

# A Code Review for Hydrogen Storage and Use

By: the Fire and Life-Safety Group (FLS)

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## I. INTRODUCTION

The following is a summary of the fire and building code requirements for the storage and use of hydrogen. These code requirements are based on the 2005 edition of the *Compressed Gases and Cryogenic Fluids Code* (NFPA 55), the 2009 edition of the *International Fire Code* (IFC), and the 2009 edition of the *International Building Code* (IBC).

## II. EXECUTIVE SUMMARY

This section is a broad overview of the fire and building code requirements for various quantities of hydrogen. A section number is listed in parenthesis after each code requirement. This section number refers to the portion of this document in which more detailed requirements can be found. Below is a table listing the maximum allowable quantities per storage area (MAQ). An appropriate MAQ should be selected for a certain storage area by determining whether the storage area is in a fully sprinklered building and by determining if all gas cylinders will be in gas cabinets.

**Table 1: MAQ's**

Unsprinklered Buildings		Sprinklered Buildings	
Not All Cylinders in a Gas Cabinet	All Cylinders in a Gas Cabinet	Not All Cylinders in a Gas Cabinet	All Cylinders in a Gas Cabinet
1,000 ft <sup>3</sup> *	2,000 ft <sup>3</sup> *	2,000 ft <sup>3</sup> *	4,000 ft <sup>3</sup> *

\* standard cubic feet (at 1 atm pressure)

- A. If the quantity of hydrogen is less than the applicable MAQ value listed in table 1, the following requirements must be met.
  - a. If the quantity of hydrogen is greater than 250 cubic feet, then that storage and use area must be separated from other occupancies by 1 hour rated construction. (IV.A.a)
  - b. Floor and floor supporting construction must be 2 hour rated. Exception: The floor and floor supporting construction may be 1 hour rated if the following conditions are met (IV.A.b):
    - 1. Building construction type is IIA, IIIA, and VA
    - 2. The building is equipped throughout with an automatic sprinkler system
    - 3. The building is three stories or less in height

- c. The room or space must have a mechanical exhaust ventilation system or natural ventilation approved by FLS (IV.B).
  - d. Any required mechanical ventilation, alarm, detection, or other electrically operated systems are required to be provided with an emergency or standby power system, unless an approved fail-safe engineered system is installed (IV.C).
  - e. Containers, tubing, and equipment are required to be approved and maintained. Cast iron piping is not to be used (IV.D).
  - f. Hazard identification, “No Smoking”, and “Compressed Gas”, signs are required to be installed at all entrances to areas containing hazardous materials. Hazard identification signs should also be located on each compressed gas cylinder. (IV.E).
  - g. Compressed gas containers, cylinders, and tanks are to be secured to prevent falling caused by contact, vibration, or seismic activity (IV.F).
  - h. Combustible material and hydrogen tanks must be separated by a 10 ft distance or a noncombustible wall which extends not less than 18 in. above and to the sides of the area used for combustible material (IV.G).
  - i. Hydrogen tanks are to be separated from incompatible materials, e.g., oxygen, by a 20 ft distance or a noncombustible wall having a fire resistance rating of at least 0.5 hr which extends not less than 18 in. above and to the sides of the cylinders (IV.G).
- B. If the quantity of hydrogen is greater than the applicable MAQ value listed in table 1, the following requirements must be met.
- a. All of the requirements listed above in section II.A must be met.
  - b. A fire detection system and a fire suppression system are required (V.A).
  - c. The space used for hydrogen storage and use must be separated from the remainder of the building by two hour rated construction for fully sprinklered buildings and 3 hour rated construction for building that are not fully sprinklered (V.B).
  - d. The room or space must have a mechanical ventilation system (V.C).
  - e. Hydrogen should not be transported through corridors unless an emergency telephone system, a local manual alarm station or an approved alarm initiating device is installed at not more than 150 foot intervals and at each exit and exit access doorway throughout the transportation route (V.D).
  - f. All Hazardous (H-2) occupancy requirements apply. For example, the H-2 area is to be separated from adjacent areas by fire barriers as specified in the IBC.

- C. This section applies if an individual system uses containers having a total hydrogen content of greater than 400 cubic feet or if multiple systems separated by a distance of less than 5 ft are used.
  - a. All of the requirements listed above in section II.A must be met.
  - b. If the total quantity of hydrogen exceeds the MAQ listed in table 1, all of the requirements listed above in section II.B must be met.
  - c. Cabinets or enclosures containing hydrogen control or operating equipment are to be ventilated to minimize the accumulation of hydrogen (VI.A)
  - d. Areas in which a hydrogen system is located are to be permanently placarded as follows (VI.B):

WARNING: HYDROGEN – FLAMMABLE GAS – NO SMOKING – NO  
OPEN FLAMES
  - e. Hydrogen storage areas are to be located at or above ground level (VI.C.a).
  - f. Hydrogen systems located within 50 ft of storage of flammable or combustible liquids are to be located on ground higher than such storage, except where solid walls or diversion curbs exist to prevent the accumulation of these liquids under the hydrogen system (VI.C.b).
  - g. Storage of hydrogen gas in excess of the applicable MAQ value listed in table 1 under Section II must be in a gas room, a detached building, or outdoors. Quantities greater than 15,000 cubic feet must be stored or used in a detached building or outdoors (VI.C.c).
  - h. Hydrogen systems of less than 3,500 scf and greater than the MAQ, where located inside a building, are to have the following separation distances:
    - 1. 25 ft from open flames and other sources of ignition
    - 2. 50 ft from air intakes
    - 3. 50 ft from other flammable gas storage
  - i. For required outdoor separation distances please see section VI.D.a.
- D. Please ensure full compliance with the cylinder manufacturer and hydrogen supplier recommendations and requirements.
- E. Please ensure compliance with campus Environmental Health and Safety Department (EHS).

### III. OCCUPANCY CLASSIFICATION

- A. Section 3.3.2.1 of NFPA 55 defines a control area as an area where limited quantities of hazardous materials are allowed to be stored, used, handled, or dispensed.

- B. Section 307.1 of the IBC states that high-hazard Group H occupancy includes, among others, the use of a building or structure, or a portion thereof, that involves the manufacturing, processing, generation, or storage of materials that constitute a physical or health hazard in quantities in excess of those allowed in control areas.
- C. Table 307.1(1) of the IBC states that the maximum quantity per control area of a flammable gas is as follows:

**Table 2: Maximum Quantities per Control Area**

Unsprinklered Buildings		Sprinklered Buildings	
Not All Cylinders in a Gas Cabinet	All Cylinders in a Gas Cabinet	Not All Cylinders in a Gas Cabinet	All Cylinders in a Gas Cabinet
1,000 ft <sup>3</sup>	2,000 ft <sup>3</sup>	2,000 ft <sup>3</sup>	4,000 ft <sup>3</sup>

- D. Section 6.3.1.3.1 of NFPA 55 states that flammable and oxidizing gases are not to be stored or used in other than industrial and storage occupancies.

*Exception: Section 6.3.1.3.2 of NFPA 55 states that containers, cylinders, or tanks not exceeding 250 cubic feet and used for maintenance purposes, patient care, or operation of equipment are to be permitted.*

**IV. REQUIREMENTS FOR HYDROGEN IN QUANTITIES LESS THAN THE VALUES SHOWN IN SECTION III.C**

**A. Fire Resistance Rating Requirements**

- a. Section 6.3.1.3.1 of NFPA 55 and Table 508.3.3 of the IBC state that where flammable gases are stored or used in quantities in excess of 250 cubic feet, the area is to be separated from other occupancies by 1 hour rated construction.
- b. Section 414.2.4 of the IBC states that the floor construction of a control area and the construction supporting the floor of the control area are to have a minimum 2-hour fire-resistance rating.

*Exception: The floor construction of the control area and the construction supporting the floor of the control area are allowed to be 1-hour rated in buildings of Type IIA, IIIA, and VA construction, provided the following conditions exist:*

1. The building is equipped throughout with an automatic sprinkler system.
2. The building is three stories or less in height.

**B. Ventilation Requirements**

- a. Section 6.16 of NFPA 55 states that indoor storage and use areas for compressed gases are to be provided with mechanical exhaust ventilation or natural ventilation, where natural ventilation can be shown to be acceptable for the material as used.

- b. Section 6.16.1 of NFPA 55 states that where mechanical ventilation is provided, the system is to be operational during the time the building or space is occupied.
- c. Section 6.16.3 of NFPA 55 states that the mechanical ventilation rate is to be at a rate of not less than  $1 \text{ ft}^3/\text{min}/\text{ft}^2$  of floor area over the area of storage or use.
- d. Section 6.16.4 of NFPA 55 states that systems are to operate continuously unless an alternate design is approved by the code official.
- e. Section 6.16.5 of NFPA 55 states that where powered ventilation is provided, a manual shutoff switch is to be provided outside of the room in a position adjacent to the principal access door to the room or in an approved location.
- f. Section 6.16.6 of NFPA 55 states that the switch is to be the break-glass type and is to be labeled as follows: "WARNING: VENTILATION SYSTEM EMERGENCY SHUTOFF."
- g. Section 6.16.7.1 of NFPA 55 states that the exhaust ventilation system design is to take into account the density of the potential gases released.
- h. Section 6.16.7.3 of NFPA 55 states that for gases that are lighter than air, exhaust is to be taken from a point within 12 in of the ceiling.
- i. Section 6.16.9 of NFPA 55 states that exhaust ventilation is not to be recirculated within the room or building if the cylinders, containers, or tanks stored are capable of releasing hazardous gases.
- j. Section 6.16.10 of NFPA 55 states that ventilation systems are to discharge a minimum of 50 ft from intakes of air-handling systems, air-conditioning equipment, and air compressors.
- k. Section 6.16.11 of NFPA 55 states that use of compressed gases is to be located not less than 50 ft. from air intakes.

#### C. Emergency Power Requirements

- a. Section 414.5.4 of the IBC states that where mechanical ventilation, treatment systems, temperature control, alarm, detection, or other electrically operated systems are required, such systems are to be provided with an emergency or standby power system.

*Exception: Standby power for mechanical ventilation, treatment systems, and temperature control systems is not to be required where an approved fail-safe engineered system is installed.*

#### D. Container, Tubing, and Equipment Requirements

- a. Section 2703.2.1 of the IFC states that containers, cylinders, and tanks are to be designed and constructed in accordance with approved standards.

- b. Section 414.4 of the IBC states that systems involving hazardous materials are to be suitable for the intended application. Controls are to be designed to prevent materials from entering or leaving process or reaction systems at other than the intended time, rate, or path. Automatic controls, where provided, are to be fail safe.
- c. Section 2703.2.6 of the IFC states that equipment, machinery, and required detection and alarm systems associated with hazardous materials are to be maintained in an operable condition. Defective containers, cylinders, and tanks are to be removed from service, repaired, or disposed of in an approved manner. Defective equipment or machinery is to be removed from service and repaired or replaced. Required detection and alarm systems are to be replaced or repaired where defective.
- d. Section 2703.2.2.1 of the IFC states that piping, tubing, valves, and fittings conveying hazardous materials are to be in accordance with the following:
  - 1. Piping, tubing, valves, fittings, and related components are to be designed and fabricated from materials that are compatible with the material to be contained and are to be of adequate strength and durability to withstand the pressure, structural and seismic stress and exposure to which they are subject.
  - 2. Piping and tubing is to be identified in accordance with ASME A13.1 to indicate the material conveyed.
  - 3. Readily accessible manual valves or automatic remotely activated fail-safe emergency shutoff valves are to be installed on supply piping and tubing at the following locations:
    - 3.1. The point of use
    - 3.2. The tank, cylinder, or bulk source.
  - 4. Manual emergency shutoff valves and controls for remotely activated emergency shutoff valves is to be identified and the location is to be clearly visible, accessible, and indicated by means of a sign.
  - 5. Backflow prevention or check valves are to be provided when the backflow of hazardous material could create a hazardous condition or cause an unauthorized discharge of hazardous materials.
  - 6. Where gases with a flammability rating of 4, e.g., hydrogen, are carried in pressurized piping above 15 pounds per square inch gauge (psig), an approved means of leak detection and emergency shutoff or excess flow control are to be provided. Where the piping originates from within a hazardous material storage room or area, the excess flow control is to be located within the storage room or area. Where the piping originates from a bulk sources, the excess flow control is to be located as close to the bulk sources as practical.

*Exceptions:*

- 1. *Piping for inlet connections designed to prevent backflow.*
- 2. *Piping for pressure relief devices.*

#### E. Sign Requirements

- a. Section 2703.5 of the IFC states that unless exempted by the fire code official, visible hazard identification signs for the specific material contained are to be placed on stationary containers and above-ground tanks and at entrances to locations where hazardous materials are stored, dispensed, used, or handled in quantities requiring a permit and at specific entrances and locations designated by the fire code official.
- b. Section 2703.5.1 of the IFC states that individual containers, cartons, or packages are to be conspicuously marked or labeled in an approved manner. Rooms or cabinets containing compressed gases are to be conspicuously labeled: COMPRESSED GAS.
- c. Section 2703.7.1 of the IFC states that smoking is to be prohibited and “No Smoking” signs provided as follows:
  1. In rooms or areas where hazardous materials are stored or dispensed or used in open systems.
  2. Within 25 feet of outdoor storage, dispensing or open use areas.
  3. Facilities or areas within facilities that have been designated as totally “no smoking” shall have “No Smoking” signs placed at all entrances to the facility or area. Designated areas within such facilities where smoking is permitted whether permanently or temporarily, are to be identified with signs designating that smoking is permitted in these areas only.
  4. In rooms or areas where flammable or combustible hazardous materials are stored, dispensed, or used.

Signs required by this section are to be in English as a primary language.

#### F. Anchoring Requirements

- a. Section 3003.5.3 of the IFC states that compressed gas containers, cylinders, and tanks are to be secured to prevent falling caused by contact, vibration, or seismic activity.

#### G. Separation Requirements

- a. Section 7.1.6.2 of NFPA 55 states that flammable and oxidizing gases are to be separated by 20 ft.
- b. Section 7.1.6.2.1 of NFPA 55 states that the 20 ft distance is permitted to be reduced without limit when separated by a barrier of noncombustible material at least 5 ft high that has a fire resistance rating of at least 0.5 hr.
- c. Section 2703.9.8 of the IFC states that incompatible materials having a capacity of more than 0.5 gallons are to be separated by 20 ft or a noncombustible partition extending not less than 18 in above and to the sides of the stored material.

- d. Section 7.1.6.3 of NFPA 55 states that combustible waste, vegetation, and similar materials are to be kept a minimum 10 ft from compressed gas containers, cylinders, tanks, and systems.

*Exception: Sections 7.1.6.3.1 and 7.1.6.3.1 of NFPA 55 states that a noncombustible partition without openings or penetrations and extending sides not less than 18 in. above and to the sides of the storage area is permitted in lieu of the minimum distance. The noncombustible partition is to either be an independent structure or the exterior wall of the building adjacent to the storage area.*

V. REQUIREMENTS FOR HYDROGEN IN QUANTITIES GREATER THAN THE VALUES SHOWN IN SECTION III.C (GROUP H-2 OCCUPANCY)

**Please note: In addition to the requirements listed below, the requirements of part IV must also be met.**

A. Fire Extinguishing and Detection Requirements

- a. Section 414.5.3 of the IBC states that Group H occupancies are to be provided with an automatic fire detection system.
- b. Section 2705.1.8 of the IFC states that indoor rooms or areas in which hazardous materials are dispensed or used are to be protected by an automatic fire-extinguishing system. Sprinkler system design is not to be less than that required for Ordinary Hazard, Group 2, with a minimum design area of 3,000 square feet. Where materials or storage arrangement are required by other regulations to be provided with a higher level of sprinkler system protection, the higher level of sprinkler protection is to be provided.
- c. Section 2705.1 of the IFC states that manual alarm detection and automatic fire-extinguishing systems required by other provisions of Section 2705 are to be supervised by an approved central, proprietary or remote station service or are to initiate an audible and visual signal at a constantly attended on-site location.

B. Required Fire Wall Separation

- a. Section 508.3.1.3 and Table 508.3.3 of the IBC state that Group H-2 occupancies are to be separated from fully sprinklered business occupancies by 2 hour rated construction and from unsprinklered business occupancies by 3 hour rated construction.

C. Ventilation Requirements

- a. Section 2705.1.9 of the IFC states that indoor hazardous material dispensing and use areas are to be provided with exhaust ventilation in accordance with Section 2704.3.

- b. Section 2704.3.1 of the IFC states that exhaust ventilation systems are to comply with the following:
1. Installation is to be in accordance with the IMC.
  2. Mechanical ventilation is to be at a rate of not less than 1 cubic foot per minute per square foot of floor area over the storage area.
  3. Systems are to operate continuously unless alternative designs are approved.
  4. A manual shutoff control is to be provided outside of the room in a position adjacent to the access door to the room or in an approved location. The switch is to be a break-glass or other approved type and is to be labeled: VENTILATION SYSTEM EMERGENCY SHUTOFF.
  5. Exhaust ventilation is to be designed to consider the density of the potential fumes or vapors released. For fumes or vapors that are heavier than air, exhaust is to be taken from a point within 12 inches of the floor. For fumes or vapors that are lighter than air, exhaust is to be taken from a point within 12 inches from the highest point of the room.
  6. The location of both the exhaust and inlet air openings is to be designed to provide air movement across all portions of the floor or room to prevent the accumulation of vapors.
  7. Exhaust air is not to be recirculated to occupied areas if the materials stored are capable of emitting hazardous vapors and contaminants have not been removed. Air-contaminated with explosive or flammable vapors, fumes or dusts; flammable, highly toxic or toxic gases; or radioactive materials is not to be recirculated.
- c. Section 414.3 of the IBC states that ducts conveying explosives or flammable vapors, fumes, or dusts are to extend directly to the exterior of the building without entering other spaces. Exhaust ducts are not to extend into or through ducts and plenums.

*Exception: Ducts conveying vapor or fumes having flammable constituents less than 25 percent of their lower flammable limit (LFL) are permitted to pass through other spaces.*

#### D. Transportation Requirements

- a. Section 2705.4.4 of the IFC states that where hydrogen is stored or used in quantities in excess of the MAQ, are transported through corridors or exit enclosures, there is to be an emergency telephone system, a local manual alarm station or an approved alarm-initiating device at not more than 150-foot intervals and at each exit and exit access doorway throughout the transport route. The signal is to be relayed to an approved central station, proprietary supervising station, or a remote supervising station or a constantly attended on-site location and it is also to initiate a local audible alarm.

## VI. ADDITIONAL REQUIREMENTS

This section applies if an individual system uses containers having a total hydrogen content of greater than 400 cubic feet or if multiple systems separated by a distance of less than 5 ft are used. **Please note: In addition to the requirements listed below, the requirements of section IV must also be met. If the quantity of hydrogen exceeds the applicable MAQ value listed in table 2 under section III, then the requirements of section V must also be met.**

### A. Design Requirements for Gaseous Hydrogen Systems

- a. Section 10.2.1 of NFPA 55 states that hydrogen venting systems discharging to the atmosphere are to be in accordance with CGA G-5.5, *Hydrogen Vent Systems*.
- b. Section 10.2.2 of NFPA 55 states that brazing materials used for joints in piping and tubing systems are to have a melting point above 1000<sup>0</sup>F.
- c. Section 10.2.3.2 of NFPA 55 states that cabinets or enclosures containing hydrogen control or operating equipment are to be ventilated to minimize accumulation of hydrogen.
- d. Section 10.2.3.4 of NFPA 55 states that mobile hydrogen supply units are to be electrically bonded to the storage system before hydrogen is discharged from the supply unit.

### B. Sign Requirements

- a. Section 10.2.4.2 of NFPA 55 states that the area in which a hydrogen system is located is to be permanently placarded as follows:

WARNING: HYDROGEN – FLAMMABLE GAS – NO SMOKING – NO  
OPEN FLAMES

### C. Location Requirements

- a. Section 10.3.1.1 of NFPA 55 states that systems are to be located above ground either at or above grade.
- b. Section 10.3.1.2 of NFPA 55 states that systems within 50 ft of aboveground storage of all classes of flammable and combustible liquids are to be located on ground higher than such storage, except where dikes, diversion curbs, grading, or separating solid walls are used to prevent accumulation of these liquids under the system.
- c. Table 10.3.2.1 of NFPA 55 states that storage of hydrogen gas in excess of the applicable MAQ value listed in Table 1 under Section II must be in a gas room, in a detached building, or outdoors. Quantities greater than 15,000 cubic feet must be stored or used in a detached building or outdoors.

- d. Section 10.4.4.1 of NFPA 55 states that hydrogen systems of less than 3,500 scf and greater than the MAQ, where located inside buildings, are to be located in the building so that the system will be as follows:
  - 1. 25 ft from open flames and other sources of ignition.
  - 2. 50 ft from intakes of ventilation, air-conditioning equipment, and air compressors.
    - a. The distance is permitted to be reduced to 10 ft where the room or area is protected by a listed detection system in accordance with NFPA 70, and the detection system shuts down the full supply in the event of a leak that results in a concentration that exceeds 25 percent of the LFL.
    - b. Isolation valves used to isolate the fuel supply shall be of a fail-safe design.
    - c. 50 ft from other flammable gas storage.
- e. Section 10.4.4.2 of NFPA 55 states that more than one system of 3500 scf or less is permitted to be installed in the same room or area, provided the systems are separated by at least 50 ft or a full-height fire-resistive partition having a minimum fire resistance rating of 2 hours is located between the systems.
- f. Section 10.4.4.2.1 of NFPA 55 states that the separation distance between multiple systems of 3500 scf or less is permitted to be reduced to 25 ft in buildings where the space between storage areas is free of combustibles and protected with a sprinkler system designed for Extra Hazard, Group 1.

#### D. Outdoor Storage Requirements

- a. Section 10.3.2.2.1 of NFPA 55 states that the separation distances listed in Table 10.3.2.2.1 must be met.

##### *Exceptions:*

- 1. *Section 10.3.2.2.2 of NFPA 55 states that the distances in numbers 1, 3 through 10, and 14 are not to apply where fire barrier walls having a minimum fire resistance rating of 2 hours are located between the system and the exposure.*
- 2. *Section 10.3.2.2.3 of NFPA 55 states that portions of a wall less than 10 ft measured horizontally from any part of a system are to have a fire resistance rating of at least 0.5 hours.*
- 3. *Section 10.3.2.2.4 of NFPA 55 states that when determining the minimum distance between the hydrogen system and adjacent fire-rated walls, windows, and doors, are to be excluded from the fire rating determination (See number 2 of Table 10.3.2.2.1).*
- 4. *Section 10.3.2.2.5 of NFPA 55 states that portions of walls less than 10 ft (measured horizontally) from any part of a system are to have a fire resistance rating of at least 1 hour.*
- 5. *Section 10.3.2.2.6 of NFPA 55 states that distances are to be permitted to be reduced to 15 ft for Class IIIB combustible liquids.*
- 6. *Section 10.4.1.1 of NFPA 55 states that where overhead cover is provided, it is to be in accordance with the provisions of 6.5.2.*

7. *Section 6.5.2 of NFPA 55 states that for other than explosive materials and hazardous materials presenting a detonation hazard, a weather protection structure is to be permitted to be used for sheltering outdoor storage or use areas, without requiring such areas to be classified as indoor storage. For such storage or use areas to be regulated as outdoor storage or use, compliance with conditions in 6.5.3 and 6.5.4 are to be required. Where storage or use areas are provided with weather protection that does not comply with these conditions, the storage or use area is to be regulated as an indoor storage or use area.*
8. *Section 6.5.3 of NFPA 55 states that supports and walls are not to obstruct more than one side or more than 25 percent of the perimeter of the storage or use area.*
9. *Section 6.5.4 of NFPA 55 states that the distance from the structure and the structural supports to buildings, lot lines, public ways, or means of egress to a public way is not to be less than the distance required for an outside hazardous material storage or use area without weather protection. Where the weather protection structure is constructed of noncombustible materials, reductions in the separation distance is to be permitted based on the use of fire barrier walls when permitted for specific materials in accordance with the requirements of Chapters 7 through 11.*

Table 10.3.2.2.1 Minimum Distance from Outdoor Gaseous Hydrogen Systems to Exposures

Type of Outdoor Exposure	Total Gaseous Hydrogen Storage					
	<3500 scf (99 m <sup>3</sup> )		≥3500 scf to 15,000 scf (≥99 m <sup>3</sup> to 425 m <sup>3</sup> )		>15,000 scf (425 m <sup>3</sup> )	
	ft	m	ft	m	ft	m
(1) Building or structure						
(A) Wall(s) adjacent to system constructed of noncombustible or limited-combustible materials						
1. Sprinklered building or structure or unsprinklered building or structure having noncombustible contents	0	0	5	1.5	5	1.5
2. Unsprinklered building or structure with combustible contents						
(a) Adjacent wall(s) with fire resistance rating less than 2 hours	0	0	10	3.1	25	7.6
(b) Adjacent wall(s) with fire resistance rating of 2 hours or greater	0	0	5	1.5	5	1.5
(B) Wall(s) adjacent to system constructed of other than noncombustible or limited-combustible materials	10	3.1	25	7.6	50	15.2
(2) Wall openings						
(A) Not above any part of a system	10	3.1	10	3.1	10	3.1
(B) Above any part of a system	25	7.6	25	7.6	25	7.6
(3) All classes of flammable and combustible liquids above ground						
(A) 0-1000 gal (3785 L)	10	3.1	25	7.6	25	7.6
(B) In excess of 1000 gal (3785 L)	25	7.6	50	15.2	50	15.2
(4) All classes of flammable and combustible liquids below ground — 0-1000 gal (3785 L)						
(A) Tank	10	3.1	10	3.1	10	3.1
(B) Vent or fill opening of tank	25	7.6	25	7.6	25	7.6
(5) All classes of flammable and combustible liquids below ground — in excess of 1000 gal (3785 L)						
(A) Tank	20	6.1	20	6.1	20	6.1
(B) Vent or fill opening of tank	25	7.6	25	7.6	25	7.6
(6) Flammable gas storage (other than hydrogen), either high-pressure or low-pressure						
(A) 0-15,000 scf (425 m <sup>3</sup> ) capacity	10	3.1	25	7.6	25	7.6
(B) In excess of 15,000 scf (425 m <sup>3</sup> ) capacity	25	7.6	50	15.2	50	15.2
(7) Oxygen storage						
(A) 0-20,000 scf (566 m <sup>3</sup> )						
(B) More than 20,000 scf (566 m <sup>3</sup> )						
(8) Fast-burning solids such as ordinary lumber, excelsior, or paper	50	15.2	50	15.2	50	15.2
(9) Slow-burning solids such as heavy timber or coal	25	7.6	25	7.6	25	7.6
(10) Open flames and welding	25	7.6	25	7.6	25	7.6
(11) Air compressor intakes or inlets to ventilating or air-conditioning equipment	50	15.2	50	15.2	50	15.2
(12) Places of public assembly	25	7.6	50	15.2	50	15.2
(13) Public sidewalks and parked vehicles	15	4.6	15	4.6	15	4.6
(14) Line of adjoining property that is able to be built upon	5	1.5	5	1.5	5	1.5
(15) Encroachment by overhead utilities						
(A) Horizontal distance from the vertical plane below the nearest overhead wire of an electric trolley, train, or bus line	50	15	50	15	50	15
(B) Horizontal distance from the vertical plane below the nearest overhead electrical wire other than those noted above	5	1.5	5	1.5	5	1.5
(C) Piping containing other hazardous materials	15	4.6	15	4.6	15	4.6

Refer to NFPA 51, *Standard for the Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes*

Refer to Chapter 9