# Medical Gas Cylinder Storage

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# MEDICAL GAS CYLINDER STORAGE

One of the most common hazards in a health care facility is the storing and handling of medical gas cylinders. NFPA 99, *Health Care Facilities Code*, provides guidance to keep patients, staff, and the public safe in facilities with these types of cylinders. This document identifies the requirements of NFPA 99 that address the storage and handling of these cylinders in a health care facility. This document also addresses what the hazards are, what kinds of signs and ventilation are required, and what precautions must be taken when working with these cylinders.

## TYPES OF HAZARDS

There are two types of hazards associated with medical gas equipment: general fire and explosions, and mechanical issues such as physical damage to compressed gas cylinders.

Fire and explosions can be caused by incidents involving oxygen, which is the most common gas used in health care facilities, and nitrous oxide, which is used frequently as an inhalation anesthetic. These gases are oxidizers that, when present in sufficient quantity and concentration, form one side of the "fire triangle." When the other two sides of the triangle, heat and fuel, are added, fire and/or explosion can result. The hazard is intensified because many materials commonly available in health care facilities that are not flammable in normal room air become flammable (or extremely flammable) when the concentration of oxygen is raised above that in room air. Nitrous oxide is not an oxidizer at room temperature, but it dissociates and forms oxygen under elevated temperatures that might be present during a fire.

Compressed gas cylinders that sustain mechanical damage can also be a hazard. Gases inside cylinders are generally under high pressures, and the cylinders often have significant weight. The cylinders can cause injuries directly due to their weight and inertia. Damage to the regulators or valves attached to a cylinder can allow the escaping gas to propel the cylinder violently in a dangerous manner. The pin-index safety system and gas regulators can also suffer physical damage and cause hazards to patients if the wrong gas is delivered.

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## GAS CYLINDER STORAGE

Requirements for the storage of medical gas cylinders depends on the volume of gas within the cylinders. The greater the volume, the more stringent the requirements for the storage locations.

**Volumes Greater than 3000 ft³.** This volume of gas must be stored in locations that include the following:

- Access to move cylinders and equipment on hand trucks
- Lockable doors or gates
- Minimum of two entries/exits (if outdoors and greater than 200 ft²)
- Enclosure of noncombustible construction (if outdoors)
- Interior finishes of noncombustible or limited combustible material (if indoors)
- Walls and floors with 1-hour fire resistance rating, and other openings with ¾-hour fire protection rating (if indoors)
- Compliance with *NFPA 70®*, *National Electrical Code®*, for ordinary locations

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- Heated by indirect means
- Racks, chains, or other fastenings to secure cylinders from falling
- Electrical power from the essential electrical system
- Racks, shelves, and supports of noncombustible or limited-combustible material
- Electrical devices protected from physical damage
- Access for delivery vehicles and management of cylinders
- Regulation of temperature (less than 125°F; over 20°F for nitrous oxide and carbon dioxide)
- Ventilation (see page 4)
- Prohibition of motor-driven machinery

**Volumes Between 300 ft³ and 3000 ft³.**

This volume of gas must be stored in locations that are outdoors or in an interior enclosure of noncombustible or limited combustible construction. Indoor locations must include the following:

- Restriction of oxidizing gases from being stored with any flammable gas, liquid, or vapor
- Separation of oxidizing gases from combustibles or flammables by:
  - A minimum distance of 20 ft
  - A distance of 5 ft where the entire storage location is sprinklered
  - A gas cabinet constructed per NFPA 30, *Flammable and Combustible Liquids Code*
- Regulation of temperatures
- Appropriate restraints
- Cylinder valve protection caps
- Smoking, open flames, electric heating elements prohibited from location and within 20 ft outside location

**Volumes Less than 300 ft³.**

- Cylinders containing this volume are not required to be stored in an enclosure.
- Precautions for handling the cylinders must still be observed.

## SPECIAL CONSIDERATIONS/PRECAUTIONS FOR CYLINDER STORAGE

In addition to the criteria for storage locations are numerous other precautions that must be observed in the use and handling of cylinders.

- Small-size cylinders (A, B, D, or E) that are in use are not considered to be in storage.
- Cylinders that are in use must be attached to a cylinder stand or to medical equipment designed to receive and hold cylinders.
- Small-size cylinders that are available for immediate use are not considered to be in storage.
- Cylinders cannot be chained to portable or moveable apparatus.
- Storage must be planned so that cylinders can be used in the order in which they are received.

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- Where empty and full cylinders are stored together, empty cylinders must be segregated from full cylinders.
- For cylinders with internal pressure gauges, the facility needs to establish a pressure at which the cylinders will be considered empty.
- Empty cylinders must be marked.
- Cylinders stored in the open (outdoors) need to be protected from weather extremes.

## SIGNS

To keep personnel safe while they work in locations with increased hazards, appropriate signage is required. Precautionary signs must meet the following requirements:

- Signs must be displayed on each door or gate of the storage room or enclosure.
- Signs must be readable from a distance of 5 ft.
- Signs must include the following language at a minimum:

CAUTION:
OXIDIZING GAS(ES) STORED WITHIN
NO SMOKING

- If the facility does not prohibit smoking, additional precautionary signs indicating where oxygen is being administered must be provided.
- If the facility does prohibit smoking and signs are prominently spaced at all major entrances, the additional signage is not required.

### Typical Volume ($ft^3$) of Medical Gas Cylinders for Select Medical Gases

To know which requirements apply to storage locations, the volume of gas must be identified. This table extracts a portion of Table 11.3.4 of NFPA 99 for a quick reference to determine the volume of gas in typical cylinders based on the gas contained.

| | | Name of Gas | | | |
|---|---|---|---|---|---|
| Cylinder Style and Dimension | Nominal Volume ($in.^3$) | Medical Air | Carbon Dioxide | Nitrous Oxide | Oxygen |
| B<br>3½ in. O.D. X 13 in. | 87 | | 13 | | 7 |
| D<br>4¼ in. O.D. X 17 in. | 176 | 13 | 33 | 33 | 14 |
| E<br>4¼ in. O.D. X 26 in. | 293 | 22 | 56 | 56 | 23 |
| M<br>7 in. O.D. X 43 in. | 1337 | 101 | 267 | 267 | 122 |
| G<br>8½ in. O.D. X 51 in. | 2370 | 178 | 434 | 487 | 211 |
| H or K<br>9¼ in. O.D. X 51 in. | 2660 | 231 | 559 | 558 | 244 |

Source: Values taken from Table A.11.3.4 of NFPA 99, *Health Care Facilities Code*, 2018 edition.

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## VENTILATION

Ventilation is required for storage locations containing greater than 3000 $ft^3$ of gas. This can be provided with natural or mechanical exhaust. The volume of fluid to be used in determining ventilation is the volume (at STP) of the largest single vessel or the entire volume of connected vessels on a common manifold, whichever is greater.

**Natural ventilation.** Natural ventilation must consist of two nonclosable louvered openings. These openings have the following requirements:

- Each opening must have an opening area of at least 24 $in.^2$/1000 $ft^3$ of the fluid stored and no less than 72 $in.^2$.
- One opening must be located within 1 ft of the floor, and one must be within 1 ft of the ceiling.
- Openings need to be located to ensure cross ventilation.
- Openings have to be direct to the outside atmosphere without ductwork.

**Mechanical ventilation.** Mechanical ventilation must include the following:

- Continuous ventilation to maintain negative pressure in the space
- Rate of 1 cfm/5 $ft^3$ of fluid designed to be stored in the space
- No less than 50 cfm
- No more than 500 cfm
- Inlets that are unobstructed and draw from within 1 ft of the floor
- Exhaust fans supplied with power from the essential electrical system
- Dedicated exhaust not required, but the system cannot connect to spaces that contain flammable materials
- Exhaust duct of noncombustible construction
- Make-up air that is provided by one of the following:
  - Noncombustible ductwork transferred from adjacent spaces, outside, or from spaces that do not include flammable or combustible material
  - A corridor under the door up to 50 cfm or 15 percent of the room exhaust per NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems* (whichever is greater)
  - Any building ventilation system that does not contain flammable or combustible vapors

### Precautions for Handling Cylinders

- Handle oxygen cylinders and manifolds based on CGA G-4, Oxygen
- Protect from contact with oil and grease
- Protect from contamination
- Protect from damage
- Handle with care
- Remove/repair defective equipment

**NOTE:** Discharge from both mechanical and natural ventilation systems requires minimum separation distances, per NFPA 55, *Compressed Gases and Cryogenic Fluids Code*.

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# FAQs

**Q** When is a cylinder considered empty?

**A** NFPA 99 does not define the point where a cylinder is considered empty. All storage requirements are based on the total volume of gas in cylinders being stored. For the purpose of segregating empty and full cylinders, the facility should establish a level of where this delineation would be made. The Joint Commission issued a clarification on this issue, stating that for the purposes of segregating cylinders, once one has been opened it is then considered empty regardless of how much of the gas has been used. This is specifically for segregation purposes and does not prevent a facility from having a "partial" cylinder designation. For facilities not accredited by The Joint Commission, NFPA 99 is still silent on this and leaves it to the facility to determine.

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**Q** Can we only have 12 e-cylinders outside of storage throughout a smoke compartment?

**A** No, there is not a specific number of cylinders that are permitted outside of storage. Up to 300 $ft^3$ (approximately 12-13 e-cylinders) is permitted to be stored within a 22,500 $ft^2$ area without requiring to be in a special storage location. Cylinders that are in-use or available for immediate use do not need to be included in this determination. While 22,500 $ft^2$ is the maximum size allowed for a smoke compartment per the 2012 edition of NFPA *101*®, *Life Safety Code*®, it is worth noting that the 2012 edition of NFPA 99 does not use that terminology. Realistically, this has been applied per smoke compartment in the field. The 2018 edition of NFPA *101* now allows for smoke compartments up to 40,000 $ft^2$ and the 2018 edition of NFPA 99 now applies this allowance directly to smoke compartments.

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**Q** What is the difference between the requirements for segregating empty cylinders and marking empty cylinders?

**A** The intent of NFPA 99 is that segregation should be specific to when both empty and full cylinders are stored within the same enclosure, and that they should be clearly separated. This would allow a staff member to be able to quickly identify which cylinders are full and suitable for use when needed in an emergency. Confusion or grabbing an empty cylinder rapidly when one is needed in an emergency could pose a risk to patient safety. Marking empty cylinders is required for the same reason. The question normally centers around whether empty cylinders stored in the same enclosure as full cylinders need to be both marked and segregated. While this could be interpreted from the code language, it is rather the intent that one of the two be done, and segregation must be provided when empty and full are stored together. When this is not the case and empty cylinders are kept on their own or have not yet been stored (are out in the open), then they need to be marked to avoid confusion in emergency situations, as is intended by the code.

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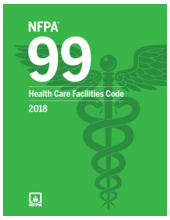
# RESOURCES

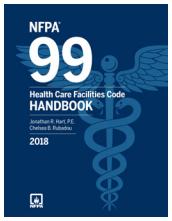
## PRODUCTS

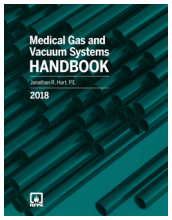
NFPA 99, *Health Care Facilities Code*, 2018 edition

*Health Care Facilities Code Handbook*, 2018 edition

*Medical Gas and Vacuum Systems Handbook,* 2018 edition




www.nfpa.org/medgas

## TRAINING

NFPA 99, *Medical Gas Systems* (2018): Online Training Preparation for ASSE Series 6000 Recertification

NFPA 99: *Health Care Facilities Code* (2012) 2-Day Classroom Training

NFPA 99: *Health Care Facilities Code* (2012) Online Training Series

NFPA *101* and NFPA 80 Fire Door Inspection for Health Care Facilities 1-Day Classroom Training

Certified Life Safety Specialist (CLSS) Core Learning Online Training Series

www.nfpa.org/training

## CERTIFICATIONS

Certified Emergency Power Systems Specialist (CEPSS-HC) for Health Care Facility Managers Certification

Certified Life Safety Specialist (CLSS-HC) for Health Care Facility Managers

www.nfpa.org/certifications

## OTHER RESOURCES

Online Community - NFPA Health Care Section: Stay up-to-date with what's happening with the Health Care Section and participate in discussions by visiting NFPA's Xchange community.

www.nfpa.org/healthcare

Visit the NFPA website to access resources for health care facilities including CMS requirements.

www.nfpa.org/cms

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