

Ontario Fire Code

SECTION 5.6

COMPRESSED GAS CYLINDERS

Illustrated Commentary



***Office of the
Ontario
Fire Marshal***

5.6.1. General

5.6.1.1.(1) Reserved

- (2) This Section does not apply to facilities at which **compressed gases** are manufactured or cylinders are filled or distributed if the storage and handling of the **compressed gases** is in conformance with
- (a) CGA P-1, "Safe Handling of Compressed Gases in Containers",
 - (b) NFPA 55, "Storage, Use and Handling of Compressed and Liquefied Gases in Portable Cylinders", or
 - (c) a procedure that bears the signature and seal of a **Professional Engineer**.
- (3) Articles 5.6.2.1. to 5.6.2.4. do not apply where the amount of **compressed gas** stored does not exceed
- (a) 25 kg of flammable **compressed gas**, or
 - (b) 150 kg of non-flammable **compressed gas**.
- (4) Despite Sentence (3), Articles 5.6.2.1. to 5.6.2.4. apply to any amount of poisonous or corrosive **compressed gas**.

The intent of this Article is to clarify the scope to which Section 5.6 applies.

Sentence (2) exempts manufacturers of compressed gas, or facilities where cylinders are filled or distributed when storage and handling meets with industry accepted standards or are qualified by a professional engineer. This exemption recognizes the unique nature of these operations. It also recognizes that the employees will be trained about proper handling and hazards.

Sentence (3) exempts users of small quantities of compressed gases, such as doctors, dentists and jewelers from having to comply with Articles 5.6.2.1. to 5.6.2.4., since the application of the stringent requirements is not warranted in the circumstances and creates unnecessary hardship.

Sentence (4) clarifies that requirements of Articles 5.6.2.1. to 5.6.2.4. apply to the storage of any amount of poisonous or corrosive compressed gases, such as chlorine or anhydrous ammonia gas.

Compressed gas means any contained mixture or material with either an absolute pressure exceeding 275.8 kPa at 21°C or an absolute pressure exceeding 717 kPa at 54°C, or both, or any liquid having an absolute vapour pressure exceeding 275.8 kPa at 37.8°C .

Professional Engineer means a member or licensee of the Association of Professional Engineers of the Province of Ontario under the Professional Engineers Act.

5.6.1. General

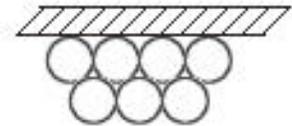
- 5.6.1.2.(1) Cylinders containing **compressed gas** shall be protected against mechanical damage.
- (2) Cylinders containing **compressed gas** shall be stored to hold them securely in place
- (a) on racks,
 - (b) by nesting, or
 - (c) by **approved** methods or devices.

The purpose of this Article is to minimize the likelihood of accidental release of compressed gases due to mechanical damage or resulting from cylinder(s) falling over. Specific storage methods are prescribed. Other methods that prevent cylinders falling may also be used when they have been approved by the Chief Fire Official.

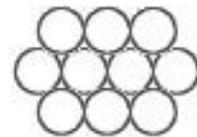


(a)

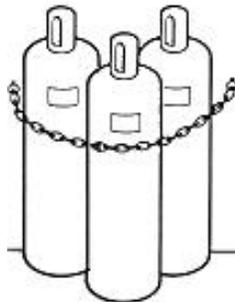
Nested
wall supported



Nested
unsupported



(b)



(c)



Approved means approved by the Chief Fire Official.

Compressed gas means any contained mixture or material with either an absolute pressure exceeding 275.8 kPa at 21°C or an absolute pressure exceeding 717 kPa at 54°C, or both, or any liquid having an absolute vapour pressure exceeding 275.8 kPa at 37.8°C .

5.6.1. General

Acetylene cylinders

- 5.6.1.3. Except when being transported, acetylene cylinders shall be kept in an upright position.

Acetylene is susceptible to rapid decomposition that can generate heat resulting from impact or from exposure to heat. For these reasons acetylene cylinders do not just contain acetylene.

Acetylene cylinders are filled with a porous-mass packing material containing very small pores or cellular spaces so that any volume of gas therein is correspondingly small. This limits the decomposition of energy available and restricts communication between spaces. In addition, the mass is saturated with acetone. Acetone is a flammable liquid in which acetylene is very soluble. The acetylene gas is compressed in the acetone in a similar manner carbon dioxide in water produces carbonated water. When the pressure in the cylinder is reduced, by opening the valve, the gas escapes from the solution and the cylinder in a gaseous state. For this reason acetylene cylinders must be kept upright to ensure that when the valve is opened, only the gas escapes, not the solution.



5.6.1. General
Valve damage

5.6.1.4. Cylinders containing **compressed gas**, which are in storage, shall be protected against valve damage.

This Article requires the valves on compressed gas cylinders to be protected against damage when in storage to minimize the possibility of accidental gas leakage.

Caps, collars, placing cylinders in a box or racks are common means used to protect cylinder valves from damage.

Valve protection against damage
by use of collar



Valve protection against damage
by use of valve cap



Compressed gas means any contained mixture or material with either an absolute pressure exceeding 275.8 kPa at 21°C or an absolute pressure exceeding 717 kPa at 54°C, or both, or any liquid having an absolute vapour pressure exceeding 275.8 kPa at 37.8°C .

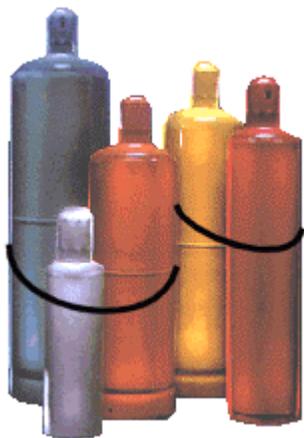
5.6.1. General

Temperature limitations

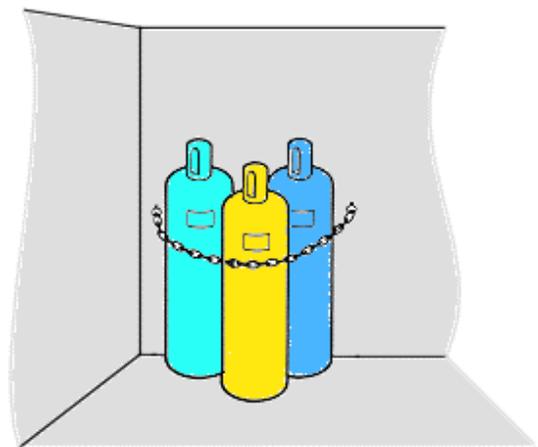
5.6.1.5. Cylinders containing **compressed gas** shall be stored in areas where the ambient air temperature does not exceed 52°C.

Compressed gas cylinders are to be stored in areas with ambient temperatures not exceeding 52°C to reduce the likelihood of the overpressure protection devices releasing gas at higher temperatures. For example, acetylene cylinders are indirectly protected against overpressure by using heat actuated fusible plugs of eutectic alloys having low melting temperatures similar to those employed in automatic sprinklers.

Ambient air temperature not to exceed 52°C



Outdoors storage



Indoors storage

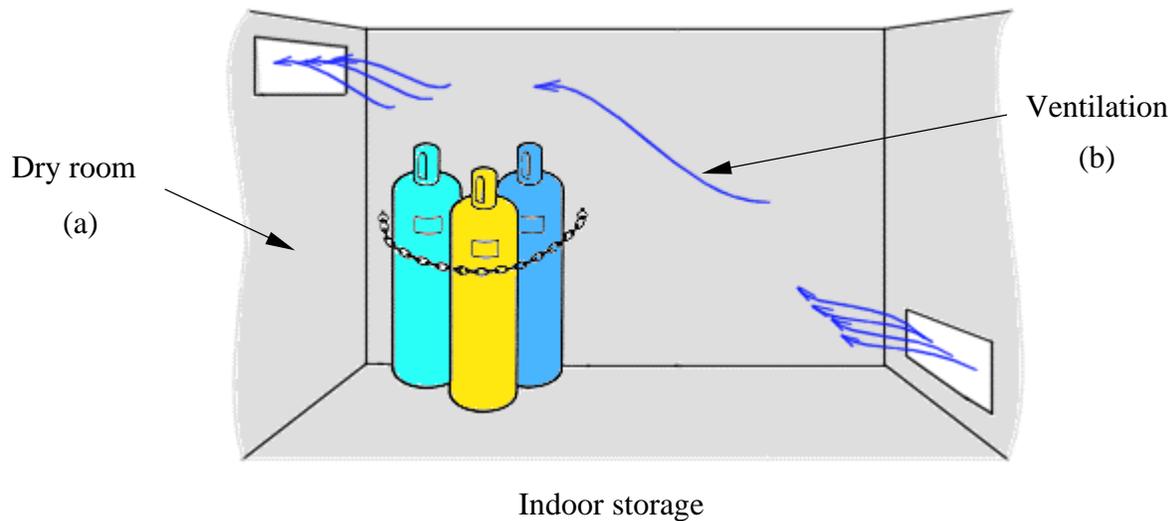
Compressed gas means any contained mixture or material with either an absolute pressure exceeding 275.8 kPa at 21°C or an absolute pressure exceeding 717 kPa at 54°C, or both, or any liquid having an absolute vapour pressure exceeding 275.8 kPa at 37.8°C .

5.6.1. General
Ventilation

5.6.1.6.(1) Where cylinders containing **compressed gas** are stored indoors, the storage areas or rooms shall be

- (a) dry, and
- (b) ventilated in accordance with Sentence 5.6.2.4.(4).

Rooms and other indoor areas used for storage of compressed gas cylinders are required to be dry and ventilated to minimize the occurrence of corrosion that could lead to gas leakage and to prevent any buildup of gas vapours that may occur. The requirements for ventilation are stipulated in Sentence 5.6.2.4.(4).



Compressed gas means any contained mixture or material with either an absolute pressure exceeding 275.8 kPa at 21°C or an absolute pressure exceeding 717 kPa at 54°C, or both, or any liquid having an absolute vapour pressure exceeding 275.8 kPa at 37.8°C .

5.6.1. General

Oxygen cylinders

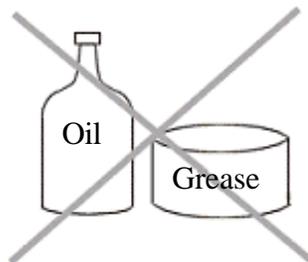
- 5.6.1.7. Oil or grease shall not be used for the lubrication of valves or fittings on oxygen cylinders.

This article is intended to prevent contact of oxygen (an oxidizer that can increase the intensity of a fire) with combustible materials (oil or grease) that could be easily ignited, resulting in a failure of the connection, permitting more oxygen to be released.

Valve or
fitting



Not to be used for the
lubrication of valves or
fittings on oxygen cylinders.



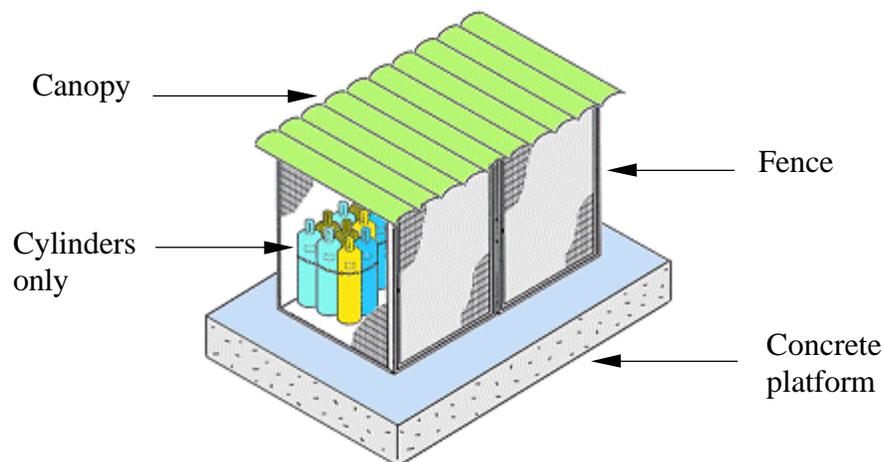
5.6.2. Storage

Outdoor platforms

- 5.6.2.1. Where cylinders containing **compressed gas** are stored outdoors, they shall be supported on raised concrete or other noncombustible platforms protected from the weather by a noncombustible canopy in an enclosure surrounded by a firmly anchored fence and used for the sole purpose of such storage.

This Article outlines the precautions required to be taken when compressed gases are stored outdoors.

The cylinders must be stored on a raised platform intended to protect the bottom of the cylinders from corrosion resulting from exposure to dampness that may result from storing them directly on the ground or on another low lying surface. The platform must be secure to support the weight of the cylinders and to reduce the likelihood of them tipping over. The canopy is intended to shelter the cylinders from rain, snow and direct solar exposure. The platform and canopy must be made of noncombustible materials intended to prevent the spread of fire to or from the storage area. Cylinders must be located in a secure fenced enclosure used for no other purpose in order to discourage tampering and to limit access.

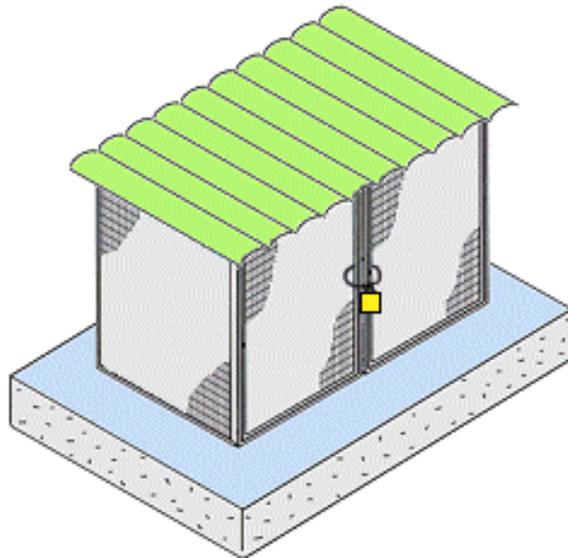


Compressed gas means any contained mixture or material with either an absolute pressure exceeding 275.8 kPa at 21°C or an absolute pressure exceeding 717 kPa at 54°C, or both, or any liquid having an absolute vapour pressure exceeding 275.8 kPa at 37.8°C .

5.6.2. Storage
Fencing

- 5.6.2.2.(1) The fence required in Article 5.6.2.1. shall
- (a) be designed to discourage climbing,
 - (b) be substantially constructed with a minimum height of 1.8 m,
and
 - (c) be equipped with a gate to be kept locked when the enclosure
is not staffed.

The intent is to reduce the risk of accidental damage or fire caused to the storage area or containers by preventing unauthorized access to the site.



5.6.2. Storage

*Clearances from building openings*5.6.2.3.(1) Cylinders containing **compressed gas** and located outdoors shall be

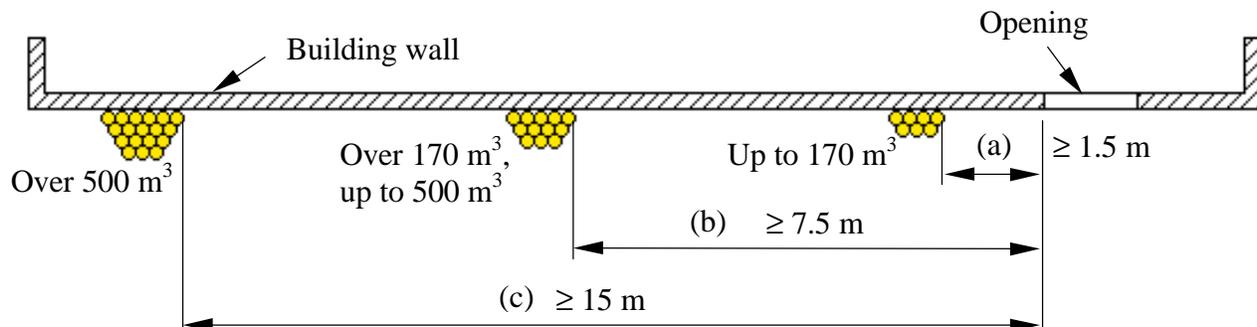
- (a) at least 1.5 m from any **building** opening if the aggregate capacity of expanded gas is not more than 170 m^3 ,
 - (b) at least 7.5 m from any **building** opening if the aggregate capacity of expanded gas is over 170 m^3 but not more than 500 m^3 , or
 - (c) at least 15 m from any **building** opening if the aggregate capacity of expanded gas is over 500 m^3 .
- (2) Sentence (1) does not apply if the **building** opening is into a room that conforms to Sentence 5.6.2.4.(1).

This Article refers to outdoors storage of compressed gas cylinders, indicating minimum distances between the storage area(s) and the nearest building opening with the intent of preventing gas escaping from the cylinders entering the building through the opening.

In order to calculate the aggregate capacity of the expanded gas stored in the area, you will have to consult the compressed gas supplier. The gas supplier should be able to provide you with information on the expanded volume ratio for each type of gas they sell.

Based on this information, it will be necessary to calculate the expanded gas volume of each cylinder depending upon the type of gas stored in the cylinder and the capacity of cylinder by weight or volume. Once calculated, the expanded quantity of gas from each cylinder must be added together to determine the aggregate capacity of the expanded gas stored in the area.

Sentence (2) allows an exemption by permitting storage close to openings into a room that conforms to Sentence 5.6.2.4.(1).



Building means any structure used or intended for supporting or sheltering any use or occupancy.

Compressed gas means any contained mixture or material with either an absolute pressure exceeding 275.8 kPa at 21°C or an absolute pressure exceeding 717 kPa at 54°C, or both, or any liquid having an absolute vapour pressure exceeding 275.8 kPa at 37.8°C .

5.6.2. Storage

Indoor storage of flammable compressed gases

- 5.6.2.4.(1) Except as provided in Sentences (2) and (3), cylinders containing flammable **compressed gas** stored indoors shall be located in a room that
- (a) is separated from the remainder of the **building** by a **fire separation** having a 2-hr **fire-resistance rating**,
 - (b) is located on an exterior wall of the **building**,
 - (c) can be entered from the exterior,
 - (d) if it has doors into the interior of the **building**, they are equipped with self-closing and latching devices, have a **fire-protection rating** of at least 1.5 hr and are constructed so as to prevent migration of gases from the room into other parts of the **building**,
 - (e) is constructed so that an exterior wall provides explosion venting
 - (i) in the ratio of 0.2 m² for each cubic metre of room volume,
 - or
 - (ii) in the ratio computed in accordance with NFPA 68, "Guide for Venting of Deflagrations", except in no case less than 650 cm² of vent area for each cubic metre of room volume,
 - (f) has ventilation conforming to Sentence (4),
 - (g) does not contain fuel fired equipment or high temperature heating elements, and
 - (h) is used for no purpose other than the storage of **compressed gas**.

The objectives of this Sentence are to reduce the likelihood of fire and limit the extent of structural damage from an explosion, should it occur, where flammable compressed gases are stored indoors.

The objectives are satisfied by having the room provided with certain features.

Building means any structure used or intended for supporting or sheltering any use or occupancy.

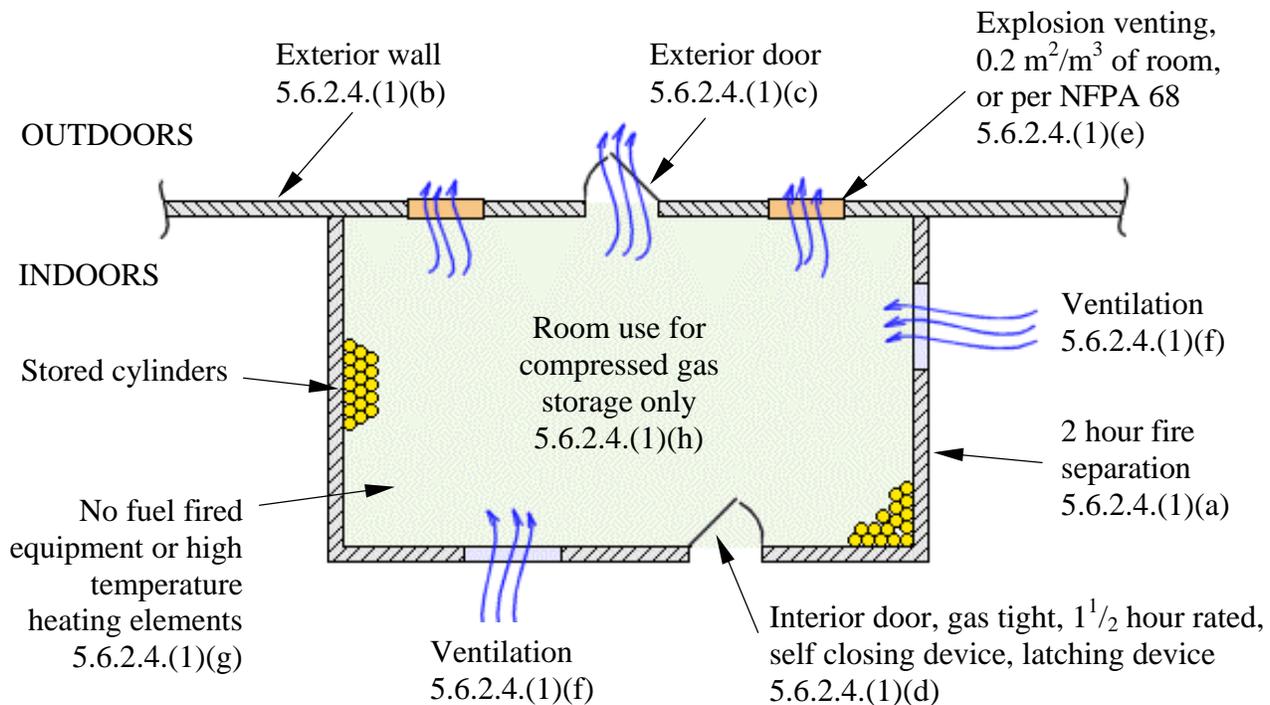
Compressed gas means any contained mixture or material with either an absolute pressure exceeding 275.8 kPa at 21°C or an absolute pressure exceeding 717 kPa at 54°C, or both, or any liquid having an absolute vapour pressure exceeding 275.8 kPa at 37.8°C .

Fire-protection rating means the time in hours or fraction thereof that a closure, window assembly or glass block assembly will withstand the passage of flame when exposed to fire under specified conditions of test and performance criteria, or as otherwise prescribed in the Building Code.

Fire-resistance rating means the time in hours or fraction thereof that a material or assembly of materials will withstand the passage of flame and the transmission of heat when exposed to fire under specified conditions of test and performance criteria, or as determined by extension or interpretation of information derived therefrom as prescribed in the Building Code.

Fire separation means a construction assembly that acts as a barrier against the spread of fire and may or may not have a fire-resistance rating or a fire-protection rating.

- Clause (1)(a) is intended to reduce the risk of a fire or explosion in the gas storage room from damaging the other parts of the building and/or prevent the spread of fire into the gas storage room from the adjoining space.
- By requiring the room to be located on the exterior wall of the building, Clause (1)(b) facilitates the construction of the following safety features:
 1. Exterior access from the outside as required in Clause 5.6.2.4.(1)(c),
 2. Explosion venting to the outside as required in Clause 5.6.2.4.(1)(e),
 3. Exhaust ventilation to the outside as required in Clause 5.6.2.4.(1)(f).
- Clause (1)(d) permits an interior door from the room into a building, provided the door is appropriately fire-rated and is gas tight. The intent is to prevent a flammable gas leak in the storage room from migrating into the building through the door way opening.
- Clause (1)(e) requires explosion venting to be provided through the exterior wall to limit structural damage resulting from an explosion occurring in the room.
- Clause (1)(f) requires the room to be provided with ventilation conforming to Sentence (4) in order to prevent gas from accumulating in the room that could cause an explosion.
- Clause (1)(g) is intended to reduce the risk of ignition of flammable gases in the event of a gas leak in the room which could result in an explosion that could endanger building occupants.
- Clause (1)(h) is intended to avoid other uses of the storage room that could create a fire or exploding hazard to the gas cylinders in introducing ignition sources or adding to the combustible loading in the room.



5.6.2. Storage

Flammable compressed gases lighter than air

- 5.6.2.4.(2) Cylinders of flammable, lighter than air **compressed gas** may be stored in rooms other than those described in Sentence (1),
- (a) in a **building of combustible construction** that is not **sprinklered** where the aggregate capacity of expanded gas is not more than 60 m³,
 - (b) in a **sprinklered building of combustible construction** where the aggregate capacity of expanded gas is not more than 170 m³, or
 - (c) in a **building of noncombustible construction** where the aggregate capacity of expanded gas is not more than 170 m³.

The intent of this Article is to remove the obligation in Sentence 5.6.2.4.(1) for limited quantities of lighter than air flammable compressed gases [i.e. they will not accumulate to hazardous concentrations at floor level or in low areas of the building] to be stored in a dedicated room. Instead it allows their storage in the open in a building according to the table below:

Building of combustible construction		Building of noncombustible construction
Nonsprinklered	Sprinklered	
Agregate capacity of expanded gas $\leq 60 \text{ m}^3$	Agregate capacity of expanded gas $\leq 170 \text{ m}^3$	Agregate capacity of expanded gas $\leq 170 \text{ m}^3$

Building means any structure used or intended for supporting or sheltering any use or occupancy.

Combustible construction means that type of construction that does not meet the requirements for noncombustible construction.

Compressed gas means any contained mixture or material with either an absolute pressure exceeding 275.8 kPa at 21°C or an absolute pressure exceeding 717 kPa at 54°C, or both, or any liquid having an absolute vapour pressure exceeding 275.8 kPa at 37.8°C .

Noncombustible construction means that type of construction in which a degree of fire safety is attained by the use of noncombustible materials for structural members and other building assemblies.

Sprinklered (as applied to a building or part thereof) means that the building or part thereof is equipped with a system of automatic sprinklers.

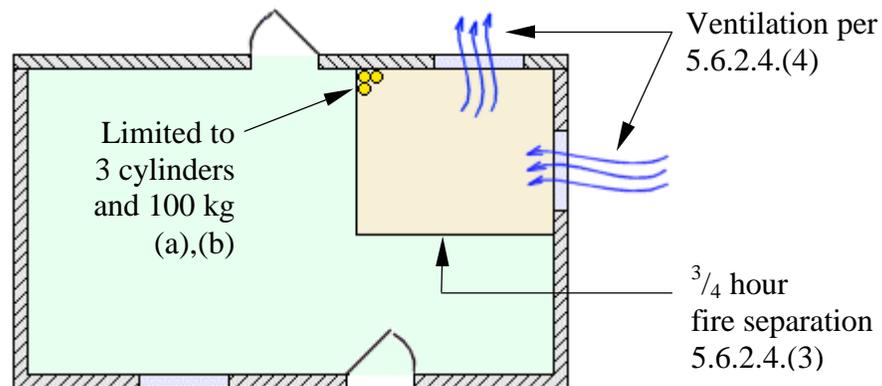
5.6.2. Storage

Flammable compressed gases heavier than air

5.6.2.4.(3) Cylinders of flammable **compressed gas** which are heavier than air may be stored in rooms other than those described in Sentence (1) if they are stored in a **fire compartment** having a **fire-resistance rating** of at least 3/4 hr and

- (a) the aggregate capacity does not exceed 100 kg,
- (b) the number of cylinders does not exceed 3,
- (c) the cylinders are not located in the **basement** or other areas below **grade**, and
- (d) the **fire compartment** has ventilation conforming to Sentence (4).

This Sentence provides an exception to the storage room requirements in Sentence (1), and applies to limited quantities of heavier than air flammable compressed gases. Containment, quantity, location and ventilation requirements are specified.



Plan view of floor other than basement (c).

Basement means a storey or storeys of a building located below the first storey.

Compressed gas means any contained mixture or material with either an absolute pressure exceeding 275.8 kPa at 21°C or an absolute pressure exceeding 717 kPa at 54°C, or both, or any liquid having an absolute vapour pressure exceeding 275.8 kPa at 37.8°C .

Fire compartment means an enclosed space in a building that is separated from all other parts of the building by enclosing construction that provides a fire separation having a required fire-resistance rating.

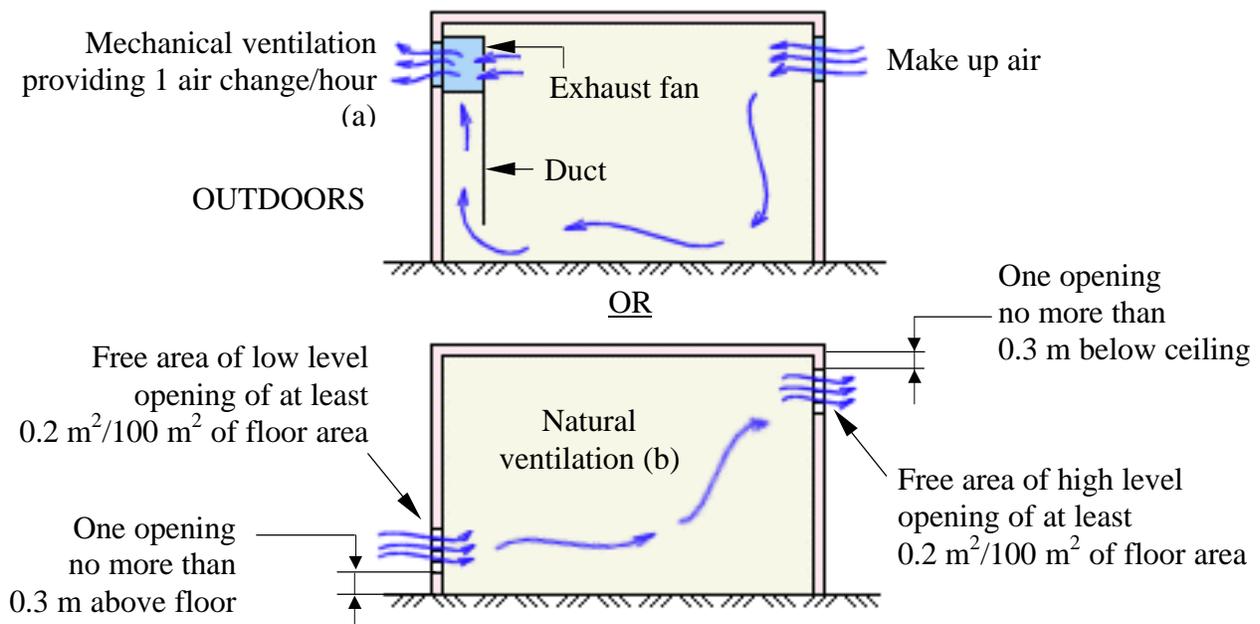
Fire-resistance rating means the time in hours or fraction thereof that a material or assembly of materials will withstand the passage of flame and the transmission of heat when exposed to fire under specified conditions of test and performance criteria, or as determined by extension or interpretation of information derived therefrom as prescribed in the Building Code.

Grade means the average level of finished ground adjoining a building at all exterior walls.

5.6.2. Storage
Ventilation

- 5.6.2.4.(4) The ventilation required by Clauses (1)(e) and (3)(d) shall be
- (a) mechanical ventilation to the outside that ensures at least 1 air change per hour, or
 - (b) natural ventilation to the outside through non-closeable louvred openings with
 - (i) at least one opening no more than 0.3 m from the ceiling and one opening no more than 0.3 m from the floor,
 - (ii) all openings at ceiling level having an aggregate free opening area of at least 0.2 m^2 per 100 m^2 of the **floor area**,
 - (iii) all openings at floor level having an aggregate free opening area of at least 0.2 m^2 per 100 m^2 of the **floor area**, and
 - (iv) the openings located to ensure cross ventilation.

Sentence 5.6.2.4.(4) specifies the ventilation requirements for compressed gas storage rooms by providing both performance requirements and a specification on how to achieve similar ventilation rates through natural means. It is important to remind people that this requirement applies to compressed gas storage, as opposed to compressed gas that is in use.



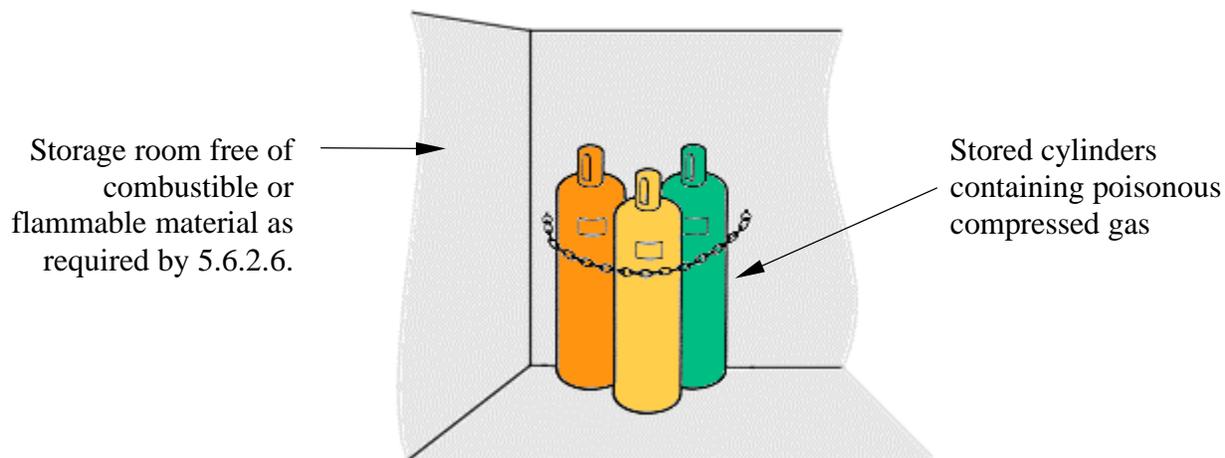
Floor area means the space on any storey of a building between exterior walls and required firewalls and includes the space occupied by interior walls and partitions, but does not include exits and vertical service spaces that pierce the storey.

5.6.3. Storage
Ventilation

5.6.2.5. Reserved

5.6.2.6. Cylinders containing poisonous **compressed gas** shall not be stored in a room containing combustible or flammable material.

Sentence 5.6.2.6. prohibits the combination of poisonous gases with any combustible or flammable material in the same room with the intent of reducing the risk of combustibles stored in the gas cylinder storage room being a source of ignition and/or contributing to a fire that could cause the release of the gases from the cylinders.



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5.6.2. Storage

Reactive gases

- 5.6.2.7.(1) Except as provided in Sentences (2) and (3), cylinders containing **compressed gases** that may react with one another shall be stored in separate **fire compartments** separated by a **fire separation** having a **fire-resistance rating** of at least 1 hr.
- (2) Cylinders containing **compressed gases** that are lighter than air and that may react with each other may be stored in the same **fire compartment** if they are separated
- (a) by a distance of at least 7.5 m, or
 - (b) by a concrete or masonry wall having a height of at least 2.0 m and projecting at least 1.0 m beyond the cylinders.
- (3) Cylinders containing **compressed gases** that may react with each other and are heavier than air may be stored in the same **fire compartment** if they are separated
- (a) by a distance of at least 15 m, or
 - (b) by a concrete or masonry wall having a height of at least 1.5 m, and projecting such that the minimum vapour travel distance between two cylinders of gases that may react with each other is not less than 15 m, measured horizontally.

This Article fully describes ways and means of storing and separating compressed gases that have differing characteristics and may react with each other. Lighter than air gases have a tendency to rise and dilute on discharge. Gases which are heavier than air accumulate and migrate along the floor. The Article accommodates both these physical characteristics.

The continuing intent is to reduce the risk of a fire originating in an other part of the building from spreading to the room and reaching the gas cylinders which could cause the release of gases that have the potential for aggravating fire conditions and/or hampering fire fighting operations.

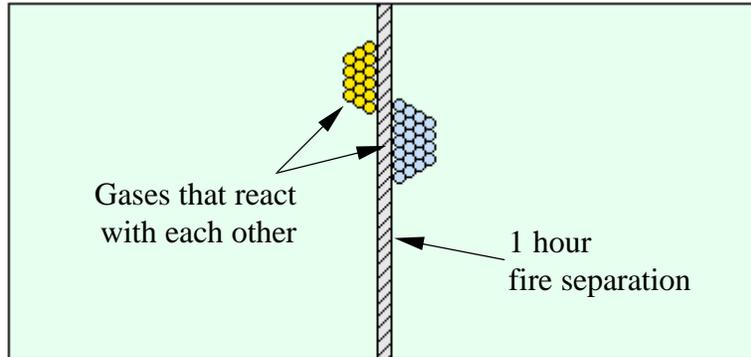
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Fire compartment means an enclosed space in a building that is separated from all other parts of the building by enclosing construction that provides a fire separation having a required fire-resistance rating.

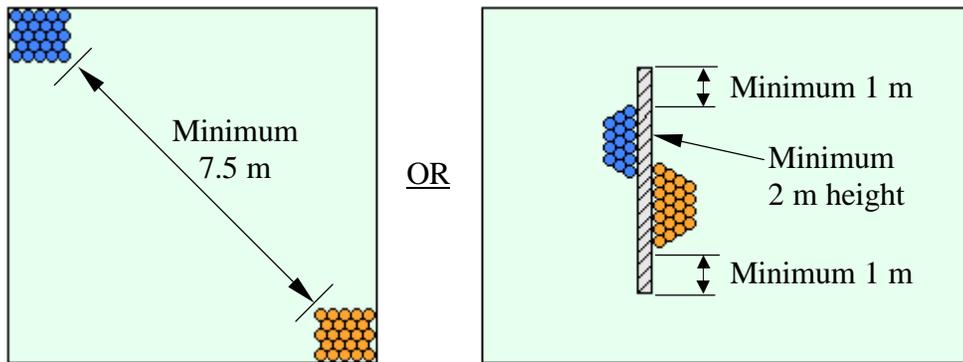
Fire-resistance rating means the time in hours or fraction thereof that a material or assembly of materials will withstand the passage of flame and the transmission of heat when exposed to fire under specified conditions of **test** and performance criteria, or as determined by extension or interpretation of information derived therefrom as prescribed in the **Building Code**.

Fire separation means a construction assembly that acts as a barrier against the spread of fire and may or may not have a fire-resistance rating or a fire-protection rating.

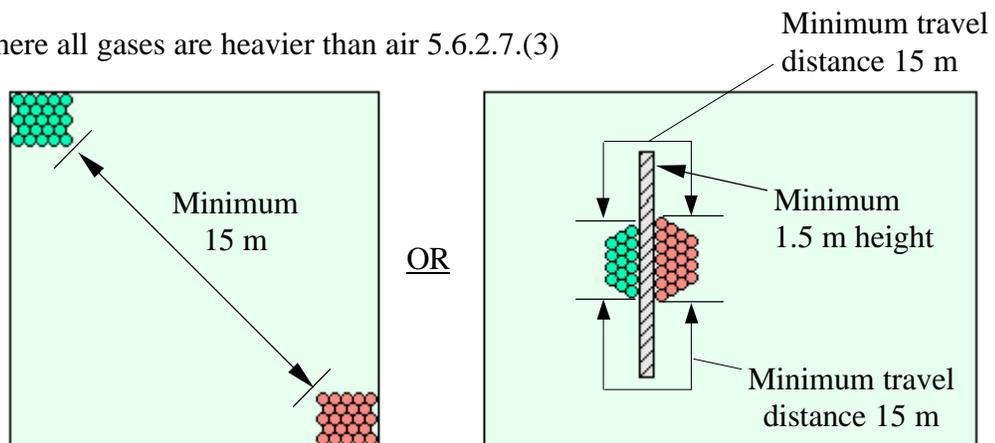
All gases that may react with one another 5.6.2.7.(1)



Exception where all gases are lighter than air 5.6.2.7.(2)



Exception where all gases are heavier than air 5.6.2.7.(3)

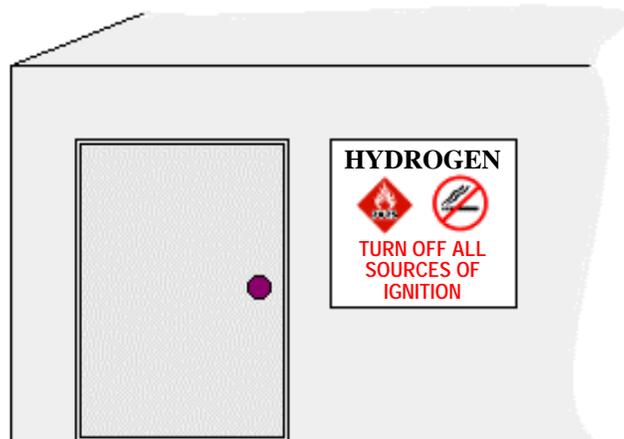


5.6.2. Storage
Signs

5.6.2.8. Storage rooms shall have exterior signs with minimum 50 mm high letters indicating the nature of the **compressed gases**.

The intent is to easily identify and indicate the storage rooms and their content.

Knowing the location and content of storage rooms for containers of compressed gases helps people who work in the building and fire fighters to become aware of the room content. This information is useful for fire prevention and fire fighting purposes.



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- Q1 What is meant by compressed gas?
A1 Compressed gas means any contained mixture or material with either an absolute pressure exceeding 275.8 kPa at 21°C or an absolute pressure exceeding 717 kPa at 54°C, or both, or any liquid having an absolute vapour pressure exceeding 275.8 kPa at 37.8°C .
- Q2 Why should oil or grease not be used to lubricate valves or fittings in oxygen cylinders?
A2 Refer to Ontario Fire Code 5.6.1.7.
- Q3 What features must indoor storage areas have when they house flammable compressed gas?
A3 Refer to Ontario Fire Code 5.6.2.4. (1) to (3).
- Q4 When reactive gases are stored, what requirements are necessary to ensure a fire or explosion can be avoided?
A4 Refer to Ontario Fire Code 5.6.2.7.
- Q5 What requirements are necessary to provide sufficient distance between outdoor storage of cylinders and building openings?
A5 Refer to Ontario Fire Code 5.6.2.3.
-