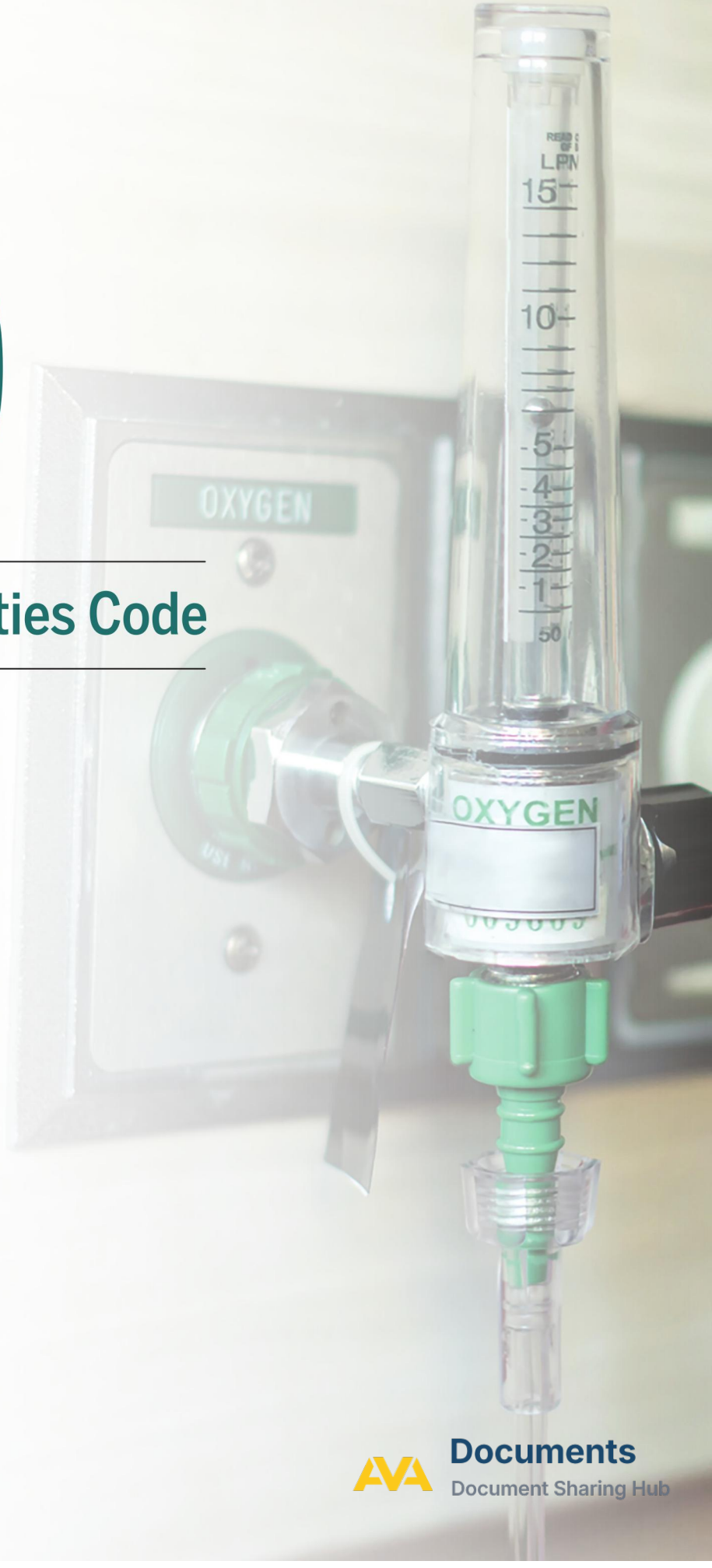
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NFPA® 99

Health Care Facilities Code

2021 Edition

This edition of NFPA 99, *Health Care Facilities Code*, was prepared by the Technical Committees on Electrical Systems, Fundamentals, Health Care Emergency Management and Security, Hyperbaric and Hypobaric Facilities, Mechanical Systems, Medical Equipment, and Piping Systems, released by the Correlating Committee on Health Care Facilities, and acted on by the NFPA membership during the 2020 NFPA Technical Meeting held June 8–29. It was issued by the Standards Council on August 11, 2020, with an effective date of August 31, 2020, and supersedes all previous editions.

This edition of NFPA 99 was approved as an American National Standard on August 31, 2020.

Origin and Development of NFPA 99

The idea for this document grew as the number of documents under the original NFPA Committee on Hospitals grew. By the end of 1980, there existed 12 documents on a variety of subjects, 11 directly addressing fire-related problems in and about health care facilities. These documents covered health care emergency preparedness, inhalation anesthetics, respiratory therapy, laboratories in health-related institutions, hyperbaric facilities, hypobaric facilities, inhalation anesthetics in ambulatory care facilities, home use of respiratory therapy, medical–surgical vacuum systems in hospitals, essential electrical systems (EES) for health care facilities, safe use of electricity in patient care areas of health care facilities, and safe use of high-frequency electricity in health care facilities.

A history on the documents that covered these topics are in the "Origin and Development of NFPA 99" in the 1984 edition of NFPA 99. What was then the Health Care Facilities Correlating Committee reviewed the matter beginning in late 1979 and concluded that combining all the documents under its jurisdiction would be beneficial to those who used those documents for the following reasons:

(1) The referenced documents were revised independently. Combining the documents into one would place them on the same revision cycle.
(2) It would place in one unit many documents that referenced each other.
(3) It would be an easier and more complete reference for the various users of the document (e.g., hospital engineers, medical personnel, designers and architects, and various enforcing authorities).

In January 1982, a compilation of the latest edition of each of the 12 documents under the jurisdiction of the correlating committee was published as NFPA 99, *Health Care Facilities Code*. The document was formally adopted at the 1983 Fall Meeting.

For the 1984 edition, technical, administrative, and organizational changes were made.

For the 1987 edition, the third and final step in the process of combining the previous individual documents took place — that of integrating the content of these individual documents into a cohesive document. Technical changes were made, and NFPA 56F, *Standard on Nonflammable Medical Piped Gas Systems*, was incorporated into the document.

For the 1990 edition, some structural changes were made and some modifiers were added to make it easier to determine where requirements apply. Technical changes included correlation with NFPA *101®*, *Life Safety Code®*, changes for compressed medical air systems on the use of gas-powered medical devices operating at a gauge pressure of 200 psi and piped gas systems in general, clarification that patient care areas and wet locations are mutually exclusive, and further guidance on the effects of a disaster on staff.

For the 1993 edition, further efforts made the document more user friendly (e.g., placing all "recommended" guidance either in notes or in the appendix). Significant technical changes included adding requirements and recommendations to further prevent or minimize fires in

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operating rooms. There were also major changes to requirements for installing, testing, inspecting, verifying, and maintaining nonflammable medical piped gas systems. New sections on dental compressed air and dental vacuum requirements were added.

For the 1996 edition, further changes to make the document easier to use included restructuring Chapters 3 and 4 so that all requirements for a Type 1, Type 2, or Type 3 essential electrical system, or a Level 1, Level 2, Level 3, or Level 4 piped gas or vacuum system, were in one section. Other technical changes included moving requirements on flammable anesthetizing locations and the use of flammable inhalation anesthetics to a new Appendix 2. Guidance on emergency preparedness was moved to a new mandatory chapter. A new chapter on home health care was added. Requirements for storage rooms containing gas cylinders and containers totaling less than 3000 ft^3 were also added.

For the 1999 edition, some significant technical and structural changes were made. Chapters on ambulatory health care centers, clinics, and medical/dental offices were replaced completely by a new Chapter 13 covering health care facilities other than hospitals, nursing homes, and limited care facilities as defined in the document. A new chapter on freestanding birthing centers was added.

The 2002 edition included format and technical revisions in accordance with the 2000 edition of the *Manual of Style for NFPA Technical Committee Documents*. Occupancy Chapters 13–21 stated what was required, while Chapters 4–12 prescribed how those requirements were to be achieved.

The changes made to the 2005 edition were mainly for clarity and were editorial in nature. A centralized computer was allowed to be used in lieu of one of the master alarms for medical gas and vacuum systems. Stainless steel tubing was added as an approved material for vacuum systems.

The 2012 edition went through a major revision. NFPA 99 was changed from a standard to a code to reflect how the document was used and adopted and to indicate how health care is delivered. The risk to the patient does not change for a given procedure; if the procedure is performed in a doctor's office versus a hospital, the risk remains the same. Therefore, NFPA 99 eliminated the occupancy chapters and transitioned to a risk-based approach. The new Chapter 4 outlined the parameters for this approach. The code reflected the risk to the patient in defined categories of risk.

Chapter 5 went through editorial changes in the 2012 edition as well, with the addition of new material on the testing and maintenance of gas and vacuum systems. In addition, the administrative details for the care, maintenance, and handling of cylinders was moved to chapters under the responsibility of the new Technical Committee on Medical Equipment, formed by the combination of the Technical Committee on Gas Delivery Equipment and the Technical Committee on Electrical Equipment. Several new chapters were added for the 2012 edition on information technology and communications systems; plumbing; heating, ventilation, and air conditioning; security management; and features of fire protection. Many of these systems, not previously addressed by NFPA 99, are important systems and protection features in health care. The hyperbaric chapter also had minor changes for clarity.

The 2015 edition of NFPA 99 built on the major changes of the 2012 edition. The way risk categories were defined was revised to be more inclusive, and the categories could then be applied to equipment and activities rather than only to chapters that deal with systems. The requirements for Category 3 medical gas and vacuum systems, while originally aimed specifically for dental applications, were expanded to include the possibility that other gases might fall under Category 3, based on the facility's risk assessment.

The Technical Committee on Electrical Systems continued the task of correlating requirements with *NFPA 70®*, *National Electrical Code®*, and Chapter 6, and they removed the requirements for Level 3 EES, determining that if there was not a need for a Level 1 or Level 2 EES, then the requirements in *NFPA 70* that apply to all buildings would provide the necessary level of safety. Each of the technical committees made a concerted effort to specifically identify how each chapter was to apply to existing buildings or installations and to list the sections that applied.

The 2018 edition of the code featured numerous technical changes as well as provisions for new technologies and materials. Some major or noteworthy changes were as follows:

(1) The requirements addressing the risk assessment in Chapter 4 were revised to clarify the responsibility for conducting a risk assessment and determining risk categories. It further stressed, through annex language, that determining risk should be a collaborative effort.
(2) Chapter 5 included requirements that allow for the use of oxygen concentrators as central supply sources for piped systems.
(3) Corrugated medical tubing was made a permitted material for medical gas and vacuum systems.
(4) Chapter 6 was reorganized to be structured in a more logical manner. This better grouped related requirements and allowed for the deletion of duplicated requirements for different types of EES.
(5) Chapter 7 included requirements for wireless phone and paging integration and for clinical information systems.
(6) Chapter 14 compiled all of the requirements for inspection, testing, and maintenance for hyperbaric facilities into one section.

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(7) A new Chapter 15 was added to the code. After several editions of trying to work the requirements for dental systems into Chapter 5, a decision was made to create a chapter dedicated to the application of piped gas and vacuum systems for these systems that do not always readily fall under the requirements for medical gas and vacuum as addressed in Chapter 5.

The 2021 edition of NFPA 99 introduces several substantial changes to the code. Some of the most notable changes are as follows:

(1) The scope has changed to include hyperbaric chambers for veterinary care.
(2) New guidance describes what to do when clinical spaces are converted to nonclinical spaces with regard to medical gas inlets and outlets.
(3) The term *responsible facility authority* has been introduced into the standard with requirements for responsibilities and qualifications.
(4) Existing language in Chapter 5 on cryogenic fluid central supply systems has been removed, and extracts from NFPA 55 have replaced it because NFPA 55 now covers this.
(5) A new section on health care microgrids has been added to Chapter 6.
(6) Requirements for electrical equipment site acceptance testing and electrical preventative maintenance have been added to Chapter 6.
(7) Procedures for removing flammable liquid–soaked materials from the operating room have been altered to require those materials to be removed only from the patient care vicinity.
(8) Requirements for the fire protection of heliports was added to Chapter 16 by referencing NFPA 418.

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Committee Scope: This Committee shall have primary responsibility for documents or portions of documents on the scope, application, and intended use of documents under the Health Care Facilities Project, including reference standards, performance, the protection from fire and explosion hazards, protection of special hazards, establishing criteria for levels of health care services based on risk, as well as definitions not assigned to other committees in the Health Care Facilities Project.

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NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents or portions of documents covering the framework for emergency management and security of health care facilities proportionate to the risk of the patient and health care staff. This Committee shall have primary responsibility for the elements of planning over a continuum from minor incidences to catastrophic events, including: management controls, mitigation practices, incident response, continuity of services, recovery, stored capacity, staff training, and program evaluation based on established risk categories.

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NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents or portions of documents covering the construction, installation, testing, performance, and maintenance of hyperbaric and hypobaric facilities for safeguarding staff and occupants of chambers.

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NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This committee shall have primary responsibility for documents or portions of documents covering the performance, operations, testing, and maintenance, for air quality, temperature, humidity, critical space pressure relationships, water and waste water, and their associated systems based on established risk categories.

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NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This committee shall have primary responsibility for documents or portions of documents covering the maintenance, performance, and testing of electrical medical equipment and portable patient-related gas equipment for the purpose of safeguarding patients and health care personnel within patient care areas of health care facilities from the hazards of fire, explosion, electricity, nonionizing radiation, heat, and electrical interference based on established risk categories.

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NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents or portions of documents covering the performance, maintenance, installation, and testing of medical and dental related gas piping systems and medical and dental related vacuum piping systems based on established risk categories.

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NFPA 99

Health Care Facilities Code

2021 Edition

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced and extracted publications can be found in Chapter 2 and Annex D.

Chapter 1 Administration

1.1 Scope.

1.1.1 The scope of this code is to establish minimum criteria as follows in 1.1.2 through 1.1.14.

1.1.2 Fundamentals. Chapter 4 establishes criteria for levels of health care services or systems based on risk to the patients, staff, or visitors in health care facilities.

1.1.3 Gas and Vacuum Systems.

1.1.3.1 Chapter 5 covers the performance, maintenance, installation, and testing of the following:

(1) Nonflammable medical gas systems with operating pressures below a gauge pressure of 2068 kPa (300 psi)
(2) Vacuum systems in health care facilities
(3) Waste anesthetic gas disposal (WAGD) systems, also referred to as scavenging
(4) Manufactured assemblies that are intended for connection to the medical gas, vacuum, or WAGD systems (also referred to as scavenging)

1.1.3.2 Requirements for portable compressed gas systems are covered in Chapter 11.

N **1.1.3.3** Requirements for piped gas and vacuum systems in hyperbaric facilities are covered in Chapter 14.

N **1.1.3.4** Requirements for piped dental gas and vacuum systems are covered in Chapter 15.

1.1.4 Electrical Systems.

1.1.4.1 Chapter 6 covers the performance, maintenance, and testing of electrical systems (both normal and essential) in health care facilities.

1.1.4.2 The following areas are not addressed in this code, but are addressed in other NFPA documents:

(1) Specific requirements for wiring and installation of electrical systems and components thereof are covered in *NFPA 70*.
(2) Requirements for illumination and identification of means of egress in health care facilities are covered in NFPA *101*.
(3) Requirements for installation, testing, and maintenance of fire protection signaling systems are covered in *NFPA 72*.
(4) Requirements for installation of fire pumps are covered in NFPA 20, except that the alternate power source is are permitted to be the essential electrical system.
(5) Requirements for installation of stationary engines and gas turbines are covered in NFPA 37.

1.1.5 Information Technology and Communications Systems. Chapter 7 covers the performance, maintenance, and testing of information technology and communications systems in health care facilities.

1.1.6 Plumbing. Chapter 8 covers the performance, maintenance, and testing of plumbing systems in health care facilities.

1.1.7 HVAC Systems. Chapter 9 covers the performance, maintenance, and testing of heating, cooling, and ventilating in health care facilities.

1.1.8 Electrical Equipment. Chapter 10 covers the performance, maintenance, and testing of electrical equipment in health care facilities.

1.1.9 Gas Equipment. Chapter 11 covers the performance, maintenance, and testing of gas equipment in health care facilities.

1.1.10* Emergency Management. Chapter 12 establishes criteria for emergency management in the development of a program for effective disaster preparedness, response, mitigation, and recovery in health care facilities.

1.1.11 Security Management. Chapter 13 establishes criteria for security management, including management controls, mitigation practices, staff training, and program evaluation in health care facilities.

1.1.12* Hyperbaric Facilities. Chapter 14 establishes criteria for design and operation of hyperbaric chambers and facilities. Chapter 14 covers electrical, fire, pressure, and gas hazards associated with hyperbaric facilities that are used, or intended to be used, for medical and experimental procedures at gauge pressures from 0 kPa to 690 kPa (0 psi to 100 psi).

1.1.13 Dental Gas and Vacuum System. Chapter 15 covers the performance, maintenance, and testing of dental gas and vacuum systems in health care facilities.

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1.1.14 Features of Fire Protection. Chapter 16 covers the performance, maintenance, and testing of fire protection equipment in health care facilities.

Δ **1.2 Purpose.** The purpose of this code is to provide minimum requirements for the installation, inspection, testing, maintenance, performance, and safe practices for facilities, material, equipment, and appliances.

1.3 Application.

1.3.1 This code shall apply to all health care facilities other than home care and veterinary care, except as required by 1.3.1.1.

N **1.3.1.1** Hyperbaric chambers for veterinary care shall be in accordance with the requirements of Chapter 14.

1.3.1.2 This code is intended for use by those persons involved in the design, construction, inspection, and operation of health care facilities and in the design, manufacture, and testing of appliances and equipment used in patient care rooms of health care facilities.

N **1.3.1.3*** Facilities that employ systems, equipment, or appliances that are subject to regulation by this code shall not be required to be subject to any other provisions of this code unless so directed by the scope of the individual chapter(s) of this code or as directed by the authority having jurisdiction's adoption of this code.

1.3.2 Construction and equipment requirements shall be applied only to new construction and new equipment, except as modified in individual chapters.

1.3.2.1 Only 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 code.

1.3.2.2 If the alteration, renovation, or modernization adversely impacts the existing performance requirements of a system or component, additional upgrading shall be required.

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

N **1.3.2.4** Reducing safety features in existing systems shall not be permitted where such is required for new construction or equipment.

1.3.3 Policies.

1.3.3.1 The health care organization shall ensure that policies are established and maintained that permit the attending medical professional to supersede the requirements of this code in order to satisfy the emergency needs of any patient.

1.3.3.2 Each application of the provisions of 1.3.3.1, where this code's requirements are superseded to satisfy the emergency needs of a patient, shall be clearly documented and reviewed with the intent of meeting similar future needs within the requirements of this code.

1.3.4 Patient Care Spaces.

1.3.4.1 The health care facility's governing body or its designee shall establish the following areas in accordance with the type of patient care anticipated *(see 3.3.140, Patient Care Space)*:

(1) Category 1 spaces
(2) Category 2 spaces
(3) Category 3 spaces
(4) Category 4 spaces

1.3.4.2 Anesthesia. It shall be the responsibility of the health care facility's governing body to designate anesthetizing locations.

1.3.4.3 Wet Procedure Locations. It shall be the responsibility of the health care facility's governing body to designate wet procedure locations.

1.4 Equivalency.

1.4.1 Nothing in this code is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety to those prescribed by this code. Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency. The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

1.4.2 Alternative systems, methods, or devices approved as equivalent by the authority having jurisdiction shall be recognized as being in compliance with this code.

1.4.3 The authority having jurisdiction shall be permitted to grant exceptions to this code.

1.5* Units. Primary units will be trade units, and secondary units will be the conversion.

1.6 Code Adoption Requirements.

1.6.1 The effective date of application of any provision of this code is not determined by the National Fire Protection Association. All questions related to applicability shall be directed to the authority having jurisdiction.

1.6.2 Enforcement. This code shall be administered and enforced by the authority having jurisdiction. *(See Annex C for a sample wording for enabling legislation.)*

Chapter 2 Referenced Publications

2.1* General. The documents referenced in this chapter, or portions of such documents, are referenced within this code and shall be considered part of the requirements of this code, and the following shall also apply:

(1) Documents referenced in this chapter, or portion of such documents, shall only be applicable to the extent called for within other chapters of this code.
(2) Where the requirements of a referenced code or standard differ from the requirements of this code, the requirements of this code shall govern.
(3) Existing buildings or installations that do not comply with the provisions of the codes or standards referenced in this chapter shall be permitted to be continued in service, provided that the lack of conformity with these documents does not present a serious hazard to the occupants as determined by the authority having jurisdiction. [***101***:2.1]

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2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 10, *Standard for Portable Fire Extinguishers,* 2018 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2019 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems,* 2019 edition.

NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection,* 2019 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems,* 2020 edition.

NFPA 30, *Flammable and Combustible Liquids Code,* 2021 edition.

NFPA 31, *Standard for the Installation of Oil-Burning Equipment,* 2020 edition.

NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines,* 2018 edition.

NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals,* 2019 edition.

NFPA 54, *National Fuel Gas Code,* 2021 edition.

NFPA 55, *Compressed Gases and Cryogenic Fluids Code,* 2020 edition.

NFPA 58, *Liquefied Petroleum Gas Code,* 2020 edition.

NFPA 70®, National Electrical Code®, 2020 edition.

NFPA 72®, National Fire Alarm and Signaling Code®, 2019 edition.

NFPA 82, *Standard on Incinerators and Waste and Linen Handling Systems and Equipment,* 2019 edition.

NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems,* 2021 edition.

NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Particulate Solids,* 2020 edition.

NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations,* 2021 edition.

NFPA *101®, Life Safety Code®,* 2021 edition.

NFPA 110, *Standard for Emergency and Standby Power Systems,* 2019 edition.

NFPA 111, *Standard on Stored Electrical Energy Emergency and Standby Power Systems,* 2019 edition.

NFPA 170, *Standard for Fire Safety and Emergency Symbols,* 2018 edition.

NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel–Burning Appliances,* 2019 edition.

NFPA 259, *Standard Test Method for Potential Heat of Building Materials,* 2018 edition.

NFPA 260, *Standard Methods of Tests and Classification System for Cigarette Ignition Resistance of Components of Upholstered Furniture,* 2019 edition.

NFPA 261, *Standard Method of Test for Determining Resistance of Mock-Up Upholstered Furniture Material Assemblies to Ignition by Smoldering Cigarettes,* 2018 edition.

NFPA 286, *Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth,* 2019 edition.

NFPA 418, *Standard for Heliports,* 2016 edition.

NFPA 400, *Hazardous Materials Code,* 2019 edition.

NFPA 495, *Explosive Materials Code,* 2018 edition.

NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films,* 2019 edition.

NFPA 750, *Standard on Water Mist Fire Protection Systems,* 2019 edition.

NFPA 853, *Standard for the Installation of Stationary Fuel Cell Power Systems,* 2020 edition.

NFPA 1600®, Standard on Continuity, Emergency, and Crisis Management, 2019 edition.

NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems,* 2018 edition.

NFPA 5000®, Building Construction and Safety Code®, 2021 edition.

2.3 Other Publications.

N **2.3.1 AAMI Publications.** Association for the Advancement of Medical Instrumentation, North Glebe Road, Suite 300, Arlington, VA 22203.

ANSI/AAMI ES60601-1, *Medical electrical equipment — Part 1: General requirements for basic safety and essential performance,* 2012.

Δ **2.3.2 ANSI Publications.** American National Standards Institute, Inc., 25 West 43rd Street, 4th Floor, New York, NY 10036.

ANSI B57.1, *Compressed Gas Cylinder Valve Outlet and Inlet Connections,* 1965.

ANSI Z136.3, *American National Standard for Safe Use of Lasers in Health Care,* 2018.

Δ **2.3.3 ASHRAE Publications.** ASHRAE, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305.

ASHRAE 90.1, *Energy Standard for Buildings Except Low-Rise Residential Buildings,* 2016.

ASHRAE 170, *Ventilation of Health Care Facilities,* 2017, including Addenda a.

Δ **2.3.4 ASME Publications.** American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016-5990.

ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators,* 2016.

ASME A17.3, *Safety Code for Existing Elevators and Escalators,* 2015.

ASME B1.20.1, *Pipe Threads, General Purpose, Inch,* 2013.

ASME B16.22, *Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings,* 2013.

ASME B16.26, *Cast Copper Alloy Fittings for Flared Copper Tubes,* 2013.

ANSI/ASME B16.50, *Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings,* 2013.

ASME B31.3, *Process Piping,* 2016.

ASME B40.100, *Pressure Gauges and Gauge Attachments,* 2013.

ASME PVHO-1, *Safety Standard for Pressure Vessels for Human Occupancy,* 2016.

Boiler and Pressure Vessel Code, 2017.

2.3.5 ASSE Publications. American Society of Sanitary Engineering, 18927 Hickory Creek Drive, Suite 220, Mokena, IL 60448.

ASSE 6010, *Professional Qualifications Standard for Medical Gas Systems Installers,* 2018.

ASSE 6015, *Professional Qualifications Standard for Bulk Medical Gas Systems Installers,* 2018.

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ASSE 6020, *Professional Qualifications Standard for Medical Gas Systems Inspectors*, 2018.

ASSE 6030, *Professional Qualifications Standard for Medical Gas Systems Verifiers*, 2018.

ASSE 6035, *Professional Qualifications Standard for Bulk Medical Gas Systems Verifiers*, 2018.

ASSE 6040, *Professional Qualifications Standard for Medical Gas Maintenance Personnel*, 2018.

Δ **2.3.6 ASTM Publications.** ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM A269/A269M, *Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service*, 2015a.

ASTM A312/A312M, *Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes*, 2018a.

ASTM B32, *Standard Specification for Solder Metal*, 2008, reapproved 2014.

ASTM B88, *Standard Specification for Seamless Copper Water Tube*, 2016.

ASTM B103/B103M, *Standard Specification for Phosphor Bronze Plate, Sheet, Strip, and Rolled Bar*, 2015.

ASTM B280, *Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service*, 2018.

ASTM B819, *Standard Specification for Seamless Copper Tube for Medical Gas Systems*,2018.

ASTM B828, *Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings*, 2016.

ASTM D5/D5M, *Standard Test Method for Penetration of Bituminous Materials*, 2019.

ASTM D1785, *Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120*, 2015e1.

ASTM D2466, *Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40*, 2017.

ASTM D2467, *Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80*, 2015.

ASTM D2672, *Standard Specification for Joints for IPS PVC Pipe Using Solvent Cement*, 2014.

ASTM D2846/D2846M, *Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems*, 2019.

ASTM D4359, *Standard Test Method for Determining Whether a Material Is a Liquid or a Solid*, 1990, reapproved 2019.

ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, 2019a.

ASTM E136, *Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C*, 2019.

ASTM E1537, *Standard Test Method for Fire Testing of Upholstered Furniture*, 2016.

ASTM E1590, *Standard Test Method for Fire Testing of Mattresses*, 2017.

ASTM E2652, *Standard Test Method for Assessing Combustibility of Materials Using a Tube Furnace with a Cone-shaped Airflow Stabilizer, at 750°C*, 2018.

ASTM E2965, *Standard Test Method for Determination of Low Levels of Heat Release Rate for Materials and Products Using an Oxygen Consumption Calorimeter*, 2017.

ASTM F438, *Standard Specification for Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40*, 2017.

ASTM F439, *Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80*, 2013.

ASTM F441/F441M, *Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80*, 2015.

ASTM F493, *Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings*, 2014.

2.3.7 AWS Publications. American Welding Society, 8669 NW 36 Street, #130, Miami, FL 33166-6672.

ANSI/AWS A5.8M/A5.8, *Specification for Filler Metals for Brazing and Braze Welding*, 2011, Addendum 1, 2014.

AWS B2.2/B2.2M, *Specification for Brazing Procedure and Performance Qualification*, 2010.

2.3.8 BICSI Publications. BICSI, 8610 Hidden River Parkway, Tampa, FL 33637-1000.

The BICSI Information Transport Systems (ITS) Dictionary, 3rd edition.

2.3.9 CDA Publications. Copper Development Association Inc., 260 Madison Avenue, #17, New York, NY 10016.

Copper Tube Handbook, 2010.

Δ **2.3.10 CGA Publications.** Compressed Gas Association, 14501 George Carter Way, Suite 103, Chantilly, VA 20151-2923.

CGA C-7, *Guide to Classification and Labeling of Compressed Gases*, 2014.

CGA G-4, *Oxygen*, 2015.

CGA G-4.1, *Cleaning Equipment for Oxygen Service*, 2009.

CGA G-6.1, *Standard for Insulated Liquid Carbon Dioxide Systems at Consumer Sites*, 2013.

CGA G-6.5, *Standard for Small Stationary Insulated Carbon Dioxide Supply Systems*, 2013.

CGA G-8.1, *Standard for Nitrous Oxide Systems at Customer Sites*, 2013.

CGA M-1, *Standard for Medical Gas Supply Systems at Health Care Facilities*, 2018.

CGA P-2.5, *Transfilling of High Pressure Gaseous Oxygen Used for Respiration*, 2011.

CGA P-2.6, *Transfilling of Liquid Oxygen Used for Respiration*, 2011.

CGA P-18, *Standard for Bulk Inert Gas Systems at Consumer Sites*, 2013.

CGA V-1, *Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections* (ANSI B57.1), 2013.

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CGA V-5, *Diameter Index Safety System (Noninterchangeable Low Pressure Connections for Medical Gas Applications)*, 2008, reaffirmed 2013.

2.3.11 CSA Group Publications. CSA Group, 178 Rexdale Blvd., Toronto, ON M9W 1R3, Canada.

CSA C22.2 No. 0.3, *Test Methods for Electrical Wires and Cables*, 2009, reaffirmed 2014.

Δ **2.3.12 FGI Publications.** Facility Guidelines Institute, 1919 McKinney Avenue, Dallas, TX 75201.

Guidelines for Design and Construction of Hospitals, 2018.

Guidelines for Design and Construction of Outpatient Facilities, 2018.

Guidelines for Design and Construction of Residential Health, Care, and Support Facilities, 2018.

2.3.13 ISA Publications. International Society of Automation, 67 T.W. Alexander Drive, P.O. Box 12277, Research Triangle Park, NC 27709.

ANSI/ISA S-7.0.01, *Quality Standard for Instrument Air*, 1996.

Δ **2.3.14 MSS Publications.** Manufacturer's Standardization Society (MSS) of the Valve and Fittings Industry, 127 Park Street NE, Vienna, VA 22180-4602.

MSS SP-58, *Pipe Hangers and Supports — Materials, Design, Manufacture, Selection, Application, and Installation*, 2009.

2.3.15 State of California Publications. State of California, Department of Consumer Affairs, 3485 Orange Grove Avenue, North Highlands, CA 95660-5595.

California Technical Bulletin 117, *Requirements, Test Procedure and Apparatus for Testing the Flame Retardance of Resilient Filling Materials Used in Upholstered Furniture*, 2000.

California Technical Bulletin 129, *Flammability Test Procedure for Mattresses for Use in Public Buildings*, 1992.

California Technical Bulletin 133, *Flammability Test Procedure for Seating Furniture for Use in Public Occupancies*, 1991.

Δ **2.3.16 TC Publications.** Transport Canada, 330 Sparks Street, Ottawa, ON K1A ON5, Canada.

Transportation of Dangerous Goods Regulations.

2.3.17 TIA Publications. Telecommunications Industry Association, 1320 North Courthouse Road, Suite 200, Arlington, VA 22201.

TIA/EIA 568-B, *Commercial Building Telecommunications Cabling Standard*, 2012.

TIA/EIA 606-B, *Administration Standard for Commercial Telecommunications Infrastructure*, 2009.

Δ **2.3.18 USP Publications.** U.S. Pharmacopeia, 12601 Twinbrook Parkway, Rockville, MD 20852-1790.

Monograph: Oxygen USP.

Monograph: Oxygen USP 93.

Δ **2.3.19 UL Publications.** Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*, 2018.

UL 1069, *Standard for Hospital Signaling and Nurse Call Equipment*, 2007, revised 2018.

UL 1685, *Standard for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables*, 2015.

Δ **2.3.20 U.S. Government Publications.** U.S. Government Publishing Office, 732 North Capitol Street, NW, Washington, DC 20401-0001.

DOE-STD-3020, *Specification for HEPA Filters Used by DOE Contractors*, Department of Energy, 2005.

Title 16, Code of Federal Regulations, Part 1632, "Standard for the Flammability of Mattresses and Mattress Pads (FF 4-72)."

Title 21, Code of Federal Regulations, Part 210, "Current Good Manufacturing Practice in Manufacturing, Processing, Packing, or Holding of Drugs — General."

Title 21, Code of Federal Regulations, Part 211, "Current Good Manufacturing Practice for Finished Pharmaceuticals."

Title 21, United States Code, Chapter 9, "Federal Food, Drug, and Cosmetic Act."

2.3.21 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 10, *Standard for Portable Fire Extinguishers*, 2018 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2019 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 2021 edition.

NFPA 55, *Compressed Gases and Cryogenic Fluids Code*, 2020 edition.

NFPA 70®, National Electrical Code®, 2020 edition.

NFPA 70B, *Recommended Practice for Electrical Equipment Maintenance*, 2019 edition.

NFPA 99B, *Standard for Hypobaric Facilities*, 2021 edition.

NFPA *101®, Life Safety Code®*, 2021 edition.

NFPA 110, *Standard for Emergency and Standby Power Systems*, 2019 edition.

NFPA 1670, *Standard on Operations and Training for Technical Search and Rescue Incidents*, 2017 edition.

NFPA 5000®, Building Construction and Safety Code®, 2021 edition.

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Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this code. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3* Code. A standard that is an extensive compilation of provisions covering broad subject matter or that is suitable for adoption into law independently of other codes and standards.

3.2.4 Guide. A document that is advisory or informative in nature and that contains only nonmandatory provisions. A guide may contain mandatory statements such as when a guide can be used, but the document as a whole is not suitable for adoption into law.

3.2.5 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.6* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.7 Shall. Indicates a mandatory requirement.

3.2.8 Should. Indicates a recommendation or that which is advised but not required.

3.2.9 Standard. An NFPA Standard, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and that is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the NFPA Manuals of Style. When used in a generic sense, such as in the phrase "standards development process" or "standards development activities," the term "standards" includes all NFPA Standards, including Codes, Standards, Recommended Practices, and Guides.

3.3 General Definitions.

3.3.1 Adiabatic Heating. The heating of a gas caused by its compression. (HYP)

3.3.2 Aerosol. An intimate mixture of a liquid or a solid in a gas; the liquid or solid, called the dispersed phase, is uniformly distributed in a finely divided state throughout the gas, which is the continuous phase or dispersing medium. (MED)

3.3.3 Alarm System. (PIP)

3.3.3.1 ***Area Alarm System.*** A warning system within an area of use that provides continuous visible and audible surveillance of Category 1 and Category 2 medical gas and vacuum systems. (PIP)

3.3.3.2 ***Category 3 Alarm System.*** A warning system within an area of use that provides continuous visible and audible surveillance of Category 3 medical gas systems. (PIP)

3.3.3.3 ***Local Alarm System.*** A warning system that provides continuous visible and audible surveillance of medical gas and vacuum system source equipment at the equipment site. (PIP)

3.3.3.4 ***Master Alarm System.*** A warning system that monitors the operation and condition of the source of supply, the reserve source (if any), and the pressure in the main lines of each medical gas and vacuum piping system. (PIP)

3.3.4 Alternate Power Source. One or more generator sets, or battery systems where permitted, intended to provide power during the interruption of the normal electrical service; or the public utility electrical service intended to provide power during interruption of service normally provided by the generating facilities on the premises. (ELS)

3.3.5 Ambulatory Health Care Occupancy. An occupancy used to provide services or treatment simultaneously to four or more patients that provides, on an outpatient basis, one or more of the following: (1) treatment for patients that renders the patients incapable of taking action for self-preservation under emergency conditions without the assistance of others; (2) anesthesia that renders the patients incapable of taking action for self-preservation under emergency conditions without the assistance of others; (3) treatment for patients who, due to the nature of their injury or illness, are incapable of taking action for self-preservation under emergency conditions without the assistance of others. [***101,*** 2021] (FUN)

3.3.6 Ampacity. The maximum current, in amperes, that a conductor can carry continuously under the conditions of use without exceeding its temperature rating. [**70,** 2020] (ELS)

3.3.7 Anesthetic. As used in this code, applies to any inhalational agent used to produce sedation, analgesia, or general anesthesia. (MED)

3.3.8 Appliance. Utilization equipment, generally other than industrial, normally built in standardized sizes or types, that is installed or connected as a unit to perform one or more functions. (MED)

3.3.9 Applicable Code. The building code, fire code, or NFPA *101* adopted by the jurisdiction, or NFPA *101* where no such code has been adopted by the jurisdiction. (FUN)

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3.3.10* Applicator. A means of applying high-frequency energy to a patient other than by an electrically conductive connection. (MED)

3.3.11 Area of Administration. Any point within a room within 4.3 m (15 ft) of oxygen equipment or an enclosure containing or intended to contain an oxygen-enriched atmosphere. (MED)

3.3.12* Atmosphere. The pressure exerted by, and gaseous composition of, an environment. (HYP)

3.3.12.1 ***Atmosphere Absolute (ATA).*** The pressure of the earth's atmosphere, 760.0 mmHg, 101.325 kPa, or 14.7 psia. Two ATA = two atmospheres. *(See also 3.3.12, Atmosphere.)* (HYP)

3.3.12.2* ***Atmosphere of Increased Burning Rate.*** Any atmosphere containing a percentage of oxygen or oxygen and nitrous oxide greater than the quotient of 23.45 divided by the square root of the total pressure in atmospheres. (HYP)

3.3.12.3 ***Chamber Atmosphere.*** The environment inside a chamber. (HYP)

3.3.13 Automatic. Providing a function without the necessity of human intervention. (ELS)

3.3.14 Bathrooms. An area including a basin with one or more of the following: a toilet, a urinal, a tub, a shower, a bidet, or similar plumbing fixtures. [**70,** 2020] (FUN)

3.3.15 Battery-Powered Lighting Units. Individual unit equipment for backup illumination consisting of a rechargeable battery, battery-charging means, provisions for one or more lamps mounted on the equipment, or with terminals for remote lamps, or both, and relaying device arranged to energize the lamps automatically upon failure of the supply to the unit equipment. [**70,** 2020] (ELS)

3.3.16 Bends. Decompression sickness; caisson worker's disease. (HYP)

3.3.17 Branch Circuit. The circuit conductors between the final overcurrent device protecting the circuit and the outlet(s). [**70,** 2020] (ELS)

3.3.18 Branch Line. See 3.3.146, Piping. (PIP)

3.3.19 Bulk System. An assembly of equipment for supplying compressed gas (consisting of, but not limited to, storage containers, pressure regulators, pressure relief devices, vaporizers, manifolds, and interconnecting piping) that terminates where the gas, at service pressure, first enters the main line. The storage containers are either stationary or movable and include unconnected reserves on hand at the site, and the source gas is stored as a compressed gas or cryogenic fluid. (PIP)

3.3.19.1 ***Bulk Inert Gas System.*** A bulk system with a storage capacity of more than 566 m^3 [20,000 ft^3 (scf)] of inert gas. (PIP)

3.3.19.2 ***Bulk Nitrous Oxide System.*** A bulk system with a storage capacity of more than 1452 kg (3200 lb) [approximately 793 m^3 (28,000 ft^3) at normal temperature and pressure] of nitrous oxide (PIP).

3.3.19.3* ***Bulk Oxygen System.*** A bulk system with a storage capacity of more than 566 m^3 (20,000 ft^3) at normal temperature and pressure of oxygen. (PIP)

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3.3.20 Category 3 Vacuum System. A Category 3 vacuum distribution system that can be either a wet system designed to remove liquids, air–gas, or solids from the treated area; or a dry system designed to trap liquid and solids before the service inlet and to accommodate air–gas only through the service inlet. (PIP)

3.3.21* Central Supply System. The complete source of supply for a medical gas or vacuum system or a medical support gas system. (PIP)

3.3.22 Clean Agent. Electrically non-conducting, volatile, or gaseous fire extinguishant that does not leave a residue upon evaporation. [**10,** 2018] (FUN)

3.3.23* Clinical IT Network. An information technology video, voice, and data communication network that is dedicated for shared use by medical devices, nurse call, clinical information systems, patient-critical applications, and clinical wireless communication equipment. (ELS)

3.3.24 Combustible. Capable of undergoing combustion. (MED)

3.3.25* Combustible Liquid. Any liquid that was a closed-cup flash point at or above 37.8°C (100°F). Combustible liquids are classified as follows: (a) Class II liquid. Any liquid that has a flash point at or above 37.8°C (100°F) and below 60°C (140°F); (b) Class IIIA liquid. Any liquid that has a flash point at or above 60°C (140°F) and below 93°C (200°F); (c) Class IIIB liquid. Any liquid that has a flash point at or above 93°C (200°F). (FUN)

3.3.26* Combustion. A chemical process of oxidation that occurs at a rate fast enough to produce heat and usually light in the form of either a glow or flame. [**5000,** 2021] (HYP)

3.3.27 Compact Storage. Storage on solid shelves not exceeding 0.9 m (36 in.) in total depth, arranged as part of a compact storage module, with no more than 0.76 m (30 in.) between shelves vertically and with no internal vertical flue spaces other than those between individual shelving sections. [**13,** 2019] (FUN)

N **3.3.28* Compressed Medical Gases (CMG).** Any liquefied or vaporized gas alone or in combination with other gases that is classified as a drug. [**55,** 2020] (PIP)

3.3.29 Container. A low-pressure, vacuum-insulated vessel containing gases in liquid form. (MED)

Δ **3.3.29.1** ***Liquid Oxygen Base Reservoir Container.*** A container used for liquid oxygen not exceeding 60 L (15.8 gal) specifically designed for use as a medical device as defined by 21 USC 9, "Federal Food, Drug and Cosmetic Act," that is intended to deliver gaseous oxygen for therapeutic use, transfilling, or both. (MED)

Δ **3.3.29.2** ***Liquid Oxygen Portable Container.*** A container used for liquid oxygen not exceeding 1.5 L (0.396 gal) specifically designed for use as a medical device as defined by 21 USC 9, "Federal Food Drug and Cosmetic Act," that is intended for portable therapeutic use and to be filled from its companion base unit, which is a liquid oxygen base reservoir container. (MED)

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3.3.30 Critical Branch. A system of feeders and branch circuits supplying power for task illumination, fixed equipment, select receptacles, and select power circuits serving areas and functions related to patient care that are automatically connected to alternate power sources by one or more transfer switches during interruption of the normal power source. (ELS)

3.3.31 Critical Equipment. That equipment essential to the safety of the occupants of the facility. (HYP)

3.3.32 Cryogenic Fluid Central Supply System. An assembly of equipment for supplying compressed gas, including, but not limited to, a stationary tank(s) that is permanently installed through anchoring to a foundation, pressure regulators, pressure relief devices, vaporizers, manifolds, and interconnecting piping that is designed to be filled at the health care facility with a cryogenic fluid and that terminates at the source valve. (PIP)

Δ **3.3.32.1** ***Bulk Nitrous Oxide Central Supply System.*** A central supply system with a storage capacity of more than 1452 kg (3200 lb) [i.e., approximately 793 m^3 (28,000 ft^3) at normal temperature and pressure] of nitrous oxide. (PIP)

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3.3.33 Cylinder. A supply tank containing high-pressure gases or gas mixtures at pressures that can be in excess of 13.8 kPa gauge (2000 psi gauge). (MED)

3.3.34 Decompression Sickness. A syndrome due to evolved gas in the tissues resulting from a reduction in ambient pressure. (HYP)

3.3.35* Defend in Place. The operational response to an emergency in a building, in which the initial action does not involve evacuation of the building occupants. (FUN)

3.3.36 Demand Check. A paired set of fittings that permit gas flow when correctly mated but interrupt flow when separated. (PIP)

Δ **3.3.37 Dental Air.** Compressed gas to drive dental devices, supplied by compressed air systems, pressurized cylinders of air, or nitrogen. (PIP)

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

3.3.39 Dental Vacuum/Scavenging. A system used in dentistry for oral evacuation and nitrous oxide/oxygen scavenging. (PIP)

3.3.40 Detonation. An exothermic reaction wherein the reaction propagates through the unreacted material at a rate exceeding the velocity of sound, hence the explosive noise. (MED)

3.3.41* Direct Electrical Pathway to the Heart. An externalized conductive pathway, insulated except at its ends, one end of which is in direct contact with heart muscle while the other is outside the body and is accessible for inadvertent or intentional contact with grounded objects or energized, ground-referenced sources. (MED)

3.3.42* Disaster. Within the context of this code, any unusual occurrence or unforeseen situation that seriously overtaxes or threatens to seriously overtax the routine capabilities of a health care facility. (HES)

3.3.43 D.I.S.S. Connector. A system of noninterchangeable medical gas and vacuum connectors complying with CGA V-5, *Diameter Index Safety System (Noninterchangeable Low Pressure Connections for Medical Gas Applications).* (PIP)

3.3.44* Double-Insulated Appliances. Appliances where the primary means of protection against electrical shock is not grounding. The primary means is by the use of combinations of insulation and separation spacings in accordance with an approved standard. (MED)

3.3.45 Electrical Life Support Equipment. Electrically powered equipment whose continuous operation is necessary to maintain a patient's life. (ELS)

N **3.3.46 Electrical Preventive Maintenance (EPM).** A managed program of inspecting, testing, analyzing, and servicing electrical systems and equipment with the purpose of maintaining safe operations and production by reducing or eliminating system interruptions and equipment breakdowns. [**70B,** 2019] (ELS)

3.3.47 Electrode. An electrically conductive connection to a patient. (MED)

3.3.48 Emergency Management. The act of developing procedures and plans to create effective preparedness, mitigation, response, and recovery during a disaster affecting a health care facility. (HES)

3.3.49 Emergency Oxygen Supply Connection (EOSC). An assembly of equipment that permits a gas supplier to make a temporary connection to supply oxygen to a building that has had its normal source of oxygen interrupted. (PIP)

3.3.50 Equipment Branch. A system of feeders and branch circuits arranged for delayed, automatic, or manual connection to the alternate power source and that serves primarily 3-phase power equipment. (ELS)

3.3.51 Equipment Grounding Bus. A grounding terminal bus in the feeder circuit of the branch circuit distribution panel that serves a particular area. (MED)

Δ **3.3.52* Essential Electrical System.** A system comprised of alternate power sources and all connected distribution systems and ancillary equipment, designed to ensure continuity of electrical power to designated areas and functions of a health care facility during disruption of normal power sources, and also to minimize disruption within the internal wiring system. (ELS)

3.3.53 Evacuation — Waste Gas. See 3.3.185, Waste Anesthetic Gas Disposal. (PIP)

3.3.54 Exposed Conductive Surfaces. Those surfaces that are capable of carrying electric current and that are unprotected, uninsulated, unenclosed, or unguarded, permitting personal contact. (ELS)

3.3.55* Facility Fire Plan. A plan developed by the health care facility to describe the actions to be taken during a fire emergency. (FUN)

3.3.56 Fault Current. A current in an accidental connection between an energized and a grounded or other conductive

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element resulting from a failure of insulation, spacing, or containment of conductors. (ELS)

3.3.57 Feeder. All circuit conductors between the service equipment, the source of a separately derived system, or other power supply source and the final branch-circuit overcurrent device. (ELS)

N **3.3.58* FGI Guidelines.** A collection of documents that includes the following: (1) *Guidelines for Design and Construction of Hospitals*; (2) *Guidelines for Design and Construction of Outpatient Facilities*; and (3) *Guidelines for Design and Construction of Residential Health, Care, and Support Facilities.*

3.3.59* Flammable. A combustible that is capable of easily being ignited and rapidly consumed by fire. (FUN)

3.3.60 Flammable Gas. Any substance that exists in the gaseous state at normal atmospheric temperature and pressure and is capable of being ignited and burned when mixed with proper proportion of air, oxygen, or other oxidizers. (HYP)

3.3.61 Flammable Liquid. A liquid that has a closed-cup flash point that is below 37.8°C (100°F) and a maximum vapor pressure of 2068 mmHg (40 psi absolute) at 37.8°C (100°F). (FUN)

3.3.62* Flash Point. The minimum temperature at which a liquid or a solid emits vapor sufficient to form an ignitable mixture with air near the surface of the liquid or the solid. (FUN)

3.3.63 Flow-Control Valve. A valve, usually a needle valve, that precisely controls flow of gas. (MED)

3.3.64* Flowmeter. A device for measuring volumetric flow rates of gases and liquids. (MED)

3.3.65* Frequency. The number of oscillations, per unit time, of a particular current or voltage waveform. The unit of frequency is the hertz. (MED)

3.3.66* Fume Hood. An enclosure designed to draw air inward by means of mechanical ventilation. (ELS)

3.3.67 Gas-Powered System. A Level 3 gas distribution system comprised of component parts including but not limited to cylinders, manifolds, air compressor, motor, receivers, controls, filters, dryers, valves, and piping that delivers compressed air or nitrogen at pressures less than 1100 kPa (less than 160 psi) gauge to power devices (e.g., hand pieces, syringes, cleaning devices) as a power source. (PIP)

3.3.68* General Anesthesia and Levels of Sedation/Analgesia.

3.3.68.1 ***General Anesthesia.*** A drug-induced loss of consciousness during which patients are not arousable, even by painful stimulation. The ability to independently maintain ventilatory function is often impaired. Patients often require assistance in maintaining a patent airway, and positive pressure ventilation may be required because of depressed spontaneous ventilation or drug-induced depression of neuromuscular function. Cardiovascular function may be impaired. (PIP)

3.3.68.2 ***Deep Sedation/Analgesia.*** A drug-induced depression of consciousness during which patients cannot be easily aroused but respond purposefully following repeated or painful stimulation. The ability to independently maintain ventilatory function may be impaired. Patients may require assistance in maintaining a patent airway, and spontaneous ventilation may be inadequate. Cardiovascular function is usually maintained. (PIP)

3.3.68.3 ***Moderate Sedation/Analgesia (Conscious Sedation).*** A drug-induced depression of consciousness during which patients respond purposefully to verbal commands, either alone or accompanied by light tactile stimulation. No interventions are required to maintain a patient airway, and spontaneous ventilation is adequate. Cardiovascular function is usually maintained. (PIP)

3.3.68.4 ***Minimal Sedation (Anxiolysis).*** A drug-induced state during which patients respond normally to verbal commands. Although cognitive function and coordination may be impaired, ventilatory and cardiovascular functions are unaffected. (PIP)

3.3.69* Ground-Fault Circuit Interrupter (GFCI). A device intended for the protection of personnel that functions to de-energize a circuit or portion thereof within an established period of time when a current to ground exceeds the values established for a Class A device. [**70,** 2020] (ELS)

3.3.70 Grounding. See 3.3.71, Grounding System. (ELS)

3.3.71* Grounding System. A system of conductors that provides a low-impedance return path for leakage and fault currents. (ELS)

3.3.72 Hazard Current. For a given set of connections in an isolated power system, the total current that would flow through a low impedance if it were connected between either isolated conductor and ground. (ELS)

3.3.72.1 ***Fault Hazard Current.*** The hazard current of a given isolated power system with all devices connected except the line isolation monitor. (ELS)

3.3.72.2 ***Monitor Hazard Current.*** The hazard current of the line isolation monitor alone. (ELS)

3.3.72.3 ***Total Hazard Current.*** The hazard current of a given isolated system with all devices, including the line isolation monitor, connected. (ELS)

3.3.73* Health Care Facilities. Buildings, portions of buildings, or mobile enclosures in which human medical, dental, psychiatric, nursing, obstetrical, or surgical care is provided. (FUN)

3.3.74* Health Care Facility's Governing Body. The person or persons who have the overall legal responsibility for the operation of a health care facility. (FUN)

N **3.3.75* Health Care Microgrid.** A group of interconnected loads and distributed energy resources within clearly defined boundaries that acts as a single controllable entity with respect to the utility. (ELS)

N **3.3.76 Health Care Microgrid Control System.** A system including health care microgrid control functions that can manage itself, operate autonomously, and connect to and disconnect from the utility for the exchange of power and the supply of ancillary services. (ELS)

Δ **3.3.77* Home Care.** Medical services or equipment provided in residential settings that purposely facilitate the provision of medical or custodial care; excludes commercial facilities. (FUN)

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3.3.78 Hospital. A building or portion thereof used on a 24-hour basis for the medical, psychiatric, obstetrical, or surgical care of four or more inpatients. [***101,*** 2021] (FUN)

3.3.79 Humidifier. A device used for adding water vapor to inspired gas. (MED)

3.3.80 Hyperbaric Facility. Building, structure, or space used to house hyperbaric chambers and auxiliary service equipment for medical applications and procedures at pressures above normal atmospheric pressure. (HYP)

3.3.81* Hyperbaric Operations. Procedures conducted on the patient receiving hyperbaric treatment. (HYP)

3.3.82 Hyperbaric Stand-Alone Oxygen System. The oxygen system is entirely separate from the hospital's Category 1 Oxygen System or is a freestanding hyperbaric facility. (HYP)

3.3.83 Hypobaric Facility. Building, structure, or space used to house hypobaric chambers and auxiliary service equipment for medical applications and procedures at pressures below atmospheric pressure. (HYP)

3.3.84 Hypoxia. A state of inadequate oxygenation of the blood and tissue sufficient to cause impairment of function. [**99B,** 2021] (HYP)

3.3.85 Immediate Restoration of Service. Automatic restoration of operation with an interruption of not more than 10 seconds. (ELS)

3.3.86* Impedance. Impedance is the ratio of the voltage drop across a circuit element to the current flowing through the same circuit element. The unit of impedance is the ohm. (MED)

3.3.87 Incident Command System (ICS). The combination of facilities, equipment, personnel, procedures, and communications operating within a common organizational structure that has responsibility for the management of assigned resources to effectively accomplish stated objectives pertaining to an incident or training exercise. [**1670,** 2017] (HES)

3.3.88* Instrument Air. A medical support gas that falls under the general requirements for medical gases. Medical air and instrument air are distinct systems for mutually exclusive applications. (PIP)

3.3.89 Intermittent Positive-Pressure Breathing (IPPB). Ventilation of the lungs by application of intermittent positive pressure to the airway. (MED)

3.3.90* Intrinsically Safe. As applied to equipment and wiring, equipment and wiring that are incapable of releasing sufficient electrical energy under normal or abnormal conditions to cause ignition of a specific hazardous atmospheric mixture. (HYP)

3.3.91 Invasive Procedure. Any procedure that penetrates the protective surfaces of a patient's body (i.e., skin, mucous membrane, cornea) and that is performed with an aseptic field (procedural site). [Not included in this category are placement of peripheral intravenous needles or catheters used to administer fluids and/or medications, gastrointestinal endoscopies (i.e., sigmoidoscopies), insertion of urethral catheters, and other similar procedures.] (ELS)

3.3.92 Isolated Patient Lead. A patient lead whose impedance to ground or to a power line is sufficiently high that connecting the lead to ground, or to either conductor of the power line, results in current flow below a hazardous limit in the lead. (MED)

3.3.93* Isolated Power System. A system comprising an isolation transformer or its equivalent, a line isolation monitor, and its ungrounded circuit conductors. (ELS)

3.3.94 Isolation Transformer. A transformer of the multiple-winding type, with the primary and secondary windings physically separated, that inductively couples its ungrounded secondary winding to the grounded feeder system that energizes its primary winding. (ELS)

3.3.95* Laboratory. A building, space, room, or group of rooms intended to serve activities involving procedures for investigation, diagnosis, or treatment in which flammable, combustible, or oxidizing materials are to be used. (FUN)

3.3.96 Leak Detectant. For purposes of this standard, a reagent, a solution, or an electronic or mechanical device suitable for the detection or visualization of escaping gas. (PIP)

3.3.97 Life Safety Branch. A system of feeders and branch circuits supplying power for lighting, receptacles, and equipment essential for life safety that is automatically connected to alternate power sources by one or more transfer switches during interruption of the normal power source. (ELS)

3.3.98* Limited-Combustible (Material). See 4.4.2. (FUN)

3.3.99 Line Isolation Monitor. A test instrument designed to continually check the balanced and unbalanced impedance from each line of an isolated circuit to ground and equipped with a built-in test circuit to exercise the alarm without adding to the leakage current hazard. (ELS)

3.3.100* Liquid. Any material that (1) has a fluidity greater than that of 300 penetration asphalt when tested in accordance with ASTM D5, *Standard Test Method for Penetration of Bituminous Materials*, or (2) is a viscous substance for which a specific melting point cannot be determined but that is determined to be a liquid in accordance with ASTM D4359, *Standard Test for Determining Whether a Material is a Liquid or a Solid.* [**30,** 2021] (FUN)

3.3.101* Local Signal. A visible indication of the operating status of equipment. (PIP)

3.3.102 mA. Milliampere. (FUN)

3.3.103 Manifold. A device for connecting the outlets of one or more gas cylinders to the central piping system for that specific gas. (PIP)

3.3.104* Manufactured Assembly. A factory-assembled product designed for aesthetics or convenience that contains medical gas or vacuum outlets, piping, or other devices related to medical gases. (PIP)

3.3.105 Mask. A device that fits over the mouth and nose (oronasal) or nose (nasal) used to administer gases to a patient. (MED)

3.3.106* Medical Air. For purposes of this code, medical air is air supplied from cylinders, bulk containers, or medical air compressors or reconstituted from oxygen USP and oil-free, dry nitrogen NF. (PIP)

3.3.106.1 ***Proportioning System for Medical Air USP.*** A central supply that produces medical air (USP) reconstituted from

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oxygen USP and nitrogen NF by means of a mixer or blender. (PIP)

3.3.107 Medical Air Compressor. A compressor that is designed to exclude oil from the air stream and compression chamber and that does not under normal operating conditions or any single fault add any toxic or flammable contaminants to the compressed air. (PIP)

3.3.108 Medical Gas. A patient medical gas or medical support gas. *(See also 3.3.144, Patient Medical Gas, and 3.3.111, Medical Support Gas.)* (PIP)

3.3.109 Medical Gas System. An assembly of equipment and piping for the distribution of nonflammable medical gases such as oxygen, nitrous oxide, compressed air, carbon dioxide, and helium. (PIP)

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

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

3.3.112 Medical–Surgical Vacuum. A method used to provide a source of drainage, aspiration, and suction in order to remove body fluids from patients. (PIP)

3.3.113 Medical–Surgical Vacuum System. An assembly of central vacuum–producing equipment and a network of piping for patient suction in medical, medical–surgical, and waste anesthetic gas disposal (WAGD) applications. (PIP)

3.3.114 Multiple Treatment Facility. A diagnostic or treatment complex under a single management comprising a number of single treatment facilities, which can be accessed one from the other without exiting the facility (i.e., does not involve widely separated locations or separate distinct practices). (FUN)

3.3.115 mV. Millivolt. (FUN)

3.3.116 Nasal Cannula. Device consisting of two short tubes to be inserted into the nostrils to administer oxygen or other therapeutic gases. (MED)

3.3.117 Nebulizer. A device used for producing an aerosol of water and/or medication within inspired gas supply. (MED)

3.3.118 Negative Pressure. Pressure less than atmospheric. (MED)

3.3.119 Nitrogen. An element that, at atmospheric temperatures and pressures, exists as a clear, colorless, and tasteless gas; it comprises approximately four-fifths of the earth's atmosphere. (MED)

3.3.119.1 ***Nitrogen NF.*** Nitrogen complying as a minimum with nitrogen NF. (PIP)

3.3.120 Nitrogen Narcosis. A condition resembling alcoholic inebriation, which results from breathing nitrogen in the air under significant pressure. (HYP)

3.3.121 Nitrous Oxide. An inorganic compound, one of the oxides of nitrogen. It exists as a gas at atmospheric pressure and temperature, possesses a sweetish smell, and is used for inducing anesthesia when inhaled. The oxygen in the compound will be released under conditions of combustion, creating an oxygen-enriched atmosphere. (MED)

3.3.122 Noncombustible (Material). See 4.4.1. (FUN)

3.3.123 Nonflammable. Not readily capable of burning with a flame and not liable to ignite and burn when exposed to flame. (FUN)

3.3.124 Nonflammable Anesthetic Agent. Refers to those inhalation agents that, because of their vapor pressure at 37°C (98.6°F) and at atmospheric pressure, cannot attain flammable concentrations when mixed with air, oxygen, or mixtures of oxygen and nitrous oxide. (MED)

3.3.125* Nonflammable Medical Gas System. See 3.3.109, Medical Gas System, and Chapter 5. (PIP)

3.3.126 Nonmedical Compressed Air. Air that is used for purposes other than patient care or medical devices that provide direct patient care. (MEC)

3.3.127 Nursing Home. A building or portion of a building used on a 24-hour basis for the housing and nursing care of four or more persons who, because of mental or physical incapacity, might be unable to provide for their own needs and safety without the assistance of another person. [***101,*** 2021] (FUN)

3.3.128 Opportunity for Improvement. An identified gap or shortfall with the potential to raise something to a more desirable or outstanding quality or condition. (HES)

3.3.129* Oxidizing Gas. A gas that supports combustion. (HYP)

3.3.130* Oxygen. A chemical element that, at normal atmospheric temperatures and pressures, exists as a colorless, odorless, and tasteless gas and comprises about 21 percent by volume of the earth's atmosphere. (MED)

3.3.130.1 ***Gaseous Oxygen.*** A colorless, odorless, tasteless, and nontoxic gas, comprising about 21 percent of normal air by volume, that is about 10 percent heavier than air; also the physical state of the element at atmospheric temperature and pressure. (MED)

3.3.130.2* ***Liquid Oxygen.*** Exists at cryogenic temperature, approximately −184.4°C (−300°F) at atmospheric pressure. It retains all of the properties of gaseous oxygen, but, in addition, when allowed to warm to room temperature at atmospheric pressure, it will evaporate and expand to fill a volume 860 times its liquid volume. (MED)

3.3.131 Oxygen Concentrator Unit. An engineered assembly of components that operate to raise the concentration of oxygen, providing oxygen as a drug product. (PIP)

3.3.132* Oxygen Delivery Equipment. Any device used to transport and deliver an oxygen-enriched atmosphere to a patient. (MED)

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3.3.133* Oxygen Hood. A device encapsulating a patient's head and used for a purpose similar to that of a mask. *(See also 3.3.105, Mask.)* (HYP)

Δ **3.3.134 Oxygen 93 USP.** Oxygen complying with Oxygen USP 93 Monograph. (PIP)

3.3.135* Oxygen Toxicity (Hyperbaric). Physical impairment resulting from breathing gaseous mixtures containing oxygen-enriched atmospheres at elevated partial pressures for extended periods of time. (HYP)

3.3.136 Oxygen USP. Oxygen complying with Oxygen USP Monograph. (PIP)

3.3.137 Oxygen-Enriched Atmosphere (OEA). For the purposes of this code, an atmosphere in which the concentration of oxygen exceeds 23.5 percent by volume. (HYP)

3.3.138 Patient Bed Location. The location of a patient sleeping bed, or the bed or procedure table of a Category 1 space. (ELS)

3.3.139 Patient Care–Related Electrical Equipment. Electrical equipment appliance that is intended to be used for diagnostic, therapeutic, or monitoring purposes in a patient care vicinity. (MED)

3.3.140* Patient Care Space. Any space of a health care facility wherein patients are intended to be examined or treated. (FUN)

3.3.140.1* *Category 1 Space.* Space in which failure of equipment or a system is likely to cause major injury or death of patients, staff, or visitors. (FUN)

3.3.140.2* *Category 2 Space.* Space in which failure of equipment or a system is likely to cause minor injury to patients, staff, or visitors. (FUN)

3.3.140.3* *Category 3 Space.* Space in which the failure of equipment or a system is not likely to cause injury to patients, staff, or visitors but can cause discomfort. (FUN)

3.3.140.4* *Category 4 Space.* Space in which failure of equipment or a system is not likely to have a physical impact on patient care. (FUN)

3.3.141 Patient Care Vicinity. A space, within a location intended for the examination and treatment of patients, extending 1.8 m (6 ft) beyond the normal location of the bed, chair, table, treadmill, or other device that supports the patient during examination and treatment and extending vertically to 2.3 m (7 ft 6 in.) above the floor. (MED)

3.3.142 Patient Equipment Grounding Point. A jack or terminal that serves as the collection point for redundant grounding of electric appliances serving a patient care vicinity or for grounding other items in order to eliminate electromagnetic interference problems. (MED)

3.3.143* Patient Lead. Any deliberate electrical connection that can carry current between an appliance and a patient. (MED)

3.3.144 Patient Medical Gas. Piped gases such as oxygen, nitrous oxide, helium, carbon dioxide, and medical air that are used in the application of human respiration and the calibration of medical devices used for human respiration. (PIP)

3.3.145 Piped Distribution System. A pipeline network assembly of equipment that starts at and includes the source valve, warning systems (master, area, local alarms), bulk gas system signal actuating switch wiring, interconnecting piping, and all other components up to and including the station outlets/inlets. (PIP)

3.3.146 Piping. The tubing or conduit of the system. The three general classes of piping are main lines, risers, and branch (lateral) lines. (PIP)

3.3.146.1 *Branch (Lateral) Lines.* Those sections or portions of the piping system that serve a room or group of rooms on the same story of the facility. (PIP)

3.3.146.2 *Main Lines.* The piping that connects the source (pumps, receivers, etc.) to the risers or branches, or both. (PIP)

3.3.146.3 *Risers.* The vertical pipes connecting the system main line(s) with the branch lines on the various levels of the facility. (PIP)

3.3.147 Plug (Attachment Plug, Cap). A device that, by insertion in a receptacle, establishes connection between the conductors of the attached flexible cord and the conductors connected permanently to the receptacle. (MED)

3.3.148 Plume (Medical). The smoke by-product consisting of vapors, smoke, and particulate debris produced during the thermal destruction of tissue by energy-based devices such as lasers, electrosurgical generators, and broadband light sources. (MEC)

3.3.149 Pressure.

3.3.149.1 *Absolute Pressure.* The total pressure in a system with reference to zero pressure. (HYP)

3.3.149.2 *Ambient Pressure.* Refers to total pressure of the environment referenced. (HYP)

3.3.149.3 *Gauge Pressure.* Refers to total pressure above (or below) atmospheric. (HYP)

3.3.149.4 *High Pressure.* A pressure exceeding 1.38 kPa (200 psi) gauge (215 psia). (MED)

3.3.149.5* *Operating Pressure.* The pressure that a particular piping system is set to operate at. (PIP)

3.3.149.6* *Partial Pressure.* The pressure, in absolute units, exerted by a particular gas in a gas mixture. (HYP)

3.3.149.7 *Positive Pressure.* Pressure greater than ambient atmospheric. (MED)

3.3.149.8 *Working Pressure (Rated).* The maximum rated operating pressure for a pipe, tube, or vessel based on its material, its allowable stress in tension, its outside diameter and wall thickness, the operating temperature, the joining method, and industry safety factors. (PIP)

3.3.150* Pressure-Reducing Regulator. A device that automatically reduces gas under high pressure to a usable lower working pressure. (MED)

3.3.151 Procedure Room. Where the proceduralist is using instrumentation that requires constant observation and control. (MED)

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3.3.152* Producer. The machine(s) or device(s) that generate the flow and suction required for vacuum, WAGD, and plume evacuation systems to operate. (PIP)

3.3.153 psia. Pounds per square inch absolute, a unit of pressure measurement with zero pressure as the base or reference pressure. (HYP)

3.3.154* psig. Pounds per square inch gauge, a unit of pressure measurement with atmospheric pressure as the base or reference pressure. (HYP)

3.3.155 Qualified Person. A person who, by possession of a recognized degree, certificate, professional standing, or skill, and who, by knowledge, training, and experience, has demonstrated the ability to perform the work. (HYP)

3.3.156 Reactance. The component of impedance contributed by inductance or capacitance. The unit of reactance is the ohm. (MED)

3.3.157 Receptacle. A receptacle is a contact device installed at the outlet for the connection of an attachment plug. A single receptacle is a single contact device with no other contact device on the same yoke. A multiple receptacle is two or more contact devices on the same yoke. [**70,** 2020] (ELS)

3.3.158 Reference Grounding Point. The ground bus of the panelboard or isolated power system panel supplying the patient care room. (MED)

3.3.159 Relocatable Power Tap (RPT). A device for indoor use consisting of an attachment plug on one end of a flexible cord and three or more receptacles on the opposite end. *(See 10.2.3.6.)* (MED)

3.3.160* Remote. A Level 3 source of supply that is accessed by exiting the single or multiple treatment facility. (PIP)

3.3.161 Reserve Supply. Where existing, that portion of the supply equipment that automatically supplies the system in the event of failure of the operating supply. The reserve supply only functions in an emergency and not as a normal operating procedure. (PIP)

3.3.162 Risk Categories. (FUN)

3.3.162.1 ***Category 1.*** Activities, systems, or equipment whose failure is likely to cause major injury or death to patients, staff, or visitors. (FUN)

3.3.162.2 ***Category 2.*** Activities, systems, or equipment whose failure is likely to cause minor injury to patients, staff, or visitors. (FUN)

3.3.162.3 ***Category 3.*** Activities, systems, or equipment whose failure is not likely to cause injury to patients, staff, or visitors but can cause discomfort. (FUN)

3.3.162.4 ***Category 4.*** Activities, systems, or equipment whose failure would have no impact on patient care. (FUN)

3.3.163 Scavenging. Evacuation of exhaled mixtures of oxygen and nitrous oxide. (PIP)

3.3.164 Selected Receptacles. A minimal number of receptacles selected by the health care facility's governing body as necessary to provide essential patient care and facility services during loss of normal power. (ELS)

3.3.165 Self-Extinguishing. A characteristic of a material such that, once the source of ignition is removed, the flame is quickly extinguished without the fuel or oxidizer being exhausted. (HYP)

3.3.166 Semipermanent Connection. A noninterchangeable connection, usually a D.I.S.S. connector, which is the termination of the pipeline and that is intended to be detached only for service. It is not the point at which the user makes connections or disconnections. (PIP)

3.3.167 Service Inlet. The pneumatic terminus of a Level 3 piped vacuum system. (PIP)

3.3.168 Service Outlet. The pneumatic terminus of a piped gas system for other than critical, continuous duty, nonflammable medical life support–type gases such as oxygen, nitrous oxide, or medical air. (PIP)

3.3.169* Single Treatment Facility. A diagnostic or treatment complex under a single management comprising a number of use points, but confined to a single contiguous group of use points (i.e., does not involve widely separated locations or separate distinct practices). (PIP)

3.3.170* Site of Intentional Expulsion. All points within 0.3 m (1 ft) of a point at which an oxygen-enriched atmosphere is intentionally vented to the atmosphere. (MED)

3.3.171 Space. A portion of the health care facility designated by the health care facility's governing body that serves a specific purpose. (FUN)

3.3.172 Standard Cubic Feet per Minute (SCFM). Volumetric flow rate of gas in units of standard cubic feet per minute. (PIP)

3.3.173 Station Inlet. An inlet point in a piped medical/surgical vacuum distribution system at which the user makes connections and disconnections. (PIP)

3.3.174 Station Outlet. An outlet point in a piped medical gas distribution system at which the user makes connections and disconnections. (PIP)

3.3.175 Supply Source. Those portions of the central supply system that act as a self-contained supply. (PIP)

3.3.175.1 ***Operating Supply.*** The portion of the central supply system that is supplying the piping system at the time of observation. (PIP)

3.3.175.2 ***Primary Supply.*** The portion of the central supply system that is the default supply for the piping system. (PIP)

3.3.175.3 ***Reserve Supply.*** Where provided, the portion of the central supply system that will supply the piping system when the primary and secondary supplies are exhausted or are not operative. (PIP)

3.3.175.4 ***Secondary Supply.*** Where provided, the portion of the central supply system that will supply the piping system when the primary supply is exhausted or is not operative. (PIP)

3.3.176* Surface-Mounted Medical Gas Rail Systems. A surface-mounted gas delivery system intended to provide ready access for two or more gases through a common delivery system to provide multiple gas station outlet locations within a single patient room or Category 1 Space. (PIP)

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Δ **3.3.177 Task Illumination.** Provisions for the minimum lighting required to carry out necessary tasks in the areas described in Chapter 6, including safe access to supplies and equipment and access to exits. (ELS)

3.3.178 Terminal. The end of a flexible hose or tubing used in a manufactured assembly where the user is intended to make connection and disconnection. (PIP)

3.3.179 Touch Current. Leakage current flowing from the enclosure or from parts thereof, excluding patient connections, accessible to any operator or patient in normal use, through an external path other than the protective grounding (earth) conductor to earth or to another part of the enclosure. (MED)

3.3.180 Transfilling. The process of transferring a medical gas in gaseous or liquid state from one container or cylinder to another container or cylinder. (MED)

3.3.181 Tube.

3.3.181.1* *Endotracheal Tube.* A tube for insertion through the mouth or nose into the upper portion of the trachea (windpipe). (MED)

3.3.182 Use Point. A location with any number of station outlets and inlets arranged for access by a practitioner during treatment of a patient. (PIP)

3.3.183 Vaporizer. A heat exchange unit designed to convert cryogenic liquid into the gaseous state. (PIP)

3.3.184 Ventilation. The mechanical or natural movement of air. (MEC)

3.3.185 Waste Anesthetic Gas Disposal (WAGD). The process of capturing and carrying away gases vented from the patient breathing circuit during the normal operation of gas anesthesia or analgesia equipment. (PIP)

3.3.186 Waste Water. (MEC)

3.3.186.1 *Black Waste Water.* Grossly contaminated and contain pathogenic, toxigenic, or other harmful agents. (MEC)

3.3.186.2 *Clear Waste Water.* Originates from a sanitary water source and does not pose substantial risk from dermal, ingestion, or inhalation exposure. (MEC)

3.3.186.3 *Gray Waste Water.* Contains significant contamination and has the potential to cause discomfort or sickness if contacted or consumed by humans. Can contain potentially unsafe levels of microorganisms or nutrients for microorganisms, as well as other organic or inorganic matter (chemical or biological). (MEC)

3.3.187* Wet Procedure Locations. The area in a patient care space where a procedure is performed that is normally subject to wet conditions while patients are present, including standing fluids on the floor or drenching of the work area, either of which condition is intimate to the patient or staff. (FUN)

3.4 BICSI Definitions. These terms are defined in *The BICSI Information Transport Systems (ITS) Dictionary.*

3.4.1 Telecommunications Entrance Facility (EF). An entrance to a building for both public and private network service cables that includes the building entrance point and the entrance room or space at the point of demarcation between campus or utility service and building interior distribution of communications systems. (ELS)

3.4.2 Telecommunications Equipment Room (TER). An environmentally controlled centralized space for telecommunications equipment, typically including main or intermediate cross-connect equipment and cabling. (ELS)

3.4.3 Telecommunications Room (TR). An enclosed architectural space for housing telecommunications equipment, cable terminations, and cross-connect cabling, serving a floor or an area of a floor. (ELS)

Chapter 4 Fundamentals

4.1* Risk Categories. All activities, as well as systems or equipment that are new or altered, shall be designed to meet Category 1 through Category 4 requirements, as detailed in this code.

4.1.1* Category 1. Activities, systems, or equipment whose failure is likely to cause major injury or death of patients, staff, or visitors shall be designed to meet Category 1 requirements, as detailed in this code.

4.1.2* Category 2. Activities, systems, or equipment whose failure is likely to cause minor injury of patients, staff, or visitors shall be designed to meet Category 2 requirements, as detailed in this code.

4.1.3 Category 3. Activities, systems, or equipment whose failure is not likely to cause injury to patients, staff, or visitors, but can cause discomfort, shall be designed to meet Category 3 requirements, as detailed in this code.

4.1.4 Category 4. Activities, systems, or equipment whose failure would have no impact on patient care shall be designed to meet Category 4 requirements, as detailed in this code.

N **4.1.5*** Activities, systems, and equipment shall be permitted to be designed to a higher risk category.

4.2* Risk Assessment.

4.2.1 The health care facility's governing body shall establish the processes and operations that are planned for the health care facility.

4.2.1.1 The governing body shall conduct risk assessments and shall determine risk categories based on the character of the processes and operations conducted in the health care facility.

4.2.2* Risk categories shall be classified by the health care facility's governing body by following and documenting a defined risk assessment procedure.

4.2.2.1 Where required by the authority having jurisdiction, the risk assessment shall be provided to the authority having jurisdiction for review based on the character of the processes and operations conducted in the health care facility.

4.2.3 A documented risk assessment shall not be required where Category 1 is selected.

4.3 Application. The Category definitions in Chapter 4 shall apply to Chapters 5 through 11, 14, and 15, except as modified in those chapters.

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4.4 Materials.

4.4.1* Noncombustible Material.

4.4.1.1 A material that complies with any of the following shall be considered a noncombustible material:

(1) A material that, in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat
(2) A material that is reported as passing ASTM E136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C*
(3) A material that is reported as complying with the pass/fail criteria of ASTM E136 when tested in accordance with the test method and procedure in ASTM E2652, *Standard Test Method for Behavior of Materials in a Tube Furnace with a Cone-shaped Airflow Stabilizer, at 750°C*

Δ **4.4.1.2** Where the term *limited-combustible* is used in this code, it shall also include the term *noncombustible*. [**5000:**7.1.4.1.2]

4.4.2* Limited-Combustible Material. A material shall be considered a limited-combustible material where one of the following is met:

(1) The conditions of 4.4.2.1 and 4.4.2.2, and the conditions of either 4.4.2.3 or 4.4.2.4, shall be met.
(2) The conditions of 4.4.2.6 shall be met.

4.4.2.1 The material shall not comply with the requirements for noncombustible material in accordance with 4.4.1.

4.4.2.2 The material, in the form in which it is used, shall exhibit a potential heat value not exceeding 3500 Btu/lb (8141 kJ/kg) where tested in accordance with NFPA 259.

Δ **4.4.2.3** The material shall have the structural base of a noncombustible material with a surfacing not exceeding a thickness of ⅛ in. (3.2 mm) where the surfacing exhibits a flame spread index not greater than 50 when tested in accordance with ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*.

Δ **4.4.2.4** The material shall be composed of materials that, in the form and thickness used, exhibit neither a flame spread index greater than 25 nor evidence of continued progressive combustion when tested in accordance with ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*, and shall be of such composition that all surfaces that would be exposed by cutting through the material on any plane would exhibit neither a flame spread index greater than 25 nor exhibit evidence of continued progressive combustion when tested in accordance with ASTM E84 or UL 723.

4.4.2.5 Materials shall be considered limited-combustible materials where tested in accordance with ASTM E2965, *Standard Test Method for Determination of Low Levels of Heat Release Rate for Materials and Products Using an Oxygen Consumption Calorimeter*, at an incident heat flux of 75 kW/m^2 for a 20-minute exposure and both of the following conditions are met:

(1) The peak heat release rate shall not exceed 150 kW/m^2 for longer than 10 seconds.
(2) The total heat released shall not exceed 8 MJ/m^2.

Δ **4.4.2.6** Where the term *limited-combustible* is used in this *Code*, it shall also include the term *noncombustible*. [**5000:**7.1.4.2.4]

Chapter 5 Gas and Vacuum Systems

5.1 Category 1 Piped Gas and Vacuum Systems.

5.1.1* Applicability.

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

Δ **5.1.1.2** Category 1 piped gas or piped vacuum system requirements shall be applied where any of the following criteria is met:

(1) General anesthesia, as defined in 3.3.68.1, or deep sedation, as defined in 3.3.68.2, is performed.
(2) The loss of the piped gas or piped vacuum systems is likely to cause major injury or death of patients, staff, or visitors.

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

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

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

(1) 5.1.2
(2) 5.1.3.1
(3) 5.1.3.2
(4) 5.1.3.3.4
(5) 5.1.3.6.2
(6) 5.1.3.6.3.10(A)(2)
(7) 5.1.3.7.6(A)(2)
(8) 5.1.3.8.4.1(2)
(9) 5.1.14

N **5.1.1.6** Category 1 systems shall be permitted to serve spaces identified as Category 1, Category 2, or Category 3.

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

5.1.3* Category 1 Sources.

5.1.3.1 Central Supply System Identification and Labeling.

5.1.3.1.1* Cylinders, containers, and tanks shall be designed, fabricated, tested, and marked (stamped) in accordance with regulations of DOT, Transport Canada (TC) *Transportation of Dangerous Goods Regulations*, or the ASME *Boiler and Pressure Vessel Code*, "Rules for the Construction of Unfired Pressure Vessels," Section VIII. [**55:**7.1.5.1]

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

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

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

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

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

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

5.1.3.1.8 Source locations containing positive pressure gases other than oxygen and medical air shall have their doors 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

N **5.1.3.1.8.1** Existing signage that is not in strict compliance with the provisions of this code shall be permitted to be continued in use as long as the authority having jurisdiction has determined that such use does not constitute a distinct hazard to life.

5.1.3.1.9 Source locations containing only oxygen or medical air shall have their doors labeled as follows:

Medical Gases
NO Smoking or Open Flame

N **5.1.3.1.9.1** Existing signage that is not in strict compliance with the provisions of this code shall be permitted to be continued in use as long as the authority having jurisdiction has determined that such use does not constitute a distinct hazard to life.

5.1.3.2 Central Supply System Operations.

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

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

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

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

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

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

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

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

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

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

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

5.1.3.2.12 Central supply systems for nitrous oxide and carbon dioxide using cylinders or portable containers shall be prevented from reaching temperatures lower than the recommendations of the central supply system's manufacturer, but shall never be lower than −7°C (20°F) or greater than 52°C (125°F).

5.1.3.3* Central Supply System Locations.

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

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

(1) Manifolds for gas cylinders *(see 5.1.3.5.10)*
(2) Manifolds for cryogenic liquid containers *(see 5.1.3.5.11)*
(3) Cryogenic fluid central supply *(see 5.1.3.5.12)*
(4)* Individual components on the oxygen side of concentrator sources *(see 5.1.3.9)*

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

(1) Manifolds for gas cylinders *(see 5.1.3.5.10)*
(2) Manifolds for cryogenic liquid containers *(see 5.1.3.5.11)*
(3) In-building emergency reserves *(see 5.1.3.5.14)*
(4) Instrument air standby headers *(see 5.1.13.3.7.6)*
(5)* Individual components on the oxygen side of concentrator sources *(see 5.1.3.9)*

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

(1) Medical air central supply compressor supply sources *(see 5.1.3.6.3)*
(2) Medical–surgical vacuum central supply sources *(see 5.1.3.7)*
(3) Waste anesthetic gas disposal (WAGD) central supply sources *(see 5.1.3.8)*
(4) Instrument air compressor central supply sources *(see 5.1.13.3.7)*
(5) Any other compressor, vacuum pump, or electrically powered machinery
(6)* Compressors, dryers, and air receivers used to supply oxygen concentrators (*see 5.1.3.9*)

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

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

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

(1) Areas involved in critical patient care
(2) Anesthetizing locations where moderate sedation, deep sedation, or general anesthesia is administered
(3) Locations storing flammables
(4) Rooms containing open electrical contacts or transformers
(5) Storage tanks for flammable or combustible liquids
(6) Engines
(7) Kitchens
(8) Areas with open flames

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

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

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

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

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

Δ 5.1.3.3.2* Design and Construction.

Δ 5.1.3.3.2.1 Locations for central supply systems, excluding cryogenic fluid central supply systems, and for the storage of positive-pressure gases shall meet the following requirements:

(1) They shall be constructed with access to move cylinders, equipment, and so forth in and out of the location on hand trucks complying with 11.4.3.1.1.
(2) They shall be provided with lockable doors or gates or otherwise able to be secured.
(3) If outdoors, they shall be well drained and provided with an enclosure (e.g., wall or fencing) constructed of noncombustible materials.
(4) If outdoors, cylinders and containers shall be protected from prolonged contact with soil.
(5) If indoors, they shall have interior finishes of noncombustible or limited-combustible materials.
(6)* If indoors, rooms containing oxygen, nitrous oxide, or other oxidizers shall be separated from the rest of the building by walls and floors having a 1-hour fire resistance rating with doors and other opening protectives having a ¾-hour fire protection rating.
(7)* They shall comply with *NFPA 70* for ordinary locations.
(8)* Fuel-fired equipment shall not be located in the room.
(9) If they require heat, the maximum allowable temperature of the in-room heating element shall be 130°C (266°F).
(10) They shall be provided with racks, chains, or other fastenings to secure all cylinders from falling, whether connected, unconnected, full, or empty.
(11)* They shall be supplied with electrical power compliant with the requirements for essential electrical systems as described in Chapter 6.
(12) They shall have racks, shelves, and supports, where provided, constructed of noncombustible materials or limited-combustible materials.
(13) They shall protect electrical devices from physical damage.
(14)* They shall allow access by delivery vehicles and management of cylinders.
(15) They shall be designed to meet the operational requirements of 5.1.3.2 with regard to room temperature.

***N* 5.1.3.3.2.2** Design and construction of locations for cryogenic fluid central supply systems shall comply with 5.1.3.5.12.

5.1.3.3.3 Ventilation.

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

5.1.3.3.3.2 Venting of Relief Valves. Indoor supply systems shall have all relief valves vented per 5.1.3.5.6.1(4) through 5.1.3.5.6.1(9).

5.1.3.3.3.3 Ventilation for Motor-Driven Equipment. The following source locations shall be ventilated to prevent accumulation of heat:

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

5.1.3.3.3.4 Ventilation for Outdoor Locations.

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

5.1.3.3.4 Storage.

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

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Approved existing installations shall be permitted to be continued in service.

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

5.1.3.4 Control Equipment. For control equipment, as specified in 5.1.3.5.5, 5.1.3.5.6, and 5.1.3.5.7, that is physically remote from the supply system, the control equipment shall be installed within a secure enclosure to prevent unauthorized access in accordance with 5.1.3.3.2.1(2).

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

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

5.1.3.5* Central Supply Systems. Central supply systems shall be permitted to consist of the following:

(1) Cylinder manifolds for gas cylinders per 5.1.3.5.10
(2) Manifolds for cryogenic liquid containers per 5.1.3.5.11
(3) Cryogenic fluid central supply systems per 5.1.3.5.12
(4) Medical air compressor systems per 5.1.3.6
(5) Medical–surgical vacuum producers per 5.1.3.7
(6) WAGD producers per 5.1.3.8
(7) Instrument air compressor systems per 5.1.13.3.7
(8) Proportioning systems for medical air USP per 5.1.3.6.3.14
(9) Oxygen central supply systems using concentrators per 5.1.3.9

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

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

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

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

5.1.3.5.4* Materials. Materials used in central supply systems shall meet the following requirements:

(1) In those portions of systems intended to handle oxygen at gauge pressures greater than 2413 kPa (350 psi), interconnecting hose shall contain no polymeric materials.
(2) In those portions of systems intended to handle oxygen or nitrous oxide material, construction shall be compatible with oxygen under the temperatures and pressures to which the components can be exposed in the containment and use of oxygen, nitrous oxide, mixtures of these gases, or mixtures containing more than 23.5 percent oxygen.
(3) If potentially exposed to cryogenic temperatures, materials shall be designed for low temperature service.
(4) If intended for outdoor installation, materials shall be installed per the manufacturer's requirements.

5.1.3.5.5 Controls for Line Pressure.

Δ **5.1.3.5.5.1*** All positive-pressure supply systems shall be provided with means to control the final line pressure at the source with all the following characteristics:

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

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

5.1.3.5.6 Relief Valves.

Δ **5.1.3.5.6.1** All pressure relief valves shall meet the following requirements:

(1) They shall be of brass, bronze, or stainless steel construction.
(2) They shall be designed for the specific gas service.
(3) They shall have a relief pressure setting not higher than the maximum allowable working pressure (MAWP) of the component with the lowest working pressure rating in the portion of the system being protected.
(4) They shall be vented to the outside of the building, except that relief valves for compressed air systems having less than 84,950 L (3000 ft^3) at STP shall be permitted to be diffused locally by means that will not restrict the flow.
(5) They shall have a vent discharge line that is not smaller than the size of the relief valve outlet or 20 mm (¾NPS), whichever is larger.
(6) Where two or more relief valves discharge into a common vent line, the internal cross-sectional area of the common line shall be not less than the aggregate cross-sectional area of all relief valve vent discharge lines served.
(7) They shall not discharge into locations creating potential hazards.

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(8) They shall have the discharge terminal turned down and screened to prevent the entry of rain, snow, or vermin.
(9) They shall be designed in accordance with ASME B31.3, *Process Piping*.

N **5.1.3.5.6.2** Pressure relief valves for cryogenic fluid central supply systems shall be in accordance with 5.1.3.10.10.

5.1.3.5.6.3 When vented to outdoors, materials and construction for relief valve discharge lines shall be the same as required for positive pressure gas distribution. *(See 5.1.10.1.)*

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

(1) They shall be located between each final line regulator and the source valve.
(2) They shall have a relief setting that is 50 percent above the normal system operating pressure, as indicated in Table 5.1.11.

5.1.3.5.6.5 When vented outside, relief valve vent lines shall be labeled in accordance with 5.1.11.1 in any manner that will distinguish them from the medical gas pipeline.

Δ **5.1.3.5.7 Multiple Pressures.** Where a single central supply system supplies separate piped distribution networks operating at different pressures, each piped distribution network shall comply with 5.1.3.5.5 for pressure controls, 5.1.3.5.6 for relief valves, 5.1.4.2 for the source valve, and 5.1.9.2.4(7) for the master alarm.

5.1.3.5.8 Local Signals.

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

(1) Manifolds for gas cylinders without reserve supply *(see 5.1.3.5.10)*
(2) Manifolds for gas cylinders with reserve supply
(3) Manifolds for cryogenic liquid containers *(see 5.1.3.5.11)*
(4) Cryogenic fluid central supply systems *(see 5.1.3.5.12)*
(5) In-building emergency reserves *(see 5.1.3.5.14)*
(6) Instrument air headers *(see 5.1.13.3.7.6)*

5.1.3.5.8.2 The local signals shall meet the following requirements:

(1) Provision of visual indication only
(2) Labeling for the service and condition being monitored
(3) If intended for outdoor installation, be installed per manufacturer's requirements

5.1.3.5.9* Headers. In central supply systems using cylinders containing either gas or liquid, each header shall include the following:

(1)* Cylinder connections in the number required for the header's application
(2) Cylinder lead for each cylinder constructed of materials complying with 5.1.3.5.4 and provided with end fittings permanently attached to the cylinder lead complying with the mandatory requirements of CGA V-1, *Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections* (ANSI B57.1)
(3) Filter of a material complying with 5.1.3.5.4 to prevent the intrusion of debris into the manifold controls
(4) Header shutoff valve downstream of the nearest cylinder connection, but upstream of the point at which the header connects to the central supply system
(5) Pressure indicator indicating the pressure of header contents
(6) Check valve to prevent backflow into the header and to allow service to the header
(7) If intended for gas cylinder service, a check valve at each connection for the cylinder lead in 5.1.3.5.9(2) to prevent loss of gas in the event of damage to the cylinder lead or operation of an individual cylinder relief valve
(8) If intended for gas cylinder service, a pressure regulator to reduce the cylinder pressure to an intermediate pressure to allow the proper operation of the primary and secondary headers
(9) If intended for service with cryogenic liquid containers, a pressure relief valve
(10) Vent valves, if fitted on a header, vented outside of the building per 5.1.3.5.6.1(5) through 5.1.3.5.6.1(9) and 5.1.3.5.6.3

5.1.3.5.10* Manifolds for Gas Cylinders.

5.1.3.5.10.1 The manifolds in this category shall be located in accordance with 5.1.3.3.1 and shall meet the following:

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

5.1.3.5.10.2 The manifold locations for this category shall be constructed in accordance with 5.1.3.3.2.

5.1.3.5.10.3 The manifolds in this category shall have their primary and secondary headers located in the same enclosure.

5.1.3.5.10.4 The manifolds in this category shall consist of the following:

(1) Two equal headers in accordance with 5.1.3.5.9, each with a sufficient number of gas cylinder connections for one average day's supply, but not fewer than two connections, and with the headers connected to the final line pressure regulator assembly in such a manner that either header can supply the system
(2) Vent valves, if fitted on a header, vented outside of the building per 5.1.3.5.6.1(5) through 5.1.3.5.6.1(9) and 5.1.3.5.6.3
(3) Intermediate relief valve(s), piped to the outside in accordance with 5.1.3.5.6.1(5) through 5.1.3.5.6.1(9), that protects the piping between the header pressure regulator and the line pressure regulator assembly, and protects the line pressure regulators from overpressure in the event of a header regulator failure

5.1.3.5.10.5 The manifolds in this category shall include an automatic means of alternating the two headers to accomplish the following in normal operation:

(1) One header is the primary and the other is the secondary, with either being capable of either role.
(2) When the primary header is supplying the system, the secondary header is prevented from supplying the system.
(3) When the primary header is depleted, the secondary header automatically begins to supply the system.

5.1.3.5.10.6 The manifolds in this category shall have a local signal that visibly indicates the operating status of the equipment and shall activate an indicator at all master alarm panels when or at a predetermined set point before the secondary

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header begins to supply the system, indicating changeover has occurred or is about to occur.

5.1.3.5.10.7 If manifolds are located out of doors, they shall be installed per the manufacturer's requirements.

5.1.3.5.11 Manifolds for Cryogenic Liquid Containers.

5.1.3.5.11.1 Manifolds for cryogenic liquid containers shall be located in accordance with 5.1.3.3.1 and shall meet the following:

(1) If located outdoors, they shall be installed in an enclosure used only for the enclosure of such containers and sited to comply with minimum distance requirements in Table 5.1.3.5.11.1.
(2) If located indoors, they shall be installed within a room used only for the enclosure of such containers.

Table 5.1.3.5.11.1 Minimum Separation Distance Between Portable Cryogenic Containers and Exposures

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

[**55:**Table 8.7.3]

5.1.3.5.11.2 The manifolds in this category shall have their primary and secondary headers located in the same enclosure.

5.1.3.5.11.3 The reserve header shall be permitted to be located in the same enclosure as the primary and secondary headers or in another enclosure compliant with 5.1.3.5.11.1.

5.1.3.5.11.4 The manifolds in this category shall consist of the following:

(1) Two equal headers in accordance with 5.1.3.5.9, each having sufficient internal or external vaporization capacity to meet the required peak flow rate and each having sufficient number of liquid container connections for one average day's supply, and with the headers connected to the final line pressure regulator assembly in such a manner that either header can supply the system
(2) Reserve header in accordance with 5.1.3.5.9 having sufficient number of gas cylinder connections for one average day's supply, but not fewer than three connections, and connected downstream of the primary/secondary headers and upstream of the final line pressure regulators
(3) Pressure relief installed downstream of the connection of the reserve header and upstream of the final line pressure regulating assembly and set at 50 percent above the nominal inlet pressure
(4) If provided with one liquid container header (primary), one gas cylinder header (secondary), and a reserve gas cylinder header (a hybrid arrangement), a secondary gas cylinder supply having equal capacity to meet the required peak flow rate of the primary header, and a reserve gas cylinder header in accordance with 5.1.3.5.9 having sufficient number of gas cylinder connections for one average day's supply, but not fewer than three connections

5.1.3.5.11.5 The manifolds in this category shall include an automatic means of controlling the three headers to accomplish the following during normal operation:

(1) If provided with two liquid container headers, one cryogenic liquid header shall be the primary and the other shall be the secondary, with either being capable of either role.
(2) If provided with one liquid container header and one gas cylinder header (a hybrid arrangement), the liquid container header is the primary and the gas cylinder header is the secondary.
(3) When the primary header is supplying the system, the secondary header is prevented from supplying the system.
(4) When the primary header is depleted, the secondary header automatically begins to supply the system.

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

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

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

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

(1) When or at a predetermined set point before the secondary header begins to supply the system, indicating changeover
(2) Where a hybrid arrangement is employed, when or at a predetermined set point before the secondary (cylinder) header contents fall to one average day's supply, indicating secondary low
(3) When or at a predetermined set point before the reserve header begins to supply the system, indicating reserve is in use
(4) When or at a predetermined set point before the reserve header contents fall to one average day's supply, indicating reserve low

5.1.3.5.12 Cryogenic Fluid Central Supply Systems. The storage, use, and handling of cryogenic fluid central supply systems that deliver compressed medical gases (CMGs) to health care facilities shall be in accordance with 5.1.3.10.

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Δ **5.1.3.5.13* Emergency Oxygen Supply Connection (EOSC).** Emergency oxygen supply connections (EOSCs) shall be installed to allow connection of a temporary auxiliary source of

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supply for emergency or maintenance situations where either of the following conditions exist:

(1) The bulk liquid system or cryogenic fluid central supply system is outside of and remote from the building that the oxygen supply serves, and there is no connected in-building oxygen reserve sufficient for one average day's supply. *(See 5.1.3.5.14 for requirements for such reserves.)*
(2) Multiple freestanding buildings are served from a single oxygen source such that damage to the interconnecting oxygen line could result in one or more buildings losing oxygen supply, in which case each building is required to be provided with a separate emergency connection.

5.1.3.5.13.1 EOSCs shall be located as follows:

(1) Located on the exterior of the building being served in a location accessible by emergency supply vehicles at all times in all weather conditions
(2) Connected to the main supply line immediately downstream of the main shutoff valve

5.1.3.5.13.2 EOSCs shall consist of the following:

(1) Physical protection to prevent unauthorized tampering
(2) Female DN (NPS) inlet for connection of the emergency oxygen source that is sized for 100 percent of the system demand at the emergency source gas pressure
(3) Manual shutoff valve to isolate the EOSC when not in use
(4) Two check valves, one downstream of the EOSC and one downstream of the main line shutoff valve, with both upstream from the tee connection for the two pipelines
(5) Relief valve sized to protect the downstream piping system and related equipment from exposure to pressures in excess of 50 percent higher than normal line pressure
(6) Any valves necessary to allow connection of an emergency supply of oxygen and isolation of the piping to the normal source of supply
(7) Minimum of 1 m (3 ft) of clearance around the EOSC for connection of temporary auxiliary source
(8)* Four alarm connection points installed to both master alarm panels to allow the temporary supply to be monitored while in use

5.1.3.5.14 In-Building Emergency Reserves (IBERs).

5.1.3.5.14.1 IBERs shall not be used as substitutes for the bulk gas reserve system that is required in 5.1.3.10.3.4.

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

(1) In a room or enclosure constructed per 5.1.3.3.2
(2) In a room or enclosure ventilated per 5.1.3.3.3

5.1.3.5.14.3 IBERs shall consist of either of the following:

(1) Gas cylinder header per 5.1.3.5.9 with sufficient cylinder connections to provide for at least one average day's supply with the appropriate number of connections being determined after consideration of the delivery schedule, the proximity of the facility to alternate supplies, and the facility's emergency plan
(2) Manifold for gas cylinders complying with 5.1.3.5.10

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

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

5.1.3.6* Category 1 Medical Air Central Supply Systems.

5.1.3.6.1* Quality of Medical Air. Medical air shall be required to have the following characteristics:

(1) It shall be supplied from cylinders, bulk containers, or medical air compressor sources, or it shall be reconstituted from oxygen USP and oil-free, dry nitrogen NF.
(2) It shall meet the requirements of medical air USP.
(3) It shall have no detectable liquid hydrocarbons.
(4) It shall have less than 25 ppm gaseous hydrocarbons.
(5) It shall have equal to or less than 1 mg/m^3 (6.85×10^{-7} lb/yd^3) of permanent particulates sized 1 micron or larger in the air at normal atmospheric pressure.

5.1.3.6.2* Uses of Medical Air. Medical air sources shall be connected to the medical air distribution system only and shall be used only for air in the application of human respiration and calibration of medical devices for respiratory application.

5.1.3.6.3* Medical Air Compressor Supply Sources.

5.1.3.6.3.1 Location. Medical air compressor systems shall be located per 5.1.3.3 as follows:

(1) Indoors in a dedicated mechanical equipment area, adequately ventilated and with any required utilities (e.g., electricity, drains, lighting)
(2) In a room ventilated per 5.1.3.3.3.3
(3) For air-cooled equipment, in a room designed to maintain the ambient temperature range as recommended by the manufacturer

5.1.3.6.3.2 Required Components. Medical air compressor systems shall consist of the following:

(1) Components complying with 5.1.3.6.3.4 through 5.1.3.6.3.8, arranged per 5.1.3.6.3.9
(2) Automatic means to prevent backflow from all on-cycle compressors through all off-cycle compressors
(3) Manual shutoff valve to isolate each compressor from the centrally piped system and from other compressors for maintenance or repair without loss of pressure in the system
(4) Intake filter–muffler(s) of the dry type
(5) Pressure relief valve(s) set at 50 percent above line pressure
(6) Piping and components between the compressor and the source shutoff valve that do not contribute to contaminant levels
(7) Except as defined in 5.1.3.6.3.2(1) through (6), materials and devices used between the medical air intake and the medical air source valve that are of any design or construction appropriate for the service as determined by the manufacturer

5.1.3.6.3.3 Air Drying Equipment. Medical air compressor systems shall preclude the condensation of water vapor in the piping distribution system by air drying equipment.

5.1.3.6.3.4 Compressors for Medical Air.

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

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(1) Elimination of oil anywhere in the compressor (e.g., liquid ring and permanently sealed bearing compressors)
(2) Reciprocating compressors provided with a separation of the oil-containing section from the compression chamber by at least two seals creating an area open to atmosphere that allows the following:
    (a) Direct and unobstructed visual inspection of the interconnecting shaft through vent and inspection openings no smaller than 1.5 shaft diameters in size
    (b) Confirmation by the facility operators of proper seal operation by direct visual inspection through the above-shaft opening, without disassembly of the compressor (e.g., extended head compressors with an atmospheric vent between the compression chamber and the crankcase)
(3) Rotating element compressors provided with a compression chamber free of oil that provide the following:
    (a) Separation of each oil-containing section from the compression chamber by at least one seal having atmospheric vents on each side with the vent closest to the oil-containing section supplied with a gravity drain to atmosphere
    (b) Unobstructed visualization of the atmospheric vent(s), closest to each oil-containing section, that is accessible for inspection without disassembling the compressor
    (c) Entry of the rotating shaft into each compression chamber at a point that is above atmospheric pressure
    (d) Confirmation by the facility operators of proper seal operation by direct visual inspection of the atmospheric vents

(B) For liquid ring compressors, service water and seal water shall be treated to control waterborne pathogens and chlorine from hyperchlorination from entering the medical air.

(C) Liquid ring compressors shall comply with the following:

(1) Service water and seal water of a quality recommended by the compressor manufacturer shall be used.
(2) Reserve medical air standby headers or a backup compressor shall be installed.
(3) When installed, the header shall comply with 5.1.3.5.9.
(4) When installed, the number of attached cylinders shall be sufficient for 1 hour normal operation.

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

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

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

5.1.3.6.3.5 Aftercoolers.

(A) Aftercoolers, where required, shall be provided with individual condensate traps.

(B) The receiver shall not be used as an aftercooler or aftercooler trap.

(C) Aftercoolers shall be constructed of materials deemed suitable by the manufacturer.

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

5.1.3.6.3.6 Medical Air Receivers. Receivers for medical air shall meet the following requirements:

(1) They shall be made of corrosion-resistant materials or otherwise be made corrosion resistant.
(2) They shall comply with Section VIII, "Unfired Pressure Vessels," of the ASME *Boiler and Pressure Vessel Code.*
(3) They shall be equipped with a pressure relief valve, automatic drain, manual drain, sight glass, and pressure indicator.
(4) They shall be of a capacity sufficient to prevent the compressors from short-cycling.

5.1.3.6.3.7 Medical Air Dryers. Medical air dryers, where required, shall meet the following requirements:

(1) Be designed to provide air at a maximum dew point that is below the frost point [0°C (32°F)] at 345 kPa to 380 kPa (50 psi to 55 psi) at any level of demand
(2) Be sized for 100 percent of the system peak calculated demand at design conditions
(3) Be constructed of materials deemed suitable by the manufacturer
(4) Be provided with antivibration mountings installed as required by equipment dynamics or location and in accordance with the manufacturer's recommendations

5.1.3.6.3.8 Medical Air Filters. Medical air filters shall meet the following requirements:

(1) Be appropriate for the intake air conditions
(2) Be located upstream (source side) of the final line regulators
(3) Be sized for 100 percent of the system peak calculated demand at design conditions and be rated for a minimum of 98 percent efficiency at 1 micron or greater
(4) Be equipped with a continuous visual indicator showing the status of the filter element life
(5) Be constructed of materials deemed suitable by the manufacturer

5.1.3.6.3.9 Piping Arrangement and Redundancies.

(A) Component arrangement shall be as follows:

(1) Components shall be arranged to allow service and a continuous supply of medical air in the event of a single fault failure.
(2) Component arrangement shall be permitted to vary as required by the technology(ies) employed, provided that an equal level of operating redundancy and medical air quality is maintained.

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

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

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

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

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

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

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

(1) They shall be installed for each component, upstream and downstream of each component, allowing each to be individually isolated.
(2) They shall be installed upstream (source side) and downstream of components in series so as to create redundant parallel branches of components.

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

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

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

(J) If the relief valve required in 5.1.3.6.3.2(5) and 5.1.3.6.3.6(3) can be isolated from the system by the valve arrangement used to comply with 5.1.3.6.3.9(F), then a redundant relief valve(s) shall be installed in the parallel sequence.

(K) A DN8 (NPS ¼) valved sample port shall be provided downstream of the final line pressure regulators, dew point monitor, and carbon monoxide monitor and upstream of the source shutoff valve to allow for sampling of the medical air.

(L) Medical air source systems shall be provided with a source valve per 5.1.4.2.

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

5.1.3.6.3.10* Electrical Power and Control.

(A) Medical air source systems shall be controlled to ensure continuous supply of medical air at pressures consistent with Table 5.1.11 under all conditions of system use as follows:

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

(B) Controls shall provide the following functions:

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

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

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

(D) Medical air compressor system controls shall be provided with electrical systems including, at a minimum:

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

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

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

5.1.3.6.3.11 Compressor Intake.

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

(B) The medical air intake shall be located a minimum of 7.6 m (25 ft) from ventilating system exhausts, fuel storage vents, combustion vents, plumbing vents, vacuum and WAGD discharges, or areas that can collect vehicular exhausts or other noxious fumes.

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

(D) The medical air intake shall be located a minimum of 3.0 m (10 ft) from any door, window, or other opening in the building.

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

(1) This alternate source of supply air shall be available on a continuous 24-hour-per-day, 7-day-per-week basis.
(2) Ventilating systems having fans with motors or drive belts located in the airstream shall not be used as a source of medical air intake.

(F) Compressor intake piping shall be permitted to be made of materials and use a joining technique as permitted under 5.1.10.2 and 5.1.10.3.

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

(1) The common intake is sized to minimize back pressure in accordance with the manufacturer's recommendations.
(2) Each compressor can be isolated by manual or check valve, blind flange, or tube cap to prevent open inlet piping when the compressor(s) is removed for service from the consequent backflow of room air into the other compressor(s).

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

N **(I)** Medical air intake shall be labeled in accordance with 5.1.11.1 with any method that would distinguish it as a medical air intake.

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

(A) A local alarm complying with 5.1.9.5 shall be provided for the medical air compressor source.

(B) Where liquid ring air compressors, compressors having water-cooled heads, or water-cooled aftercoolers are used, air receivers shall be equipped with a high water level sensor that shuts down the compressor system and activates a local alarm indicator. *[See 5.1.9.5.4(8).]*

(C) Where liquid ring compressors are used, each compressor shall have a liquid level sensor in each air–water separator that, when the liquid level is above the design level, shuts down its compressor and activates a local alarm indicator. *[See 5.1.9.5.4(9).]*

(D) Where nonliquid ring compressors compliant with 5.1.3.6.3.4(A)(1) are used, the air temperature at the immediate outlet of each compressor cylinder shall be monitored by a high-temperature sensor that shuts down that compressor and activates a local alarm indicator *[see 5.1.9.5.4(10)]*. The temperature setting shall be as recommended by the compressor manufacturer.

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

(1) The air temperature at the immediate outlet of each compressor chamber shall be monitored by a high-temperature sensor that shuts down that compressor and activates a local alarm indicator *(see 5.1.9.5.4)*, the temperature setting shall be as recommended by the compressor manufacturer.
(2) Coalescing filters with element change indicator shall be provided.
(3) Charcoal absorber shall be provided.
(4) Gaseous hydrocarbons shall be monitored on a quarterly basis.

(F) When the capacity of the medical air system not in use is less than the equivalent capacity of one compressor, a local alarm shall activate *[see 5.1.9.5.4(1)]*. This signal shall require manual reset.

5.1.3.6.3.13 Medical Air Quality Monitoring. Medical air quality shall be monitored downstream of the medical air regulators and upstream of the piping system as follows:

(1) Dew point shall be monitored and shall activate a local alarm and all master alarms when the dew point at system delivery pressure exceeds +2°C (+35°F).
(2) Carbon monoxide shall be monitored and shall activate a local alarm when the CO level exceeds 10 ppm. *[See 5.1.9.5.4(2).]*
(3) Dew point and carbon monoxide monitors shall activate their individual monitor's signal at the alarm panels where their signals are required when their power is lost.

5.1.3.6.3.14 Category 1 Medical Air Proportioning Supply Sources.

Δ (A) General.

(1)* Medical air reconstituted from oxygen USP and nitrogen NF, produced using a proportioning system(s), shall be required to meet the following:
  (a) The quality of medical air shall be in accordance with 5.1.3.6.1.
  (b) The system shall be capable of supplying this quality of medical air, in accordance with 5.1.3.6.1, over the entire range of flow.
  (c) The system shall produce medical air with an oxygen content of 19.5 percent to 23.5 percent.
(2) The medical air proportioning system shall operate automatically.
(3) The mixture shall be analyzed continuously, and a recording capability shall be provided (e.g., via data port).
(4) The analyzing system specified in 5.1.3.6.3.14(A)(3) shall be a dedicated and independent analyzer used to control the medical air proportioning system.
(5) If the mixture goes out of specification, an alarm shall be activated automatically, the primary medical air proportioning system shall be disconnected, and the reserve supply shall be activated.
(6) The system shall be arranged such that manual intervention is necessary to correct the composition of the mixture before reconnecting the medical air proportioning system to the health care facility pipeline system.
(7) If dedicated sources of oxygen USP and nitrogen NF supply the medical air proportioning system, reserve sources for the oxygen and nitrogen shall not be required.
(8) If dedicated sources of oxygen USP and nitrogen NF supply the medical air proportioning system, they shall not be used as the reserves for oxygen and nitrogen

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systems supplying the pipelines of the health care facility.

(9)* If the sources of oxygen USP and nitrogen NF that supply the medical air proportioning system are the same sources that supply the health care facility, engineering controls shall be provided to prevent cross contamination of oxygen and nitrogen supply lines, as provided in 5.1.3.5.7.

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

(B) Location. The medical air proportioning system shall be located per 5.1.3.3 as follows:

(1) The medical air proportioning system's supply of oxygen USP and nitrogen NF shall be located per 5.1.3.3 and NFPA 55, as applicable.
(2) The mixing device and controls, analyzers, and receivers shall be located indoors within a room or area per 5.1.3.3.1.
(3) The indoor location shall include atmospheric monitoring for oxygen concentration.
(4) The indoor location shall be constructed with all required utilities (e.g., electricity, drains, lighting) per *NFPA 5000*.
(5) The indoor location shall be ventilated and heated per Chapter 9 and the manufacturer's recommendations.

(C) Required Components. The medical air proportioning system shall consist of the following:

(1) Supply of oxygen USP and supply of nitrogen NF as follows:
   (a) The supply lines shall be filtered to remove particulate entering the proportioning system.
   (b) The minimum safe supply gas temperature and recommended local signal shall be specified by the medical air proportioning system manufacturer.
(2) Mixing device with analyzers and engineering controls per manufacturer's recommendations to include, as a minimum, the following:
   (a) At least two oxygen analyzers capable of independently monitoring oxygen concentration
   (b) Mechanism where each analyzer based upon nonconforming oxygen concentration is capable, directly or via other medical air proportioning system controls, of automatically shutting off the supply from the medical air proportioning system to the medical air piped distribution system and activating the reserve supply
   (c) Mechanism where each analyzer, based upon nonconforming oxygen concentration, is capable, directly or via other proportioning system controls, of automatically shutting off the supply of oxygen and nitrogen to the proportioning system and activating the reserve supply
   (d) Provision for manual resetting of the proportioning system after detection of nonconforming oxygen concentration and subsequent shutdown once conforming oxygen concentration is established, in order to re-establish flow to the medical air piping system
   (e) Means of verifying the performance of the analyzers by reference to an air standard, with known traceable oxygen content
(3) Minimum of one recorder for recording the medical air proportioning system performance and air quality for a period of not less than 24 hours
(4) Continuous analysis of the mixture and a recording capability provided (e.g., via a data port)
(5) Mechanism for isolating the primary medical air proportioning system from the reserve supply and the medical air piping distribution system by employing sequential valves for redundancy
(6) Capability of the reserve supply to automatically activate if the primary supply is isolated
(7) Reserve supply of medical air USP sized, at minimum, for one average day's supply and consisting of one of the following:
   (a) Additional medical air proportioning unit with a dedicated supply of oxygen USP and nitrogen NF
   (b) Medical air compressor system per 5.1.3.6.3, with the exception of the allowance of a simplex medical air compressor system
   (c) Medical air cylinder manifold per 5.1.3.5.10
(8) Receiver fitted with a pressure relief valve and pressure gauge as follows:
   (a) The receiver shall be constructed of corrosion-resistant materials.
   (b) The receiver, relief valves, and pressure gauges shall comply with ASME *Boiler and Pressure Vessel Code* and manufacturer's recommendations.
(9)* Warning systems per 5.1.9, including a local signal and master alarm that indicates nonconforming oxygen concentration per manufacturer's recommendations
(10) Final line pressure regulators complying with 5.1.3.5.5
(11) Pressure relief complying with 5.1.3.5.6
(12) Local signals complying with 5.1.3.5.8.2

5.1.3.7* Medical–Surgical Vacuum Central Supply Systems.

5.1.3.7.1 Medical–Surgical Vacuum Central Sources. Medical–surgical vacuum central supply systems shall be located per 5.1.3.3 as follows:

(1) Indoors in a dedicated mechanical equipment area, adequately ventilated and with any required utilities
(2) In a room ventilated per 5.1.3.3.3.3
(3) For air-cooled equipment, in a room designed to maintain the ambient temperature range as recommended by the equipment manufacturer

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

(1) Two or more vacuum pumps sufficient to serve the peak calculated demand with the largest single vacuum pump out of service
(2) Automatic means to prevent backflow from any on-cycle vacuum pumps through any off-cycle vacuum pumps
(3) Shutoff valve or other isolation means to isolate each vacuum pump from the centrally piped system and other vacuum pumps for maintenance or repair without loss of vacuum in the system
(4) Vacuum receiver
(5) Piping between the vacuum pump(s), discharge(s), receiver(s), and vacuum source shutoff valve in accordance with 5.1.10.2, except brass, galvanized, or black steel pipe, which is permitted to be used as recommended by the manufacturer

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(6) Except as defined in 5.1.3.7.1.1(1) through 5.1.3.7.1.1(5), materials and devices used between the medical vacuum exhaust and the medical vacuum source that are permitted to be of any design or construction appropriate for the service as determined by the manufacturer
(7) Vacuum filtration per 5.1.3.7.4

5.1.3.7.2 Vacuum Pumps.

5.1.3.7.2.1 Vacuum pumps shall be constructed of materials deemed suitable by the manufacturer.

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

5.1.3.7.2.3 Flexible connectors shall connect the vacuum pumps with their intake and outlet piping.

5.1.3.7.2.4 For liquid ring vacuum pumps, seal water shall be of a quality recommended by the vacuum pump manufacturer.

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

(1) They shall be made of materials deemed suitable by the manufacturer.
(2) They shall comply with Section VIII, "Unfired Pressure Vessels," of the ASME *Boiler and Pressure Vessel Code*.
(3) They shall be capable of withstanding a gauge pressure of 415 kPa (60 psi) and 760 mm (30 in.) gauge HgV.
(4) They shall be equipped with a manual drain.
(5) They shall be of a capacity based on the technology of the pumps.

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

(1) Filtration shall be at least duplex to allow one filter to be exchanged without impairing the vacuum system.
(2) Filtration shall be located on the patient side of the vacuum producer.
(3) Filters shall be efficient to 0.3 μ and 99.97 percent HEPA or better, per DOE-STD-3020, *Specification for HEPA Filters Used by DOE Contractors*.
(4) Filtration shall be sized for 100 percent of the peak calculated demand while one filter or filter bundle is isolated.
(5) It shall be permitted to group multiple filters into bundles to achieve the required capacities.
(6) The system shall be provided with isolation valves on the source side of each filter or filter bundle and isolation valves on the patient side of each filter or filter bundle, permitting the filters to be isolated without shutting off flow to the central supply system.
(7) A means shall be available to allow the user to observe any accumulations of liquids.
(8) A vacuum relief petcock shall be provided to allow vacuum to be relieved in the filter canister during filter replacement.
(9) Filter elements and canisters shall be permitted to be constructed of materials as deemed suitable by the manufacturer.
(10) In normal operation, one filter or filter bundle shall be isolated from the system to be available for service should a blockage in the operating filter occur or rotation of the filters be desired after filter element exchange.

5.1.3.7.5 Piping Arrangement and Redundancies.

5.1.3.7.5.1 Piping arrangement shall be as follows:

(1) Piping shall be arranged to allow service and a continuous supply of medical–surgical vacuum in the event of a single fault failure.
(2) Piping arrangement shall be permitted to vary based on the technology(ies) employed, provided that an equal level of operating redundancy is maintained.
(3) Where only one set of vacuum pumps is available for a combined medical–surgical vacuum system and an analysis, a research, or a teaching laboratory vacuum system, such laboratories shall be connected separately from the medical–surgical system directly to the receiver tank through its own isolation valve and fluid trap located at the receiver, and between the isolation valve and fluid trap, a scrubber shall be permitted to be installed.

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

5.1.3.7.5.3 Medical–surgical vacuum central supply systems shall be provided with a source shutoff valve per 5.1.4.2.

5.1.3.7.6 Electrical Power and Control.

(A) Medical vacuum source systems shall be controlled to ensure continuous supply of suction at pressures consistent with Table 5.1.11 under all conditions of system use as follows:

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

(B) Controls shall provide the following functions:

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

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

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

(D) Vacuum source system controls shall be provided with electrical systems including, at a minimum:

(1) Control circuits shall be arranged so that failure of any component of the control circuit, or shutdown of one

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

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

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

5.1.3.7.7 Medical–Surgical Vacuum Exhaust.

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

5.1.3.7.7.2 The exhaust shall be located as follows:

(1) Outdoors
(2) At least 7.5 m (25 ft) from any door, window, air intake, or other openings in buildings or places of public assembly
(3) At a level different from air intakes
(4) Where prevailing winds, adjacent buildings, topography, or other influences will not divert the exhaust into occupied areas or prevent dispersion of the exhaust

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

N **5.1.3.7.7.4** Vacuum exhaust shall be labeled in accordance with 5.1.11.1 with any method that would distinguish it as a vacuum exhaust.

5.1.3.7.7.5 The exhaust shall be free of dips and loops that might trap condensate or oil or provided with a drip leg and valved drain at the bottom of the low point.

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

(1) The common exhaust is sized to minimize back pressure in accordance with the pump manufacturer's recommendations.
(2) Each pump can be isolated by manual or check valve, blind flange, or tube cap to prevent open exhaust piping when the pump(s) is removed for service from consequent flow of exhaust air into the room.

5.1.3.7.7.7 Vacuum exhaust piping shall be permitted to be made of materials and use a joining technique as permitted under 5.1.10.2 and 5.1.10.3.

5.1.3.7.8 Operating Alarms. When the capacity of the medical vacuum supply system not in use is less than the equivalent capacity of one pump, a local alarm shall activate *[see 5.1.9.5.4(4)]*. This signal shall require manual reset.

5.1.3.8* Waste Anesthetic Gas Disposal (WAGD) Central Supply Systems.

5.1.3.8.1* Supply Sources. WAGD supply sources shall be chosen in consultation with the medical staff having knowledge of the requirements to determine the type of system, number and placement of terminals, and other required safety and operating devices.

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

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

(1) The medical–surgical vacuum source shall comply with 5.1.3.7.
(2) The total concentration of oxygen shall be maintained below 23.6 percent, or the vacuum pump shall comply with 5.1.3.8.2.1.
(3) The medical–surgical vacuum source shall be sized to accommodate the additional volume.

5.1.3.8.1.3 If WAGD is produced by a dedicated WAGD producer with a total power equal to or greater than 1 horsepower in total (both producers), the following shall apply:

(1) The WAGD source shall be located in accordance with 5.1.3.3.
(2) The WAGD source shall be located indoors in a dedicated mechanical equipment area with any required utilities.
(3) The WAGD source shall be ventilated per 5.1.3.3.3.3.
(4) For air-cooled equipment, the WAGD source shall be located to maintain the ambient temperature range as recommended by the manufacturer.
(5) The WAGD producers shall comply with 5.1.3.8.2.

5.1.3.8.1.4 If WAGD is produced by a dedicated WAGD producer with a total power less than 1 horsepower in total (both producers), the following shall apply:

(1) The WAGD source shall be permitted to be located near the inlet(s) served.
(2) For air-cooled equipment, the WAGD source shall be located to maintain the ambient temperature range as recommended by the manufacturer.

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

5.1.3.8.1.6 The WAGD source shall consist of the following:

(1) Two or more WAGD producers sufficient to serve the peak calculated demand with the largest single WAGD producer out of service
(2) Automatic means to prevent backflow from any on-cycle WAGD producers through any off-cycle WAGD producers
(3) Shutoff valve to isolate each WAGD producer from the centrally piped system and other WAGD producers for maintenance or repair without loss of WAGD in the system
(4) Piping between the WAGD producers and the source shutoff valve compliant with 5.1.10.2, as recommended by the manufacturer

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

5.1.3.8.1.7 If WAGD is produced by a venturi, the following shall apply:

(1) The venturi shall not be user-adjustable (i.e., require the use of special tools).
(2) The venturi shall be driven using water, inert gas, instrument air, or other dedicated air source.
(3) Medical air shall not be used to power the venturi.

5.1.3.8.2 WAGD Producers.

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

(1) Compliant with 5.1.3.7.2
(2) Designed of materials and using lubricants and sealants that are inert in the presence of oxygen, nitrous oxide, and halogenated anesthetics

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

(1) Permitted to be made of any materials determined by the manufacturer as suitable for the service
(2) Provided with antivibration mountings as required by equipment dynamics or location and in accordance with the manufacturer's recommendation
(3) Connected with their intake and outlet piping through flexible connections
(4) Used only for WAGD service and not employed for other services
(5) Interconnected via piping, ductwork, and so forth, made of materials determined by the manufacturer as suitable to the service

5.1.3.8.3 WAGD Alarms.

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

5.1.3.8.3.2 Where WAGD source systems have two or more producers, and the capacity of the WAGD system not in use is less than the equivalent capacity of one producer, a local alarm shall activate *[see 5.1.9.5.4(5)]*. This signal shall require manual reset.

5.1.3.8.4 Electrical Power and Control.

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

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

5.1.3.8.4.2 Controls shall provide the following functions:

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

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

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

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

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

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

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

5.1.3.8.5 WAGD Exhaust. The WAGD pumps shall exhaust in compliance with 5.1.3.7.7.

5.1.3.9* Oxygen Central Supply Systems Using Concentrators. Any oxygen central supply system that includes one or more oxygen concentrator supply systems shall comply with 5.1.3.9.1 through 5.1.3.9.5.

5.1.3.9.1* Oxygen Concentrator Supply Units.

5.1.3.9.1.1 Oxygen concentrator supply units for use with medical gas pipelines shall produce oxygen meeting the requirements of Oxygen 93 USP or Oxygen USP.

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

5.1.3.9.1.3 Materials of construction on the air side of the oxygen concentrator unit shall be suitable for the service as determined by the manufacturer.

5.1.3.9.1.4 Materials of construction on the oxygen side of the oxygen concentrator unit shall comply with 5.1.3.5.4.

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5.1.3.9.1.5 The components that make up the oxygen concentrator unit shall be as follows:

(1) The manufacturer of the concentrator unit shall be permitted to use such components and arrangement of such components as needed to produce oxygen complying with 5.1.3.9.1.1 in the quantity as required by the facility, except where otherwise specifically defined in this code.
(2) Air receivers and oxygen accumulators, where used, shall comply with Section VIII, "Unfired Pressure Vessels," of the ASME *Boiler and Pressure Vessels Code* and be provided with overpressure relief valves.

Δ **5.1.3.9.1.6** The supply air to the concentrator(s) shall be of a quality to ensure the oxygen concentrator unit can produce oxygen complying with 5.1.3.9.1.1 and shall not be subject to normally anticipated contamination (e.g., vehicle or other exhausts, gas leakage, discharge from vents, flooding).

Δ **5.1.3.9.1.7** The oxygen concentrator supply unit and any associated electrical equipment shall be provided with, at a minimum, the following electrical components:

(1) Either a disconnect switch for each major electrical component or a single disconnect that deactivates all electrical components in the concentrator unit
(2) Motor-starting devices with overload protection for any component with an electrical motor over 2 hp

5.1.3.9.1.8 A vent valve shall be provided as follows:

(1) Located on the source side of the concentrator outlet isolation valve to permit the operation of the oxygen concentrator unit for validation, calibration, and testing while the unit is isolated from the pipeline system
(2) Sized to allow for at least 25 percent of the oxygen concentrator unit flow
(3) Vented to a location compliant with 5.1.3.3.3.2

5.1.3.9.1.9 A DN8 (NPS ¼) valved sample port shall be provided near the oxygen concentration monitor sensor connection for sampling of the gas from the oxygen concentrator unit.

5.1.3.9.1.10 At least one 0.1 micron filter suitable for oxygen service shall be provided at the outlet of the oxygen concentrator supply unit.

5.1.3.9.1.11 A check valve shall be provided at the outlet of the oxygen concentrator supply unit to prevent backflow into the oxygen concentrator supply unit and to allow service to the unit.

5.1.3.9.1.12 An outlet valve shall be provided to isolate all components of the oxygen concentrator from the pipeline with the following characteristics:

(1) The valve shall have both manual and automatic actuation with visual indication of open or closed.
(2) The valve shall close automatically whenever the oxygen concentrator unit is not producing oxygen of a concentration equal to that in 5.1.3.9.1.1.
(3) Continuing operation of the oxygen concentrator supply unit through the vent mode shall be permitted with the isolating valve closed.
(4) The isolating valve, when automatically closed due to low concentration, shall require manual reset to ensure the oxygen concentrator supply unit is examined prior to return to service.
(5) Closing the isolating valve, whether automatically or manually, shall activate an alarm signal at the master alarms *(see 5.1.9.2)* indicating that the oxygen concentrator supply unit is disconnected.

5.1.3.9.1.13 The oxygen concentrator supply unit shall be provided with an oxygen concentration monitor with the following characteristics:

(1) The monitor shall be capable of monitoring 99 percent oxygen concentration with 1 percent accuracy.
(2) The monitor shall continuously display the oxygen concentration and shall activate local alarm and master alarms in accordance with 5.1.3.9.5 when a concentration lower than 91 percent is observed.
(3) The monitor shall continuously display the oxygen concentration.
(4) It shall be permitted to insert the monitor into the pipeline without a demand check.

5.1.3.9.2 Location. An oxygen central supply system using a concentrator(s) shall be located in accordance with 5.1.3.3 and as follows:

(1) Indoors in a dedicated mechanical equipment area, ventilated, and with any required utilities (e.g., electricity, drains, lighting).
(2)* In a room ventilated in accordance with 5.1.3.3.3.3.
(3) For air cooled equipment, in a room designed to maintain the ambient temperature range as recommended by the manufacturer.
(4) A room containing an oxygen central supply system using a concentrator(s) that does not have the concentrator purge gas vented to the outside shall be equipped with oxygen depletion monitors with alarm indicators at the entrance(s) that will indicate ambient oxygen levels in the room below 19.5 percent.
(5)* Individual elements of the oxygen central supply system using a concentrator(s) shall be permitted to be located in separate rooms or enclosures as necessary to meet 5.1.3.9.2(1) through 5.1.3.9.2(4).

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

(1) If two supply sources are provided, one shall be an oxygen concentrator supply unit and the second shall be a cylinder header complying with 5.1.3.5.9 with sufficient cylinder connections for one average day's supply. Containers shall not be used as a supply source.
(2) If three supply sources are provided, each shall be capable of independently supplying the full system demand in the event of the unavailability of one or both of the other sources. The three sources shall be permitted to be either of the following:
    (a) An oxygen concentrator supply system complying with 5.1.3.9.1.
    (b) A cylinder header complying with 5.1.3.5.9 with sufficient cylinder connections for one average day's supply. Containers shall not be used as a supply source.
(3) Use of oxygen concentrator supply systems as all three sources shall only be permitted after a documented risk analysis by the governing authority of the health care facility indicating understanding of the inherent risks and defining how those risks shall be mitigated.

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(4) An isolation valve and automatic check valve shall be provided to isolate each of the three sources from the others and from the pipeline. The valves in 5.1.3.5.9(4), 5.1.3.5.9(6), 5.1.3.9.1.11, and 5.1.3.9.1.12 shall be permitted to be used for this purpose.
(5) Each of the three supply sources shall be provided with a pressure relief valve complying with 5.1.3.5.6 on the source side of its respective isolating valve.
(6) The three supply sources shall join to the pipeline systems through control arrangements with at least the following characteristics:
    (a) Able to maintain stable pressures within the limits of Table 5.1.11
    (b) Able to flow 100 percent of the peak calculated demand
    (c) Redundant, such that each component of the control mechanism can be isolated for service or replacement while maintaining normal operation
    (d) The cascade of sources described in 5.1.3.9.4
    (e) Protected against overpressure *(see 5.1.3.5.6)*
(7) A pressure relief valve shall be provided in the common line between the sources and the line pressure controls.
(8) A source valve in accordance with 5.1.4.2 shall be provided on the patient side of the line pressure controls.
(9) A gauge and switch or sensor shall be located between the three sources and the line pressure controls to monitor the pressure feeding the line pressure controls.
(10) An oxygen concentration monitor, sampling the gas on the patient side of the line pressure controls and on the source side of the source valve, shall be provided with the following characteristics:
    (a) The monitor shall be capable of monitoring 99 percent oxygen concentration with ±1.0 percent accuracy.
    (b) The monitor shall be attached to the pipeline through a demand check in accordance with 5.1.8.2.3.
    (c) The monitor shall continuously display the oxygen concentration and shall activate local alarm and master alarms when an oxygen concentration lower than 91 percent is observed.
(11) A DN8 (NPS ¼) valved sample port shall be provided on the patient side of the line pressure controls and source side of the source valve for sampling the oxygen.
(12) An auxiliary source connection shall be provided complying with 5.1.4.10.
(13) Electrical installation and wiring shall conform to the requirements of *NFPA 70*.
(14) Emergency electrical service for all components of the oxygen supply system shall conform to the requirements of the essential electrical system as described in Chapter 6.

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

(1) Selection of an appropriate primary supply source. When the primary supply source is in operation and oxygen quality is suitable, the secondary and reserve supply sources shall be prevented from supplying the system.
(2) Automatic activation of the secondary supply source shall be available if the primary supply source is not able to maintain pressure or concentration of oxygen.
(3) Automatic activation of the reserve supply source shall be available if the primary and secondary supply source are not able to maintain supply pressure or concentration of oxygen.
(4) Where two or more concentrator supply sources are included in the system, the oxygen concentrator supply sources shall be permitted to rotate as the primary supply source.
(5) Automatic operation such that the supply of gas will continue through interruption of the main electrical source.
(6) The oxygen concentrator supply source(s) in the system shall be capable of automatically returning to normal operation following a power interruption. If required by the technology, it shall be permitted to isolate the concentrator supply source(s) using the automatic valve(s) to restore normal oxygen concentration prior to reconnecting the oxygen concentrator supply source to the system by opening the automatic valve. The valve can be actuated automatically for this purpose as an exception to 5.1.3.9.1.12(4).

5.1.3.9.5 Operating Alarms and Local Signals.

Δ **5.1.3.9.5.1** For each oxygen concentrator supply source in the system, the supply source's concentration monitor *(see 5.1.3.9.1.13)* shall be able to perform the following:

(1) Indicate low oxygen concentration when a concentration lower than 91 percent is observed
(2) Activate a local alarm *(see 5.1.9.5)*
(3) Activate an alarm signal at the master alarm *(see 5.1.9.2)* indicating that the oxygen concentration from that supply source is low
(4) Activate the automatic isolating valve for that oxygen concentrator supply source *(see 5.1.3.9.1.12)* to prevent supply from that oxygen concentrator supply source
(5) Close the automatic isolating valve for that oxygen concentrator supply source *(see 5.1.3.9.1.12)*, which activates an alarm signal at the master alarm *(see 5.1.9.2)* indicating that the oxygen concentrator supply source is disconnected

5.1.3.9.5.2 For the entire oxygen central supply system, the system concentration monitor *[see 5.1.3.9.3(10)]* shall be able to perform the following:

(1) Indicate low oxygen concentration when a concentration lower than 91 percent is observed
(2) Activate a local alarm *(see 5.1.9.5)*
(3) Activate an alarm signal at the master alarm *(see 5.1.9.2)* indicating the oxygen concentration is low

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

(1) A pressure gauge for delivery pressure
(2) A means to activate an alarm signal at the master alarm *(see 5.1.9.2)* indicating the oxygen cylinders are in use
(3) A means to activate an alarm signal at the master alarm *(see 5.1.9.2)* indicating the content of the oxygen cylinder header is reduced below one average day's supply

5.1.3.9.5.4 An oxygen central supply system using a concentrator(s) shall be provided with operating alarms as follows:

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

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(a) If the supply source in use fails to supply the system and is changed in accordance with 5.1.3.9.4(2) or 5.1.3.9.4(3), a local alarm and a signal at the master alarm shall be activated, indicating an oxygen supply change has occurred.
(b) The signal in 5.1.3.9.5.4(1)(a) shall not be activated if the system has rotated sources in accordance with 5.1.3.9.4(6).

(2) *Internal Pressure Low.* A local alarm and a signal at the master alarm shall be activated when or just before the pressure falls below the pressure required to drive the calculated required flow rate through the line pressure controls indicating the oxygen supply internal pressure is low *[see 5.1.3.9.3(9) for sensor location].*

***N* 5.1.3.10* Cryogenic Fluid Central Supply Systems.**

***N* 5.1.3.10.1 General.**

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

***N* 5.1.3.10.1.2 Applicability.**

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

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

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

***N* 5.1.3.10.2 Cryogenic Fluid Central Supply Systems Installation.**

***N* 5.1.3.10.2.1** Cryogenic fluid central supply systems shall be installed by personnel qualified in accordance with CGA M-1, *Standard for Medical Gas Supply Systems at Health Care Facilities,* or ASSE 6015, *Professional Qualifications Standard for Bulk Medical Gas Systems Installers.* [**55:**17.2.1]

***N* 5.1.3.10.2.2** Cryogenic fluid central supply systems shall be installed in compliance with the Food and Drug Administration (FDA) Current Good Manufacturing Practices per 21 CFR 210 and 21 CFR 211. [**55:**17.2.2]

***N* 5.1.3.10.2.3** Cryogenic fluid central supply systems shall be anchored with foundations in accordance with CGA M-1, *Standard for Medical Gas Supply Systems at Health Care Facilities.* [**55:**17.2.3]

***N* 5.1.3.10.2.4** Cryogenic fluid central supply systems shall have a minimum work space clearance of 3 ft (1 m) around three sides of the storage container, three sides of the vaporizer(s), and the cabinet opening or front side of the pressure-regulating manifold for system maintenance and operation.

***N* 5.1.3.10.2.5** Inert cryogenic fluid central supply systems shall be sited in accordance with Chapter 8 of NFPA 55 and CGA P-18, *Standard for Bulk Inert Gas Systems at Consumer Sites.* [**55:**17.2.5]

***N* 5.1.3.10.2.6** Oxygen cryogenic fluid central supply systems shall be sited in accordance with Chapters 8 and 9 of NFPA 55, as applicable, and CGA M-1, *Standard for Medical Gas Supply Systems at Health Care Facilities.* [**55:**17.2.6]

***N* 5.1.3.10.2.7** Carbon dioxide refrigerated liquid central supply systems shall be sited in accordance with Chapter 13 of NFPA 55 and CGA G-6.1, *Standard for Insulated Liquid Carbon Dioxide Systems at Consumer Sites.* [**55:**17.2.7]

***N* 5.1.3.10.2.8** Nitrous oxide refrigerated liquid central supply systems shall be sited in accordance with Chapter 16 of NFPA 55 and CGA G-8.1, *Standard for Nitrous Oxide Systems at Customer Sites.* [**55:**17.2.8]

***N* 5.1.3.10.3 Cryogenic Fluid Central Supply Systems Operation.**

***N* 5.1.3.10.3.1** The following components of the cryogenic fluid central supply system shall be accessible and visible to delivery personnel during filling operations:

(1) Fill connection
(2) Top and bottom fill valves
(3) Hose purge valve
(4) Vent valve
(5) Full trycock valve
(6) Liquid level indicator
(7) Tank pressure indicator

[**55:**17.3.1]

***N* 5.1.3.10.3.2** Cryogenic fluid central supply systems shall consist of the following:

(1) One or more main supply vessel, with capacity determined after consideration of the customer usage requirements, delivery schedules, proximity of the facility to alternative supplies, and the emergency plan
(2) A contents gauge on every main vessel
(3) A reserve supply sized for greater than an average day's supply, with the size of vessel or number of cylinders determined after consideration of delivery schedules, proximity of the facility to alternative supplies, and the emergency plan
(4) At least two main vessel relief valves and rupture discs installed downstream of a three-way (i.e., three-port) valve
(5) A check valve located in the primary supply piping upstream of the intersection with a secondary supply or reserve supply

[**55:**17.3.2]

***N* 5.1.3.10.3.3** Reserve CMG supply systems consisting of either a second cryogenic fluid source or a compressed gas source shall include the following:

(1) Where the reserve source is a compressed gas source, the reserve shall be equipped with the following:
(a) A cylinder manifold having not less than three gas cylinder connections or as otherwise required for an average of one day's gas supply
(b) A pressure switch to monitor the pressure in the cylinder manifold
(2) Where the reserve source is a second cryogenic fluid vessel, the reserve tank shall be equipped with the following:
(a) An actuating switch or sensor to monitor the internal tank pressure
(b) A contents gauge to monitor the liquid level
(3) Where the reserve source is either a cryogenic fluid or compressed gas source, a check valve shall be provided to prevent backflow into the reserve system.

[**55:**17.3.3]

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N **5.1.3.10.3.4** Bulk cryogenic liquid sources shall include automatic means to provide the following functions:

(1) When the main supply is supplying the system, the reserve supply shall be prevented from supplying the system until the main supply is reduced to a level at or below the reserve activation pressure.
(2) When the main supply cannot supply the system, the reserve supply shall automatically begin to supply the system.
(3) Where there is more than one main supply vessel, the system shall operate as follows for primary, secondary, and reserve operation:
   (a) If provided with two liquid container headers, one cryogenic liquid header shall be the primary and the other shall be the secondary, with either being capable of either role.
   (b) If provided with one liquid container header and one gas cylinder header (i.e., a hybrid arrangement), the liquid container header shall be the primary and the gas cylinder header shall be the secondary.
   (c) When the primary header is supplying the system, the secondary header shall be prevented from supplying the system.
   (d) When the primary header is depleted, the secondary header shall automatically begin to supply the system.
(4) Where there are two or more cryogenic vessels, they shall be permitted to alternate (e.g., on a timed basis) in the roles of primary, secondary, and reserve, provided that an operating cascade (i.e., primary–secondary–reserve) is maintained at all times.
(5) Where a cryogenic vessel is used as the reserve, the reserve vessel shall include a means to conserve the gas produced by evaporation of the cryogenic liquid in the reserve vessel and to discharge the gas into the line upstream of the final line regulator assembly.

[**55:**17.3.4]

N **5.1.3.10.4 Main Supply System.** The main supply vessel for a cryogenic fluid central supply system shall be a cryogenic storage tank. [**55:**17.4]

N **5.1.3.10.5 Reserve Supply System.**

N **5.1.3.10.5.1** A CMG reserve supply system shall consist of either of the following:

(1) A secondary cryogenic vessel
(2) A high-pressure compressed gas source

[**55:**17.5.1]

N **5.1.3.10.5.2** A cryogenic source reserve supply shall have a switch or sensor to monitor the tank pressure. [**55:**17.5.2]

N **5.1.3.10.5.3** A compressed gas reserve supply shall meet the following requirements:

(1) It shall be manifolded with no fewer than three gas cylinders.
(2) It shall have a pressure switch or sensor to monitor the contents using manifold pressure.
(3) It shall have a check valve to prevent backflow into the system.
(4) It shall have a check valve at each connection on the cylinder header to minimize loss of gas from the reserve system.

[**55:**17.5.3]

N **5.1.3.10.6 Cryogenic Fill System.** Cryogenic fluid central supply systems shall include a fill mechanism consisting of the following components:

(1) A nonremovable product-specific fill connection in compliance with CGA V-6, *Standard Bulk Refrigerated Liquid Transfer Connections*
(2) A means to cap and secure the fill connection inlet
(3) A check valve to prevent product backflow from the fill inlet
(4) A fill hose purge valve
(5) Supports that hold the fill piping off the ground
(6) A secure connection between the bulk tank and the fill piping
(7) Supports, as necessary, to hold the fill line in position during all operations associated with the filling procedure

[**55:**17.6]

N **5.1.3.10.7 Vaporizers.**

N **5.1.3.10.7.1** Vaporizers used to convert cryogenic CMG to a gaseous state shall meet the following requirements:

(1) Vaporizers shall be permitted to operate by either ambient heat transfer or external thermal source (e.g., electric heater, hot water, steam).
(2) Vaporizers using a heat source other than ambient air shall be protected in the event of a loss of the energy source.

[**55:**17.7.1]

N **5.1.3.10.7.2** Vaporizers shall be designed to provide capacity for the customer's use under the following conditions:

(1) Customer's average and peak flows
(2) Local conditions (e.g., structures that obstruct air circulation or sunlight)
(3) Seasonal conditions (e.g., freeze periods)

[**55:**17.7.2]

N **5.1.3.10.7.3** A system design that uses switching vaporizers shall meet all of the following requirements:

(1) Valves shall be permitted to be manual or automatic.
(2) Valves and piping shall allow an operating vaporizer or an operating section of a vaporizer to be switched to a nonoperating condition for deicing.
(3) The system design shall provide continuous flow of CMG to the health care facility during vaporizer switchover.
(4) The system design shall provide continuous flow of CMG to the health care facility if vaporizer switchover fails.

[**55:**17.7.3]

N **5.1.3.10.7.4** Where a vaporizer uses an external thermal source, the flow of the CMG shall be unaffected by the loss of the external thermal source by one of the following methods:

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

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

[**55:**17.7.4]

N **5.1.3.10.7.5** Where vaporizers are used in the reserve system, they shall be as follows:

(1) Sized by the supplier to provide a source of vaporized CMG from the reserve bulk liquid storage vessel during times when the reserve system is operational
(2) Able to provide a flow rate equal to at least that of the main system vaporizer(s); however, the duration of flow might be different
(3) Indirectly heated by ambient air

[**55:**17.7.5]

N **5.1.3.10.7.6** Low-temperature protection systems that interrupt or reduce flow shall not be used on the reserve system of cryogenic fluid central supply systems. [**55:**17.7.6]

N **5.1.3.10.8 High-Pressure Manifolds.**

N **5.1.3.10.8.1** Manifold assemblies shall be fit for service and shall have supports that are independent of the cylinders. [**55:**17.8.1]

N **5.1.3.10.8.2** Cylinders on the manifold shall be secured against falling. [**55:**17.8.2]

N **5.1.3.10.8.3*** Cylinders on the manifold shall have the same service pressure rating or the filled pressure of each cylinder shall not exceed the service pressure rating of the lowest rated cylinder on the manifold. [**55:**17.8.3]

N **5.1.3.10.9 Pressure Control Devices.** The final pressure control device assembly or assemblies shall not be fabricated on-site. [**55:**17.9]

N **5.1.3.10.10 Pressure Relief Devices.**

N **5.1.3.10.10.1** Pressure relief devices (PRDs) shall meet the following requirements:

(1) PRDs shall have a relief pressure setting not higher than the maximum allowable working pressure (MAWP) of the component with the lowest working pressure rating in the portion of the system being protected.
(2) PRDs shall be of brass or bronze construction.
(3) PRDs shall be designed for the specific gas service.
(4) PRDs shall have the discharge protected to prevent the entry of rain or snow.
(5) PRDs shall be designed in accordance with ASME B31.3, *Process Piping*.

[**55:**17.10.1]

N **5.1.3.10.10.2** PRDs shall have an identifier that contains the date of manufacture or test. [**55:**17.10.2]

N **5.1.3.10.10.3** The final line pressure relief valves shall be approved by a nationally recognized organization and shall have a relief capacity greater than or equal to the maximum throughput of the final line regulator. [**55:**17.10.3]

N **(A)** The pressure relief valve shall be set at 50 percent above the normal working pressure, but no higher than the MAWP, of the health care facility pipeline. [**55:**17.10.3.1]

N **(B)** The relief valve information shall be permanently identified either on the nameplate of the relief valve or on a permanently attached metal tag. [**55:**17.10.3.2]

N **5.1.3.10.11 Tubing and Valves.**

N **5.1.3.10.11.1** New, hard-drawn Type K or L copper tube shall be used for all process piping. [**55:**17.11.1]

N **(A)** Tubing shall comply with ASTM B819, *Standard Specification for Seamless Copper Tube for Medical Gas Systems*. [**55:**17.11.1.1]

N **(B)** Tubing shall be capped and bear the marking OXY or MEDICAL or be otherwise packaged and labeled to indicate it is clean for oxygen service according to the supplier's policy. [**55:**17.11.1.2]

N **5.1.3.10.11.2**

N **(A)** Instrumentation tubing shall be constructed of annealed copper tubing or seamless stainless steel tubing. [**55:**17.11.2.1]

N **(B)** Copper tubing shall comply with ASTM B88, *Standard Specification for Seamless Copper Water Tube*. [**55:**17.11.2.2]

N **5.1.3.10.11.3** Valves of quick-open or quarter-turn designs, such as ball or plug valves, shall not be permitted in the portion of an oxygen piping system operating above 435 psi [3000 kPa]. [**55:**17.11.3]

N **5.1.3.10.11.4**

N **(A)*** Alternate materials of construction for piping, tubing, valves, and instruments shall be permitted for installation at the request of the health care facility or the supplier. [**55:**17.11.4.1]

N **(B)** Technical documentation of alternate materials shall be submitted to the health care facility QA representative to demonstrate equivalency. [**55:**17.11.4.2]

N **5.1.3.10.12* Alarms.** The cryogenic fluid central supply system shall have a local signal that visibly indicates the operating status of the equipment and an indicator at all master alarms under the following conditions:

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

[**55:**17.12]

5.1.4* Valves.

5.1.4.1 General.

5.1.4.1.1 Gas and Vacuum Shutoff Valves. Shutoff valves shall be provided to isolate sections or portions of the piped distri-

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bution system for maintenance, repair, or planned future expansion need and to facilitate periodic testing.

5.1.4.1.2 Security. All valves, except valves in zone valve box assemblies, shall be secured by any of the following means:

(1) Located in secured areas
(2) Locked or latched in their operating position
(3) Located above ceilings, but remaining accessible and not obstructed

5.1.4.1.3 Labeling. All valves shall be labeled as to gas supplied and the area(s) controlled, in accordance with 5.1.11.2.

5.1.4.1.4 Accessibility.

(A) Zone valves shall be installed in valve boxes with removable covers large enough to allow manual operation of valves.

(B) Zone valves for use in certain areas, such as psychiatric or pediatric areas, shall be permitted to be secured with the approval of the authority having jurisdiction to prevent inappropriate access.

5.1.4.1.5 Flammable Gases. Valves for nonflammable medical gases shall not be installed with valves for flammable gases in the same zone valve box assembly with flammable gases.

5.1.4.1.6 Valve Types. New or replacement valves shall be permitted to be of any type as long as they meet the following conditions:

(1) They have a minimum Cv factor in accordance with either Table 5.1.4.1.6(a) or Table 5.1.4.1.6(b).
(2) They use a quarter turn to off.
(3) They are constructed of materials suitable for the service.
(4) They are provided with copper tube extensions by the manufacturer for brazing or with corrugated medical tubing (CMT) fittings.
(5) They indicate to the operator if the valve is open or closed.
(6) They permit in-line serviceability.
(7) They are cleaned for oxygen service by the manufacturer if used for any positive-pressure service.
(8) They have threaded purge ports on the patient side and the source side.
(9) They have a minimum working pressure equal to or greater than the relief valve protecting the piping system on which the valve is installed for any positive-pressure service.

Table 5.1.4.1.6(a) Positive Pressure Gases

Valve Size (in.)	Minimum Cv (full open)
½	17
¾	31
1	60
1¼	110
1½	169
2	357
2½	390
3	912
4	1837

Δ Table 5.1.4.1.6(b) Vacuum and WAGD

Valve Size (in.)	Minimum Cv (full open)
½	17
¾	31
1	60
1¼	110
1½	169
2	357
2½	196
3	302
4	600
5	1022
6	1579
8	3136

5.1.4.2 Source Valve.

5.1.4.2.1 A shutoff valve shall be placed at the immediate connection of each central supply system to the piped distribution system to allow the entire central supply system, including all accessory devices (e.g., air dryers, final line regulators), to be isolated from the facility.

5.1.4.2.2 The source valve shall be located in the immediate vicinity of the central supply system.

5.1.4.3* Main Line Valve.

5.1.4.3.1 A shutoff valve shall be provided in the main supply line inside of the buildings being served, except where one or more of the following conditions exist:

(1) The source and source valve are located inside the building served.
(2) The source system is physically mounted to the wall of the building served, and the pipeline enters the building in the immediate vicinity of the source valve.

5.1.4.3.2 The main line valve shall be located on the facility side of the source valve and outside of the source room, the enclosure, or where the main line first enters the building.

5.1.4.4 Riser Valve. Each riser supplied from the main line shall be provided with a shutoff valve in the riser adjacent to the main line.

5.1.4.5 Service Valves.

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

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

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

5.1.4.6 Zone Valves.

5.1.4.6.1 All station outlets/inlets shall be supplied through a zone valve, which shall be placed as follows:

(1) It is installed so that a wall intervenes between the valve and the outlets/inlets that it controls.

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