|------------------------------------------------------------------|-----------------|------------------------------|-----------------|---------------|----------|--------|----------------|
| Patient rooms for medical/surgical, obstetrics, and pediatrics   | 1/bed           | 1/bed                        | 1/bed           | —             | —        | —      | —              |
| Examination/treatment for nursing units                          | 1/bed           | 1/bed                        | —               | —             | —        | —      | —              |
| Intensive care (all)                                             | 3/bed           | 3/bed                        | 2/bed           | —             | —        | —      | —              |
| Nursery <sup>1</sup>                                             | 2/bed           | 2/bed                        | 1/bed           | —             | —        | —      | —              |
| General operating rooms                                          | 2/room          | 3/room <sup>4</sup>          | 2/room          | 1/room        | 1/room   | —      | —              |
| Cystoscopic and invasive special procedures                      | 2/room          | 3/room <sup>4</sup>          | 2/room          | —             | —        | —      | —              |
| Recovery delivery and labor/delivery/recovery rooms <sup>2</sup> | 2/bed<br>2/room | 2/bed<br>3/room <sup>4</sup> | 1/bed<br>1/room | —             | —        | —      | —              |
| Labor rooms                                                      | 1/bed           | 1/bed                        | 1/bed           | —             | —        | —      | —              |
| First aid and emergency treatment <sup>3</sup>                   | 1/bed           | 1/bed <sup>4</sup>           | 1/bed           | —             | —        | —      | —              |
| Autopsy                                                          | —               | 1/station                    | 1/station       | —             | —        | —      | —              |
| Anesthesia workroom                                              | 1/station       | —                            | 1/station       | —             | —        | —      | —              |

**Notes:**

<sup>1</sup> Includes pediatric nursery.

<sup>2</sup> Includes obstetric recovery.

<sup>3</sup> Emergency trauma rooms used for surgical procedures shall be classified as general operating rooms.

<sup>4</sup> Vacuum inlets required are in addition to inlets used as part of a scavenging system for removal of anesthetizing gases.

**1306.3 Health Care Organization Personnel.** Health care organization personnel shall be permitted to install piping systems where the requirements of Section 1306.1 through Section 1306.2.1 are met during the installation. [NFPA 99:5.1.10.11.10.6]

## **1307.0 Brazing Procedures.**

**1307.1 General.** Brazing procedures and brazer performance for the installation of medical gas and medical vacuum piping shall be qualified in accordance with Section IX of the ASME Boiler and Pressure Vessel Code or AWS B2.2, both as modified in Section 1307.2 through Section 1307.7. [NFPA 99:5.1.10.11.11.1, 5.3.6.3.1]

**1307.2 Examination.** Brazers shall be qualified by visual examination of the test coupon followed by sectioning. [NFPA 99:5.1.10.11.11.2, 5.3.6.3.2]

**1307.3 Brazing Procedure Specification.** The brazing procedure specification shall address cleaning, joint clearance, overlap, internal purge gas, purge gas flow rate, and filler metal. [NFPA 99:5.1.10.11.11.3, 5.3.6.3.3]

**1307.4 Documentation.** 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 absence of internal oxidation in the completed coupon. [NFPA 99:5.1.10.11.11.4, 5.3.6.3.4]

**1307.5 Procedures.** 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 not less than one brazer following each brazing procedure specification used. [NFPA 99:5.1.10.11.11.5, 5.3.6.3.5]

**1307.6 Conditions of Acceptance.** An employer shall be permitted to accept brazer qualification records of a previous employer under the following conditions:

- (1) The brazer has been qualified following the same or an equivalent procedure that the new employer uses.
- (2) The new employer obtains a copy of the record of brazer performance qualification tests from the previous employer and signs and dates this record, thereby accepting responsibility for the qualifications performed by the previous employer. [NFPA 99:5.1.10.11.11.6, 5.3.6.3.6]

**1307.7 Qualifications.** 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. [NFPA 99:5.1.10.11.11.7, 5.3.6.3.7]

## **Part II – Medical Gas and Medical Vacuum System Piping.**

### **1308.0 Pipe Materials.**

**1308.1 General.** The provisions of this section shall apply to field-installed piping for the distribution of medical gases and medical vacuum systems.

**1308.2 Cleaning.** Tubes, valves, fittings, station outlets, and other piping components in medical gas systems shall have been cleaned for oxygen service by the manufacturer prior to installation in accordance with CGA G-4.1 except that fittings shall be permitted to be cleaned by a supplier or agency other than the manufacturer. [NFPA 99:5.1.10.1.1, 5.3.6.2.2]

Where tube ends, fittings, or other components become contaminated before installation they shall be recleaned in accordance with Section 1311.0.

**1308.3 Delivery.** Each length of tube shall be delivered plugged or capped by the manufacturer and kept sealed until prepared for installation. Fittings, valves, and other components shall be delivered sealed, labeled, and kept sealed until prepared for installation. [NFPA 99:5.1.10.1.2, 5.1.10.1.3]

**1308.4 Tubes for Medical Gas Systems.** Tubes shall be hard-drawn seamless copper ASTM B819 medical gas tube, Type L, except Type K shall be used where operating pressures exceed a gauge pressure of 185 psi (1276 kPa) and the pipe sizes exceed DN80 [(NPS 3) (31 /8 inches O.D.)]. [NFPA 99:5.1.10.1.4]

ASTM B819 medical gas tube shall be identified by the manufacturer's markings "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in blue (Type L) or green (Type K). [NFPA 99:5.1.10.1.5]

**1308.5 Tubes for Medical Vacuum Systems.** Piping for medical vacuum systems shall be constructed of one of the following:

(1) Hard-drawn seamless copper tube in accordance with one of the following:

(a) ASTM B88 copper tube (Type K, L, or M)

(b) ASTM B280 copper ACR tube

(c) ASTM B819 copper medical gas tubing (Type K or L)

(2) Stainless steel tube [NFPA 99:5.1.10.2.1]

**Exceptions:** Piping for Category 3 medical vacuum systems shall be permitted to be as follows:

(1) Schedule 40 or Schedule 80 PVC plastic piping manufactured in accordance with ASTM D1785. [NFPA 99:5.3.8.2.3(1)]

(2) Schedule 40 or Schedule 80 CPVC IPS (iron pipe size) plastic piping manufactured in accordance with ASTM F441. [NFPA 99:5.3.8.2.4(1)]

(3) CPVC CTS (copper tube size) plastic pipe manufactured in accordance with ASTM D2846, 1/2 of an inch (15 mm) through 2 inches (50 mm) in diameter. [NFPA 99:5.3.8.2.4(3)]

## **1309.0 Joints and Connections.**

**1309.1 General.** This section sets forth the requirements for pipe joint installations for a medical gas or medical vacuum system.

**1309.2 Changes in Direction.** Medical gas and medical vacuum systems shall have turns, offsets, and other changes in direction made using the following fittings or joining methods:

(1) Brazed in accordance with Section 1309.3.

(2) Memory metal fittings in accordance with Section 1309.4.1.

(3) Axially swaged, elastic preload fittings in accordance with Section 1309.4.2.

(4) Threaded in accordance with Section 1309.4.3.

(5) Welded in accordance with Section 1309.5. [NFPA 99:5.1.10.3.1]

**Exceptions:** Fittings or joints for Category 3 medical vacuum systems shall be permitted in accordance with the following:

(1) Flared fittings that comply with ASME B16.26. [NFPA 99:5.3.7.2.2(4)]

(2) Compression fittings that do not exceed 3/4 of an inch (20 mm) in size. [NFPA 99:5.3.7.2.2(5)]

(3) Soldered joints shall be made in accordance with ASTM B828 using a lead-free solder filler metal containing not more than 0.2 percent lead by volume in accordance with ASTM B32. [NFPA 99:5.3.7.2.3.3]

(4) Schedule 40 or Schedule 80 PVC plastic pipe fittings manufactured in accordance with ASTM D2466 or ASTM D2467. Joints shall be solvent-cemented in accordance with ASTM D2672. [NFPA 99:5.3.8.2.3(2), 5.3.8.2.3(3)]

(5) Schedule 40 or Schedule 80 CPVC IPS plastic pipe fittings manufactured in accordance with ASTM F438 or ASTM F439, or CPVC CTS plastic pipe fittings manufactured in accordance with ASTM D2846, 1/2 of an inch (15 mm) through 2 inches (50 mm) in diameter. Solvent cement used for joints shall be in accordance with ASTM F493. [NFPA 99:5.3.8.2.4(2) – 5.3.8.2.4(4)]

**1309.2.1 Medical Vacuum Systems.** Medical vacuum systems shall be permitted to have branch connections made using mechanically formed, drilled, and extruded tee-branch connections that are formed in accordance with the tool manufacturer's instructions. Such branch connections shall be joined by brazing in accordance with Section 1309.3. [NFPA 99:5.1.10.3.2]

**1309.3 Brazed Joints and Fittings.** Brazed joints shall be made using a brazing alloy that exhibits a melting temperature in excess of 1000°F (538°C) to retain the integrity of the piping system in the event of fire exposure. [NFPA 99:5.1.10.4.1.3, 5.3.6.4.2]

Fittings for tubes, turns, offsets, and other changes in direction shall be made with wrought-copper capillary fittings in accordance with ASME B16.22 or brazed fittings in accordance with ASME B16.50. [NFPA 99:5.1.10.4.1.1, 5.3.6.2.3] Cast-copper alloy fittings shall not be permitted. [NFPA 99:5.1.10.4.1.2, 5.3.6.2.4]

**1309.3.1 Tube Joints.** Brazed tube joints shall be the socket type. [NFPA 99:5.1.10.4.1.4, 5.3.6.4.1]

**1309.3.2 Filler Metals.** Filler metals shall bond with and be metallurgically compatible with the base metals being joined. [NFPA 99:5.1.10.4.1.5, 5.3.6.4.3]

Filler metals shall comply with AWS A5.8. [NFPA 99:5.1.10.4.1.6, 5.3.6.4.4]

**1309.3.3 Copper-to-Copper Joints.** Copper-to-copper joints shall be brazed using a copper-phosphorus or copper-phosphorus-silver brazing filler metal (BCuP series) without flux. [NFPA 99:5.1.10.4.1.7, 5.3.6.4.5]

**1309.3.4 Accessible.** Joints to be brazed in place shall be accessible for necessary preparation, assembly, heating, filler application, cooling, cleaning, and inspection. [NFPA 99:5.1.10.4.1.9, 5.3.6.4.6]

**1309.3.5 Tube Ends.** Tube ends shall be cut square using a sharp tubing cutter to avoid deforming the tube. [NFPA 99:5.1.10.4.2.1, 5.3.6.5.1]

**1309.3.5.1 Cutting Wheels.** The cutting wheels on tubing cutters shall be free from grease, oil, or other lubricant not approved for oxygen service. [NFPA 99:5.1.10.4.2.2, 5.3.6.5.2]

**1309.3.5.2 Cut Ends.** 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. [NFPA 99:5.1.10.4.2.3, 5.3.6.5.3]

**1309.3.6 Cleaning Procedures.** 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. [NFPA 99:5.1.10.4.3.1, 5.3.6.6.1]

**1309.3.6.1 Exterior Surfaces.** The exterior surfaces of tube ends shall be cleaned prior to brazing to remove surface oxides. [NFPA 99:5.1.10.4.3.2, 5.3.6.6.2]

Where cleaning the exterior surfaces of tube ends, no matter shall be permitted to enter the tube. [NFPA 99:5.1.10.4.3.3]

**1309.3.6.2 Interior Surfaces.** Where the interior surfaces of fitting sockets become contaminated prior to brazing, they shall be recleaned for oxygen in accordance with Section 1311.0 and shall be cleaned for brazing with a clean, oil-free wire brush. [NFPA 99:5.1.10.4.3.4]

**1309.3.6.3 Abrasive Pads.** Clean, nonshedding, abrasive pads shall be used to clean the exterior surfaces of the tube ends. [NFPA 99:5.1.10.4.3.5]

*Exception: For Category 3 systems, nonabrasive pads shall be used to clean the exterior surfaces of tube ends. [NFPA 99:5.3.6.6.3]*

**1309.3.6.4 Prohibited.** The use of steel wool or sand cloth shall be prohibited. [NFPA 99:5.1.10.4.3.6] For Category 3 systems, the use of wire brushes shall also be prohibited. The cleaning process shall not result in grooving of the surfaces to be joined. [NFPA 99:5.1.10.4.3.7, 5.3.6.6.5]

**1309.3.6.5 Wiped.** After being abraded, the surfaces shall be wiped using a clean, lint-free white cloth. [NFPA 99:5.1.10.4.3.8, 5.3.6.6.6]

**1309.3.6.6 Examination.** 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. [NFPA 99:5.1.10.4.3.9, 5.3.6.6.7]

**1309.3.6.7 On-Site Recleaning.** The interior surfaces of tube ends, fittings, and other components that were cleaned for oxygen service by the manufacturer, but become contaminated prior to being installed, shall be permitted to be recleaned in accordance with Section 1311.0.

**1309.3.6.8 Contamination.** Material that has become contaminated shall be cleaned in accordance with Section 1311.0.

**1309.3.6.9 Timeframe for Brazing.** Joints shall be brazed within 8 hours after the surfaces are cleaned for brazing. [NFPA 99:5.1.10.4.3.13, 5.3.6.6.9]

**1309.3.7 Brazing Dissimilar Metals.** Flux shall only be used where brazing dissimilar metals, such as copper and bronze or brass, using a silver (BAg series) brazing filler metal. [NFPA 99:5.1.10.4.4.1, 5.3.6.7.1] **Cast metals shall not be field-brazed.** [NFPA 99:5.3.6.7.2]

**1309.3.7.1 Surface Cleaning.** Surfaces shall be cleaned for brazing in accordance with Section 1309.3.6. [NFPA 99:5.1.10.4.4.2, 5.3.6.7.3]

**1309.3.7.2 Flux.** Flux shall be applied sparingly to minimize contamination of the inside of the tube with flux. [NFPA 99:5.1.10.4.4.3, 5.3.6.7.4]

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. [NFPA 99:5.1.10.4.4.4, 5.3.6.7.5]

**1309.3.7.3 Short Sections of Copper.** Short sections of copper tube shall be brazed onto the non-copper component, and the interior of the subassembly shall be cleaned of flux prior to installation in the piping system. [NFPA 99:5.1.10.4.4.5, 5.3.6.7.6]

**1309.3.7.4 Flux-Coated Brazing Rods.** On joints DN20 (NPS 3/4) (7/8 of an inch 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. [NFPA 99:5.1.10.4.4.6, 5.3.6.7.7]

**1309.3.8 Nitrogen Purge.** Where being brazed, 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. [NFPA 99:5.1.10.4.5.1, 5.3.6.8.1]

**1309.3.8.1 Source.** The source of the purge gas shall be monitored, and the installer shall be audibly alerted where the source content is low. [NFPA 99:5.1.10.4.5.2, 5.3.6.8.2]

**1309.3.8.2 Flow Rate Control.** The purge gas flow rate shall be controlled by the use of a pressure regulator and a flowmeter, or a combination thereof. [NFPA 99:5.1.10.4.5.3, 5.3.6.8.4] Pressure regulators alone shall not be used to control purge gas flow rates. [NFPA 99:5.1.10.4.5.4, 5.3.6.8.5]

For Category 3 systems, the nitrogen purge gas flow rate shall not be high enough to produce a positive pressure in the piping system. [NFPA 99:5.3.6.8.3]

**1309.3.8.3 Oxygen Analyzer.** In order to assure that 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. [NFPA 99:5.1.10.4.5.5]

**1309.3.8.4 During Installation.** 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. [NFPA 99:5.1.10.4.5.6, 5.3.6.8.6]

**1309.3.8.5 Discharge Opening.** 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. [NFPA 99:5.1.10.4.5.7, 5.3.6.8.7]

**1309.3.8.6 Temperature of Joint.** The flow of purge gas shall be maintained until the joint is cool to the touch. [NFPA 99:5.1.10.4.5.8, 5.3.6.8.8]

**1309.3.8.7 Opening to be Sealed.** 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. [NFPA 99:5.1.10.4.5.9, 5.3.6.8.9]

**1309.3.8.8 Final Brazed Connection.** 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. [NFPA 99:5.1.10.4.5.10]

**1309.3.8.9 Final Tie-In Test.** 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 portions of both the new and existing piping shall be tested in accordance with the following [NFPA 99:5.1.10.4.5.11]:

- (1) 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. [NFPA 99:5.1.12.3.9.2]
- (2) Vacuum joints shall be tested using an ultrasonic leak detector or other means that will allow detection of leaks in an active medical vacuum system. [NFPA 99:5.1.12.3.9.3]
- (3) For pressure gases, immediately after the final brazed connection is made and leak-tested, an outlet in the new piping and an outlet in the existing piping that are

immediately downstream from the point or area of intrusion shall be purged in accordance with Section 1309.3.8.9(4). [NFPA 99:5.1.12.3.9.4]

(4) Where traces of particulate matter have been deposited in the pipelines as a result of construction, a heavy, intermittent purging of the pipeline shall be done. [NFPA 99:5.1.12.3.6]

(5) Before the new work is used for patient care, positive-pressure gases shall be tested for operational pressure and gas concentration in accordance with Section 1319.10 and Section 1319.11. [NFPA 99:5.1.12.3.9.5]

(6) Permanent records of these tests shall be maintained. [NFPA 99:5.1.12.3.9.6]

**1309.3.8.10 Autogenous Orbital Welding Process.** Where 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. [NFPA 99:5.1.10.4.5.12]

**1309.3.9 Assembling and Heating Brazed Joints.** Tube ends shall be inserted fully into the socket or to a mechanically limited depth that is not less than the minimum cup depth (overlap) in accordance with ASME B16.50. [NFPA 99:5.1.10.4.6.1, 5.3.6.9.1]

**1309.3.9.1 Heating of Joint.** Where flux is permitted, the joint shall be heated slowly until the flux has liquefied. [NFPA 99:5.1.10.4.6.2, 5.3.6.9.2] 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. [NFPA 99:5.1.10.4.6.3, 5.3.6.9.3]

**1309.3.10 Inspection of Brazed Joints.** After brazing, the outside of joints shall be cleaned by washing with water and a wire brush to remove residue and permit clear visual inspection of the joint. [NFPA 99:5.1.10.4.7.1, 5.3.6.10.1]

**1309.3.10.1 Where Flux is Used.** Where flux has been used, the wash water shall be hot. [NFPA 99:5.1.10.4.7.2, 5.3.6.10.2]

**1309.3.10.2 Visually Inspected.** Each brazed joint shall be visually inspected after cleaning the outside surfaces. [NFPA 99:5.1.10.4.7.3, 5.3.6.10.3]

**1309.3.10.3 Prohibited Brazed Joints.** Joints exhibiting the following conditions shall not be permitted:

(1) Flux or flux residue (where 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 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 in accordance with Section 1319.5 and the standing pressure test in accordance with Section 1319.7 or Section 1319.8. [NFPA 99:5.1.10.4.7.4, 5.3.6.10.4]

**1309.3.10.4 Defective Brazed Joints.** Brazed joints that are identified as defective under the conditions of Section 1309.3.10.3(2) or Section 1309.3.10.3(5) shall be replaced. [NFPA 99:5.1.10.4.7.5, 5.3.6.10.5]

Brazed joints that are identified as defective under the conditions of Section 1309.3.10.3(1), Section 1309.3.10.3(3), Section 1309.3.10.3(4), Section 1309.3.10.3(6), or Section 1309.3.10.3(7) shall be permitted to be repaired, except that no joint shall be reheated more than once before being replaced. [NFPA 99:5.1.10.4.7.6, 5.3.6.10.6]

**1309.4 Special Fittings.** The special fittings in Section 1309.4.1 through Section 1309.4.5 shall be permitted to be used in lieu of brazed joints.

**1309.4.1 Memory Metal Fittings.** Memory metal fittings having a temperature rating not less than 1000°F (538°C) and a pressure rating not less than 300 psi (2068 kPa) shall be permitted to be used to join copper or stainless steel tube. Such fittings shall be installed by qualified technicians in accordance with the manufacturer's installation instructions. [NFPA 99:5.1.10.6]

**1309.4.2 Axially Swaged Fittings.** Axially swaged, elastic strain preload fittings providing metal-to-metal seals, having a temperature rating not less than 1000°F (538°C) and a pressure rating not less than 300 psi (2068 kPa), and where complete, are permanent and nonseparable shall be permitted to be used to join copper or stainless steel tube. Such fittings shall be installed by qualified technicians in accordance with the manufacturer's installation instructions. [NFPA 99:5.1.10.7]

**1309.4.3 Threaded Fittings.** Threaded fittings shall comply with the following requirements:

- (1) Be limited to connections for pressure and vacuum indicators, alarm devices, check valves, and source equipment on the source side of the source valve.
- (2) Be tapered pipe threads in accordance with ASME B1.20.1.
- (3) Be made up with polytetrafluoroethylene tape or other thread sealant recommended for oxygen service, with the sealant applied to the male threads only and care taken to ensure sealant does not enter the pipe. [NFPA 99:5.1.10.8, 5.3.6.2.5]

**1309.4.4 Dielectric Fittings.** Dielectric fittings shall comply with the following requirements, and shall only be permitted where required by the manufacturer of special medical equipment to electrically isolate the equipment from the system distribution piping:

- (1) Be of brass or copper construction with an approved dielectric.
- (2) Be permitted to be a union.
- (3) Be clean for oxygen where used for medical gases. [NFPA 99:5.1.10.9.2]

**1309.4.5 Other Types of Fittings.** Approved metallic gas tube fittings that provide a permanent joint having the mechanical, thermal, and sealing integrity of a brazed joint shall be permitted to be used. [NFPA 99:5.1.10.9.1]

**1309.5 Welded Joints.** Welded joints for medical gas and medical-surgical vacuum systems shall be permitted to be made using a gas tungsten arc welding (GTAW) autogenous orbital procedure. [NFPA 99:5.1.10.5.1.1]

**1309.5.1 Qualifications.** Welders shall be qualified in accordance with Section IX of the ASME Boiler and Pressure Vessel Code. [NFPA 99:5.1.10.5.2.2]

**1309.5.2 Welder Qualification Procedure.** The GTAW autogenous orbital procedure and the welder qualification procedure shall be qualified in accordance with Section IX of the ASME Boiler and Pressure Vessel Code. Welder qualification procedures shall include a bend test and a tensile test in accordance with Section IX of the ASME Boiler and Pressure Vessel Code on each tube size diameter. [NFPA 99:5.1.10.5.1.2, 5.1.10.5.1.3]

**1309.5.2.1 Purging of Joints.** GTAW autogenous orbital welded joints shall be purged during welding with a commercially available mixture of 75 percent

helium (+/- 5 percent) and 25 percent argon (+/- 5 percent). [NFPA 99:5.1.10.5.1.5]

**1309.5.2.2 Test Coupons.** Test coupons shall be welded and inspected, as a minimum, at the start of work and every 4 hours thereafter, or where the machine is idle for more than 30 minutes, and at the end of the work period. Test coupons shall be inspected on the I.D. and O.D. by a qualified quality control inspector, and shall be welded at change of operator, weld head, welding power supply, or gas source. [NFPA 99:5.1.10.5.1.7 – 5.1.10.5.1.9]

**1309.5.3 Welding for Stainless Tube.** Stainless tube shall be welded using metal inert gas (MIG) welding, tungsten inert gas (TIG) welding, or other welding techniques approved for joining stainless tube. [NFPA 99:5.1.10.5.2.1]

**1309.6 Prohibited Joints.** The following joints shall be prohibited throughout medical gas and medical vacuum distribution pipeline systems [NFPA 99:5.1.10.10, 5.3.6.2.6]:

- (1) Flared and compression-type connections, including connections to station outlets and inlets, alarm devices, and other components. [NFPA 99:5.1.10.10(1), 5.3.6.2.6(1)]
- (2) Other straight-threaded connections, including unions. [NFPA 99:5.1.10.10(2), 5.3.6.2.6(3)]
- (3) The use of pipe-crimping tools to permanently stop the flow of medical gas and medical vacuum piping. [NFPA 99:5.1.10.10(3)]
- (4) Removable and nonremovable push-fit fittings that employ a quick assembly push fit connector. [NFPA 99:5.1.10.10(4)]
- (5) Push-lock connections for Category 3 medical gas systems. [NFPA 99:5.3.6.2.6(2)]

## **1310.0 Installation of Piping.**

**1310.1 General.** The installer shall furnish documentation certifying that installed piping materials for medical gas or medical vacuum systems are in accordance with Section 1308.0. [NFPA 99:5.1.10.1.6]

**1310.2 Required Pipe Sizing.** Medical gas and medical vacuum piping systems shall be designed and sized to deliver the required flow rates at the utilization pressures in accordance with Section 1310.2.1 through Section 1310.2.3. [NFPA 99:5.1.10.11.1.1, 5.3.6.11.1] In no case, shall pipe sizing be less than as follows:

(1) Mains and branches in medical gas piping systems shall be not less than DN15 (NPS 1/2) (5/8 of an inch O.D.) size. [NFPA 99:5.1.10.11.1.2]

(2) Mains and branches in medical-surgical vacuum systems shall be not less than DN20 (NPS 3/4) (7/8 of an inch O.D.) size. [NFPA 99:5.1.10.11.1.3]

(3) Drops to individual station outlets and inlets shall be not less than DN15 (NPS 1/2) (5/8 of an inch O.D.) size. [NFPA 99:5.1.10.11.1.4]

(4) Runouts to alarm panels and connecting tubing for gauges and alarm devices shall be permitted to be DN8 (NPS 1/4) (3/8 of an inch O.D.) size. [NFPA 99:5.1.10.11.1.5]

(5) Category 3 medical gas piping systems that utilize oxygen shall be not less than DN10 (NPS 3/8) (1/2 of an inch O.D.) size, and systems that utilize nitrous oxide shall be not less than DN8 (NPS 1/4) (3/8 of an inch O.D.) size. [NFPA 99:5.3.6.11.2]

**1310.2.1 Maximum Demand.** Where the maximum demand for each medical gas or medical vacuum system does not exceed the values in Table 1310.2.1(2) through Table 1310.2.1(7), the size of pipe of each section of the system shall be determined in accordance with Section 1310.2.2. The size for systems beyond the range of Table 1310.2.1(2) through Table 1310.2.1(7) shall be determined in accordance with Section 1310.2.3.

**1310.2.2 Sizing Procedures.** The size of each section of pipe in a system within the range of Table 1310.2.1(2) through Table 1310.2.1(7) shall be determined in accordance with the following:

(1) Determine the total flow rate and number of outlets or inlets for each section of pipe in accordance with Table 1305.2 and Table 1305.3.

(2) Measure the length of the section of pipe to each station outlet or inlet on the system. Multiply the measured pipe length by 1.5 (150 percent), to account for the number of fittings in the system, to determine the pipe equivalent length.

(3) Beginning with the most remote outlet or inlet, multiply the total flow rate by the diversity factor specified in Table 1310.2.1(1) for each section of pipe to determine the sizing flow rate for the piping.

(4) Select Table 1310.2.1(2) through Table 1310.2.1(7) based on the medical gas or medical vacuum being transported through the piping.

(5) Select an estimated pipe size for determining the system pressure loss. Multiply the pipe equivalent length, for a given section of pipe, by the pressure loss for the sizing flow

rate in the applicable table. Divide that number by 100 to determine the system pressure loss for the section of pipe.

(6) Add the pressure loss for each section of piping, from the source equipment location to the outlet or inlet, to determine the total system pressure loss to each outlet or inlet. The total system pressure loss in the piping to each outlet or inlet shall not exceed the values specified in Table 1310.2.2(1).

**TABLE 1310.2.1(1)**  
**SYSTEM SIZING – FLOW REQUIREMENTS FOR STATION OUTLETS AND INLETS<sup>1</sup>**

| NUMBER OF OUTLETS AND INLETS<br>TERMINAL UNITS PER FACILITY | DIVERSITY PERCENTAGE OF AVERAGE<br>FLOW PER OUTLETS AND INLETS<br>TERMINAL UNITS | MINIMUM PERMISSIBLE SYSTEM FLOW<br>OF ALL PRESSURIZED MEDICAL GAS SYSTEMS <sup>2</sup><br>(standard cubic feet per minute) |
|-------------------------------------------------------------|----------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|
| 1–10                                                        | 100%                                                                             | Actual Demand                                                                                                              |
| 11–25                                                       | 75%                                                                              | 7.0                                                                                                                        |
| 26–50                                                       | 50%                                                                              | 13.1                                                                                                                       |
| 51–100                                                      | 50%                                                                              | 17.5                                                                                                                       |

**Notes:**

<sup>1</sup> Flow rates of station outlets and inlets in accordance with Table 1305.2.

<sup>2</sup> The minimum system flow is the average outlets and inlets flow times the number of station outlets and inlets times the diversity percentage.

**TABLE 1310.2.2(1)**  
**MAXIMUM PERMITTED PRESSURE LOSS IN MEDICAL GAS  
AND MEDICAL VACUUM SYSTEMS**

| TYPE OF SYSTEM | MAXIMUM ALLOWABLE SYSTEM<br>PRESSURE LOSS (psi) |
|----------------|-------------------------------------------------|
| Medical Air    | 5                                               |
| Nitrogen       | 15                                              |
| Nitrous Oxide  | 5                                               |
| Carbon Dioxide | 5                                               |
| Oxygen         | 5                                               |
| Medical Vacuum | 4 inches of mercury                             |

For SI units: 1 pound-force per square inch = 6.8947 kPa, 1 inch of mercury = 3.386 kPa

**1310.2.3 Engineering Methods.** For conditions other than those covered by Section 1310.2.1, such as longer runs of greater gas or vacuum demands, the size of each medical gas or medical vacuum piping system shall be determined by standard engineering methods acceptable to the Authority Having Jurisdiction, and

each system shall be so designed that the total pressure drop or gain between the source equipment and an outlet or inlet shall not exceed the allowable pressures shown in Table 1305.1.

**1310.3 Pipe Protection.** Piping shall be protected against freezing, corrosion, and physical damage. [NFPA 99:5.1.10.11.2, 5.3.6.11.4.1]

**1310.3.1 Exposed Piping.** Piping exposed in corridors and other areas where subject to physical damage from the movement of carts, stretchers, beds, portable equipment, or vehicles shall be protected. [NFPA 99:5.1.10.11.2.1, 5.3.6.11.4.2]

**1310.3.2 Underground Piping.** Piping underground within buildings or embedded in concrete floors or walls shall be installed in a continuous conduit. [NFPA 99:5.1.10.11.2.2]

**Exception:** *Category 3 medical gas piping shall not be installed within floor slabs.*

[NFPA 99:5.3.6.15]

**1310.3.3 Frost Protection.** Buried piping outside of buildings shall be installed below the local level of frost penetration. [NFPA 99:5.1.10.11.5.1, 5.3.6.13.1]

**1310.4 Location of Piping.** Piping risers shall be permitted to be installed in pipe shafts where protected from physical damage, effects of excessive heat, corrosion, or contact with oil. [NFPA 99:5.1.10.11.3.1]

**1310.4.1 Prohibited Locations.** Piping shall not be installed in kitchens, elevator shafts, elevator machine rooms, areas with open flames, electrical service equipment exceeding 600 volts, and areas prohibited under NFPA 70 except for the following locations:

- (1) Room locations for medical air compressor supply systems and medical-surgical vacuum pump supply systems.
- (2) Room locations for secondary distribution circuit panels and breakers having a voltage rating not exceeding 600 volts. [NFPA 99:5.1.10.11.3.2]
- (3) Medical gas piping, including oxygen and nitrous oxide piping, shall not be located where subject to contact with oil, including a possible flooding area in the case of a major oil leak. [NFPA 99:5.1.10.11.3.4, 5.3.6.11.3]

**1310.4.2 Approved Locations.** Medical gas piping shall be permitted to be installed in the same service trench or tunnel with fuel gas lines, fuel oil lines, electrical lines, steam lines, and similar utilities provided that the space is ventilated (naturally or mechanically) and the ambient temperature around the medical gas piping does not exceed 130°F (54°C). [NFPA 99:5.1.10.11.3.3]

**1310.5 Pipe Support.** Piping shall be supported from the building structure. [NFPA 99:5.1.10.11.4.1, 5.3.6.12.1]

**1310.5.1 Hangers and Supports.** Hangers and supports shall be installed in accordance with MSS SP- 58. [NFPA 99:5.1.10.11.4.2, 5.3.6.12.2]

**1310.5.2 Copper Tube.** Hangers and supports for copper tube shall be sized for copper tube. [NFPA 99:5.1.10.11.4.3, 5.3.6.12.3]

**1310.5.3 Damp Locations.** In damp locations, copper tube hangers or supports that are in contact with the tube shall be plastic-coated or otherwise be electrically insulated from the tube by a material that will not absorb moisture. [NFPA 99:5.1.10.11.4.4, 5.3.6.12.4]

**1310.5.4 Maximum Spacing.** Maximum support spacing for metallic piping shall be in accordance with Table 1310.5.4(1). [NFPA 99:5.1.10.11.4.5, 5.3.6.12.5] Maximum support spacing for plastic pipe shall be in accordance with Table 1310.5.4(2). [NFPA 99:5.3.8.3.4]

**1310.5.5 Seismic Provisions.** Where required, medical gas and medical vacuum piping shall be seismically restrained against earthquakes in accordance with the applicable building code. [NFPA 99:5.1.10.11.4.6]

**TABLE 1310.5.4(1)**  
**MAXIMUM METALLIC PIPE SUPPORT SPACING**  
**[NFPA 99: TABLE 5.1.10.11.4.5, 5.3.6.12.5]**

| PIPE SIZE                                                      |                                    |                                                 | HANGER<br>SPACING (feet) |
|----------------------------------------------------------------|------------------------------------|-------------------------------------------------|--------------------------|
| DN8                                                            | (NPS ¼)                            | ( <sup>3</sup> / <sub>8</sub> of an inch O.D.)  | 5                        |
| DN10                                                           | (NPS <sup>3</sup> / <sub>8</sub> ) | (½ of an inch O.D.)                             | 6                        |
| DN15                                                           | (NPS ½)                            | ( <sup>5</sup> / <sub>8</sub> of an inch O.D.)  | 6                        |
| DN20                                                           | (NPS <sup>3</sup> / <sub>4</sub> ) | ( <sup>7</sup> / <sub>8</sub> of an inch O.D.)  | 7                        |
| DN25                                                           | (NPS 1)                            | (1 <sup>1</sup> / <sub>8</sub> of an inch O.D.) | 8                        |
| DN32                                                           | (NPS 1¼)                           | (1 <sup>3</sup> / <sub>8</sub> of an inch O.D.) | 9                        |
| DN40 and<br>larger                                             | (NPS 1½)                           | (1 <sup>5</sup> / <sub>8</sub> of an inch O.D.) | 10                       |
| Vertical risers, all sizes, every floor, but not to<br>exceed: |                                    |                                                 | 15                       |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm

**TABLE 1310.5.4(2)**  
**MAXIMUM PLASTIC PIPE SUPPORT SPACING**  
**[NFPA 99: TABLE 5.3.8.3.4]**

| PIPE SIZE                                                   |          |                                  | HANGER SPACING (feet) |
|-------------------------------------------------------------|----------|----------------------------------|-----------------------|
| DN15                                                        | (NPS ½)  | ( $\frac{5}{8}$ of an inch O.D.) | 4                     |
| DN20                                                        | (NPS ¾)  | ( $\frac{7}{8}$ of an inch O.D.) | 4                     |
| DN25                                                        | (NPS 1)  | (1⅛ of an inch O.D.)             | 4.33                  |
| DN32                                                        | (NPS 1¼) | (1⅜ of an inch O.D.)             | 4.33                  |
| DN40                                                        | (NPS 1½) | (1⅝ of an inch O.D.)             | 4.67                  |
| DN50                                                        | (NPS 2)  | (2⅜ of an inch O.D.)             | 4.67                  |
| DN65 and larger                                             | (NPS 2½) | (2⅞ of an inch O.D.)             | 5                     |
| Vertical risers, all sizes, every floor, but not to exceed: |          |                                  | 10                    |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm