Second Revision No. 23-NFPA 55-2014 [ Global Comment ]

Change all references to Material Safety Data Sheets (MSDS) to Safety Data Sheets (SDS).

Submitter Information Verification

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Submittal Date: Mon Jul 14 10:40:31 MDT 2014

Committee Statement

Committee Statement: This is an editorial change to align the terminology of NFPA 55 with that of the Global Harmonized System adopted by OSHA in 2012

Response
Message:
In Annex H, change all occurrences of Tables 10.3.2.2.1(a) through (c) and Tables 10.3.2.1(a) and (b) to Tables 10.4.2.2.1(a) through (c), respectively.

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Submittal Date: Fri Sep 05 12:23:35 EDT 2014

Committee Statement

Committee Statement: Response to PC-35. Note that the submitted attached a word file to the document, the SR just makes the changes in Terra. This updates the table numbers in Annex H to match the reorganizations of Chapters 7 and 10.

Response Message:
Second Revision No. 65-NFPA 55-2014 [ Global Comment ]

Reorganize Chapters 7 and 10 according to the attached spreadsheet and/or word files.

Supplemental Information

<table>
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<th>File Name</th>
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<tr>
<td>NFPA_55_Chapter_7_and_10_Reorganization.xlsx</td>
<td>Spreadsheet with reorganization</td>
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<td>55-Chapter_7-SR-clean.docx</td>
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Submitter Information Verification

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Submittal Date: Thu Oct 02 14:22:34 EDT 2014

Committee Statement

Committee Statement: The committee is reorganizing the material currently in Chapters 7 and 10 of the document to locate all of the hydrogen content in Chapter 10. The material in Chapter 10 is being renumbered after the material moves from Chapter 7 and is reorganized. Attached is a spreadsheet that shows the reorganization and the new numbering scheme along with word files of both chapters.
## Chapter 7  NFPA 55 Reorganization

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Chapter 7 Compressed Gases

7.1 General.

The storage, use, and handling of compressed gases in cylinders, containers, and tanks shall be in accordance with the provisions of Chapters 1 through 7.

7.1.1

Where the primary supply of compressed gas is stored in a bulk liquid form, the provisions of Chapter 8 shall apply to piping and other gaseous system components downstream of the liquid vaporizer and upstream of the source valve.

7.1.2 Compressed Gas Systems.

7.1.2.1 Design.

Compressed gas systems shall be designed for the intended use and shall be designed by persons competent in such design.

7.1.2.2 Installation.

Installation of bulk compressed gas systems shall be supervised by personnel knowledgeable in the application of the standards for their construction and use.

7.1.3 Insulated Liquid Carbon Dioxide Systems.

Insulated liquid carbon dioxide systems shall be in accordance with Chapter 13.

7.1.4* Insulated Liquid Nitrous Oxide Systems. (Reserved)

7.1.5 Cylinders, Containers, and Tanks.

7.1.5.1 Design and Construction.

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.

7.1.5.2 Defective Cylinders, Containers, and Tanks.

7.1.5.2.1

Defective cylinders, containers, and tanks shall be returned to the supplier.

7.1.5.2.2

Suppliers shall repair the cylinders, containers, and tanks, remove them from service, or dispose of them in an approved manner.

7.1.5.2.3

Suppliers shall ensure that defective cylinders, containers, and tanks that have been repaired are evaluated by qualified individuals to verify that the needed repairs and any required testing has been performed and that those repaired or tested are in a serviceable condition before returning them to service.

7.1.5.3 Supports.

Stationary cylinders, containers, and tanks shall be provided with engineered supports of noncombustible material on noncombustible foundations.

7.1.5.4 Cylinders, Containers, and Tanks Containing Residual Gas.
Compressed gas cylinders, containers, and tanks containing residual product shall be treated as full except when being examined, serviced, or refilled by a gas manufacturer, authorized cylinder requalifier, or distributor.

7.1.5.5 Pressure Relief Devices.

7.1.5.5.1
When required by 7.1.5.5.2, pressure relief devices shall be provided to protect containers and systems containing compressed gases from rupture in the event of overpressure from thermal exposure.

7.1.5.5.2
Pressure relief devices to protect containers shall be designed and provided in accordance with CGA S-1.1, Pressure Relief Device Standards – Part 1 – Cylinders for Compressed Gases, for cylinders; CGA S-1.2, Pressure Relief Device Standards – Part 2 – Cargo and Portable Tanks for Compressed Gases, for portable tanks; and CGA S-1.3, Pressure Relief Device Standards – Part 3 – Stationary Storage Containers for Compressed Gases, for stationary tanks or in accordance with applicable equivalent requirements in the country of use.

7.1.5.5.3
Pressure relief devices shall be sized in accordance with the specifications to which the container was fabricated.

7.1.5.5.4
The pressure relief device shall have the capacity to prevent the maximum design pressure of the container or system from being exceeded.

7.1.5.5.5
Pressure relief devices shall be arranged to discharge unobstructed to the open air in such a manner as to prevent any impingement of escaping gas upon the container, adjacent structures, or personnel. This requirement shall not apply to DOT specification containers having an internal volume of 2.0 scf (0.057 Nm³) or less.

7.1.5.5.6
Pressure relief devices or vent piping shall be designed or located so that moisture cannot collect and freeze in a manner that would interfere with operation of the device.

7.1.5.5.7 Shutoffs Between Pressure Relief Devices and Containers.

7.1.5.5.7.1 General.
Shutoff valves installed between pressure relief devices and containers shall be in accordance with 7.1.5.5.7.2 through 7.1.5.5.7.4.

7.1.5.5.7.2 Location.
Shutoff valves shall not be installed between pressure relief devices and containers unless the valves or their use meet the requirements of 7.1.5.5.7.3 or 7.1.5.5.7.4.

7.1.5.5.7.3+ Security.
Shutoff valves, where used, shall be locked in the open position, and their use shall be limited to service-related work performed by the supplier under the requirements of the ASME Boiler and Pressure Vessel Code.

7.1.5.5.7.4 Multiple Pressure Relief Devices.
Shutoff valves controlling multiple pressure relief devices on a container shall be installed so that either the type of valve installed or the arrangement provides the full required flow through the relief devices at all times.
7.1.6 Cathodic Protection.
Where required, cathodic protection shall be in accordance with 7.1.6.

7.1.6.1 Operation.
Where installed, cathodic protection systems shall be operated and maintained to continuously provide corrosion protection.

7.1.6.2 Inspection.
Container systems equipped with cathodic protection shall be inspected for the intended operation by a cathodic protection tester. The frequency of inspection shall be determined by the designer of the cathodic protection system.

7.1.6.2.1
The cathodic protection tester shall be certified as being qualified by the National Association of Corrosion Engineers, International (NACE).

7.1.6.3 Impressed Current Systems.
Systems equipped with impressed current cathodic protection systems shall be inspected in accordance with the requirements of the design and 7.1.6.2.

7.1.6.3.1
The design limits of the cathodic protection system shall be available to the AHJ upon request.

7.1.6.3.2
The system owner shall maintain the following records to demonstrate that the cathodic protection is in conformance with the requirements of the design:

(1) The results of inspections of the system

(2) The results of testing that has been completed

7.1.6.4
Repairs, maintenance, or replacement of a cathodic protection system shall be under the supervision of a corrosion expert certified by NACE.

7.1.6.4.1
The corrosion expert shall be certified by NACE as a senior corrosion technologist, a cathodic protection specialist, or a corrosion specialist or shall be a registered engineer with registration in a field that includes education and experience in corrosion control.

7.1.7 Labeling Requirements.

7.1.7.1 Containers.
Individual compressed gas cylinders, containers, and tanks shall be marked or labeled in accordance with DOT requirements or those of the applicable regulatory agency.

7.1.7.2 Label Maintenance.
The labels applied by the gas manufacturer to identify the liquefied or nonliquefied compressed gas cylinder contents shall not be altered or removed by the user.

7.1.7.3 Stationary Compressed Gas Cylinders, Containers, and Tanks.

7.1.7.3.1
Stationary compressed gas cylinders, containers, and tanks shall be marked in accordance with NFPA 704.

7.1.7.3.2
Markings shall be visible from any direction of approach.

7.1.7.4 Piping Systems.

7.1.7.4.1
Except as provided in 7.1.7.4.2, piping systems shall be marked in accordance with ASME A13.1, *Scheme for the Identification of Piping Systems*, or other applicable approved standards as follows:

(1) Marking shall include the name of the gas and a direction-of-flow arrow.

(2) Piping that is used to convey more than one gas at various times shall be marked to provide clear identification and warning of the hazard.

(3) Markings for piping systems shall be provided at the following locations:
   (a) At each critical process control valve
   (b) At wall, floor, or ceiling penetrations
   (c) At each change of direction
   (d) At a minimum of every 20 ft (6.1 m) or fraction thereof throughout the piping run

7.1.7.4.2
Piping within gas manufacturing plants, gas processing plants, refineries, and similar occupancies shall be marked in an approved manner.

7.1.8 Security.

7.1.8.1 General.
Compressed gas cylinders, containers, tanks, and systems shall be secured against accidental dislodgement and against access by unauthorized personnel.

7.1.8.2* Security of Areas.
Storage, use, and handling areas shall be secured against unauthorized entry.

7.1.8.2.1
Administrative controls shall be allowed to be used to control access to individual storage, use, and handling areas located in secure facilities not accessible by the general public.

7.1.8.3 Physical Protection.

7.1.8.3.1
Compressed gas cylinders, containers, tanks, and systems that could be exposed to physical damage shall be protected.

7.1.8.3.2
Guard posts or other means shall be provided to protect compressed gas cylinders, containers, tanks, and systems indoors and outdoors from vehicular damage in accordance with Section 4.11.

7.1.8.4 Securing Compressed Gas Cylinders, Containers, and Tanks.
Compressed gas cylinders, containers, and tanks in use or in storage shall be secured to prevent them from falling or being knocked over by corralling them and securing them to a cart, framework, or fixed object by use of a restraint, unless otherwise permitted by 7.1.8.4.1 and 7.1.8.4.2.

7.1.8.4.1
Compressed gas cylinders, containers, and tanks in the process of examination, servicing, and refilling shall not be required to be secured.

7.1.8.4.2
At cylinder-filling plants, authorized cylinder requalifier's facilities, and distributors' warehouses, the nesting of cylinders shall be permitted as a means to secure cylinders.

7.1.9 Valve Protection.

7.1.9.1 General.
Compressed gas cylinder, container, and tank valves shall be protected from physical damage by means of protective caps, collars, or similar devices.

7.1.9.1.1 Valve protection of individual valves shall not be required to be installed on individual cylinders, containers, or tanks installed on tube trailers or similar transportable bulk gas systems equipped with manifolds that are provided with a means of physical protection that will protect the valves from physical damage when the equipment is in use. Protective systems required by DOT for over the road transport shall provide an acceptable means of protection.

7.1.9.1.1.1 Valve protection of individual valves shall not be required on cylinders, containers, or tanks that comprise bulk or non-bulk gas systems where the containers are stationary, or portable equipped with manifolds, that are provided with physical protection in accordance with Section 4.11 and 7.1.8.3 or other approved means. Protective systems required by DOT for over the road transport shall provide an acceptable means of protection.

7.1.9.2 Valve-Protective Caps.
Where compressed gas cylinders, containers, and tanks are designed to accept valve-protective caps, the user shall keep such caps on the compressed gas cylinders, containers, and tanks at all times, except when empty, being processed, or connected for use.

7.1.9.3 Valve Outlet Caps or Plugs.

7.1.9.3.1 Gastight valve outlet caps or plugs shall be provided and in place for all full or partially full cylinders, containers, and tanks containing toxic, highly toxic, pyrophoric, or unstable reactive Class 3 or Class 4 gases that are in storage.

7.1.9.3.2 Valve outlet caps and plugs shall be designed and rated for the container service pressure.

7.1.10 Separation from Hazardous Conditions.

7.1.10.1 General.
Compressed gas cylinders, containers, tanks, and systems in storage or use shall be separated from materials and conditions that present exposure hazards to or from each other.

7.1.10.2* Incompatible Materials.
Gas cylinders, containers, and tanks shall be separated in accordance with Table 7.1.10.2.

Table 7.1.10.2 Separation of Gas Cylinders, Containers, and Tanks by Hazard Class
### Toxic or highly toxic

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NR: No separation required.

7.1.10.2.1

Subparagraph 7.1.10.2 shall not apply to gases contained within closed piping systems.

7.1.10.2.2

The distances shown in Table 7.1.10.2 shall be permitted to be reduced without limit where compressed gas cylinders, containers, and tanks are separated by a barrier of noncombustible construction that has a fire resistance rating of at least 0.5 hour and interrupts the line of sight between the containers.

7.1.10.2.3

The 20 ft (6.1 m) distance shall be permitted to be reduced to 5 ft (1.5 m) where one of the gases is enclosed in a gas cabinet or without limit where both gases are enclosed in gas cabinets.

7.1.10.2.4

Cylinders without pressure relief devices shall not be stored without separation from flammable and pyrophoric gases with pressure relief devices.

7.1.10.2.5*

Spatial separation shall not be required between cylinders deemed to be incompatible in gas production facilities where cylinders are connected to manifolds for the purposes of filling, analysis of compressed gases or, manufacturing procedures, assuming the prescribed controls for the manufacture of gas mixtures are in place.

7.1.10.3* Clearance from Combustibles and Vegetation.

Combustible waste, vegetation, and similar materials shall be kept a minimum of 10 ft (3.1 m) from compressed gas cylinders, containers, tanks, and systems.

7.1.10.3.1

A noncombustible partition without openings or penetrations and extending not less than 18 in. (457 mm) above and to the sides of the storage area shall be permitted in lieu of the minimum distance.

7.1.10.3.2
The noncombustible partition shall be either an independent structure or the exterior wall of the building adjacent to the storage area.

7.1.10.4 Ledges, Platforms, and Elevators.

Compressed gas cylinders, containers, and tanks shall not be placed near elevators, unprotected platform ledges, or other areas where compressed gas cylinders, containers, or tanks could fall distances exceeding one-half the height of the container, cylinder, or tank.

7.1.10.5 Temperature Extremes.

Compressed gas cylinders, containers, and tanks, whether full or partially full, shall not be exposed to temperatures exceeding 125°F (52°C) or subambient (low) temperatures unless designed for use under such exposure.

7.1.10.5.1

Compressed gas cylinders, containers, and tanks that have not been designed for use under elevated temperature conditions shall not be exposed to direct sunlight outdoors where ambient temperatures exceed 125°F (52°C). The use of a weather protected structure or shaded environment for storage or use shall be permitted as a means to protect against direct exposure to sunlight.

7.1.10.6 Falling Objects.

Compressed gas cylinders, containers, and tanks shall not be placed in areas where they are capable of being damaged by falling objects.

7.1.10.7 Heating.

Compressed gas cylinders, containers, and tanks, whether full or partially full, shall not be heated by devices that could raise the surface temperature of the container, cylinder, or tank to above 125°F (52°C).

7.1.10.7.1 Electrically Powered Heating Devices.

Electrical heating devices shall be in accordance with NFPA 70.

7.1.10.7.2 Fail-Safe Design.

Devices designed to maintain individual compressed gas cylinders, containers, and tanks at constant temperature shall be designed to be fail-safe.

7.1.10.8 Sources of Ignition.

Open flames and high-temperature devices shall not be used in a manner that creates a hazardous condition.

7.1.10.9 Exposure to Chemicals.

Compressed gas cylinders, containers, and tanks shall not be exposed to corrosive chemicals or fumes that could damage cylinders, containers, tanks, or valve-protective caps.

7.1.10.10 Exposure to Electrical Circuits.

Compressed gas cylinders, containers, and tanks shall not be placed where they could become a part of an electrical circuit.

7.1.10.10.1

Electrical devices mounted on compressed gas piping, cylinders, containers, or tanks shall be installed, grounded, and bonded in accordance with the methods specified in NFPA 70 (NEC).

7.1.11 Service and Repair.
Service, repair, modification, or removal of valves, pressure relief devices, or other compressed gas cylinder, container, and tank appurtenances shall be performed by trained personnel and with the permission of the container owner.

7.1.12 Unauthorized Use.
Compressed gas cylinders, containers, and tanks shall not be used for any purpose other than to serve as a vessel for containing the product for which it was designed.

7.1.13 Cylinders, Containers, and Tanks Exposed to Fire.
Compressed gas cylinders, containers, and tanks exposed to fire shall not be used or shipped while full or partially full until they are requalified in accordance with the pressure vessel code under which they were manufactured.

7.1.14 Leaks, Damage, or Corrosion.

7.1.14.1 Removal from Service.
Leaking, damaged, or corroded compressed gas cylinders, containers, and tanks shall be removed from service.

7.1.14.2 Replacement and Repair.
Leaking, damaged, or corroded compressed gas systems shall be replaced or repaired.

7.1.14.3* Handling of Cylinders, Containers, and Tanks Removed from Service.
Compressed gas cylinders, containers, and tanks that have been removed from service shall be handled in an approved manner.

Compressed gas systems that are determined to be leaking, damaged, or corroded shall be repaired to a serviceable condition or shall be removed from service.

7.1.15 Surfaces.

7.1.15.1
To prevent bottom corrosion, cylinders, containers, and tanks shall be protected from direct contact with soil or surfaces where water might accumulate.

7.1.15.2
Surfaces shall be graded to prevent accumulation of water.

7.1.16 Storage Area Temperature.

7.1.16.1 Compressed Gas Containers.
Storage area temperatures shall not exceed 125°F (52°C).

7.1.17 Underground Piping.

7.1.17.1
Underground piping shall be of welded construction without valves, unwelded mechanical joints, or connections installed underground.

7.1.17.1.1
Valves or connections located in boxes or enclosures shall be permitted to be installed underground where such boxes or enclosures are accessible from above ground and where the valves or connections contained are isolated from direct contact with earth or fill.
Valve boxes or enclosures installed in areas subject to vehicular traffic shall be constructed to resist uniformly distributed and concentrated live loads in accordance with the building code for areas designated as vehicular driveways and yards, subject to trucking.

7.1.17.1.2*

Piping installed in trench systems located below grade where the trench is open to above shall not be considered to be underground.

7.1.17.2

Gas piping in contact with earth or other material that could corrode the piping shall be protected against corrosion in an approved manner.

7.1.17.2.1

When cathodic protection is provided, it shall be in accordance with 7.1.6.

7.1.17.3

Underground piping shall be installed on at least 6 in. (150 mm) of well-compacted bedding material. [30:27.6.5.1]

7.1.17.4

In areas subject to vehicle traffic, the pipe trench shall be deep enough to permit a cover of at least 18 in. (450 mm) of well-compacted backfill material and pavement. [30:27.6.5.2]

7.1.17.5

In paved areas where a minimum 2 in. (50 mm) of asphalt is used, backfill between the pipe and the asphalt shall be permitted to be reduced to 8 in. (200 mm) minimum. [30:27.6.5.3]

7.1.17.6

In paved areas where a minimum 4 in. (100 mm) of reinforced concrete is used, backfill between the pipe and the concrete shall be permitted to be reduced to 4 in. (100 mm) minimum. [30:27.6.5.4]

7.1.17.7

In areas not subject to vehicle traffic, the pipe trench shall be deep enough to permit a cover of at least 12 in. (300 mm) of well-compacted backfill material.

7.1.17.8

A greater burial depth shall be provided when required by the manufacturer's instructions or where frost conditions are present. [30:27.6.5.6]

7.1.17.9

Piping within the same trench shall be separated horizontally by at least two pipe diameters. Separation shall not need to exceed 9 in. (230 mm). [30:27.6.5.7]

7.1.17.10

Two or more levels of piping within the same trench shall be separated vertically by a minimum 6 in. (150 mm) of well-compacted bedding material. [30:27.6.5.8]

7.1.18 Cleaning and Purging of Gas Piping Systems.

7.1.18.1 General.

7.1.18.1.1

Piping systems shall be cleaned and purged in accordance with the requirements of 7.1.18 when one or more of the following conditions exist:

(1) The system is installed and prior to being placed into service
There is a change in service

There are alterations or repair of the system involving the replacement of parts or addition to the piping system and prior to returning the system to service

The design standards or written procedures specify cleaning and purging

7.1.18.1.2
Cleaning and purging of the internal surfaces of piping systems shall be conducted by qualified individuals trained in cleaning and purging operations and procedures, including the recognition of potential hazards associated with cleaning and purging.

7.1.18.1.3*
A written cleaning or purging procedure shall be provided to establish the requirements for the cleaning and purging operations to be conducted.

7.1.18.1.3.1*
An independent or third-party review of the written procedure shall be conducted after the procedure has been written and shall accomplish the following:

1. Evaluate hazards, errors, and malfunctions related to each step in the procedure
2. Review the measures prescribed in the procedure for applicability
3. Make recommendations for additional hazard mitigation measures if deemed necessary

7.1.18.1.3.2
The completed written procedure shall be:

1. Maintained on site by the facility owner/operator
2. Provided to operating personnel engaged in cleaning or purging operations
3. Made available to the AHJ upon request

7.1.18.1.3.3
Where generic cleaning or purging procedures have been established, a job-specific operating procedure shall not be required.

7.1.18.1.3.4
Generic procedures shall be reviewed when originally published or when the procedure or operation is changed.

7.1.18.1.4
Written procedures to manage a change in process materials, technology, equipment, procedures, and facilities shall be established by the facility owner/operator.

7.1.18.1.4.1
The management-of-change procedures shall ensure that the following topics are addressed prior to any change in the configuration or design of the piping system:

1. The technical basis for the proposed change
2. The safety and health implications
3. Whether the change is permanent or temporary
4. Whether modifications to the cleaning and purging procedures are required as a result of the identified changes
7.1.18.1.4.2
When modifications to the cleaning and purging procedures are required, the written procedure shall be updated to incorporate any elements identified by the management-of-change procedures.

7.1.18.1.5
Prior to cleaning or purging, piping systems shall be inspected and tested to determine that the installation, including the materials of construction, and method of fabrication, comply with the requirements of the design standard used and the intended application for which the system was designed.

7.1.18.1.5.1
Inspection and testing of piping systems shall not be required to remove a system from service.

7.1.18.1.5.2
Purging of piping systems shall not be required for systems that are utilized for operations designated by written operating procedures in accordance with the requirements of the cleaning or purging procedure specified in 7.1.18.1.1.

7.1.18.1.5.3*
Personnel in the affected area(s), as determined by the cleaning or purging procedure, shall be informed of the hazards associated with the operational activity and notified prior to the initiation of any such activity.

7.1.18.2* Cleaning.
Piping system designs shall be documented to specify the requirements for the internal cleaning of the piping system prior to installation and initial use.

7.1.18.2.1
The internal surfaces of gas piping systems shall be cleaned to ensure that the required standard of cleanliness specified by the design is met prior to placing the gas piping system into service.

7.1.18.2.2*
When piping systems are cleaned in stages during installation or assembly, the interior of the cleaned piping shall be protected against the infiltration of unwanted contaminants.

7.1.18.3* Purging.
Piping systems used to contain gases with a physical or health hazard in any of the categories specified by Section 5.1 shall be purged prior to being placed into service for initial use.

7.1.18.3.1
Piping systems shall be purged to remove the internal contents preceding the following activities or operations:

1. Activating or placing a piping system into service
2. Deactivating or removing a piping system from service
3. Changing the service of a piping system from one gas to another, except when such gas is supplied to a manifold or piping system designed for the purpose of filling or otherwise processing cylinders, containers, or tanks in a process with established procedures
4. Performing service, maintenance, or modifications on a system where personnel or designated areas will potentially be exposed to the internal contents of the piping system
5. Performing hot work, including but not limited to, welding, cutting, or brazing on the piping system
7.1.18.3.2
The termination point for the release of purged gases shall be in accordance with Section 6.15.

7.1.18.3.2.1
The release of purged gases or mixtures containing any quantity of corrosive, toxic, or highly toxic gases shall be through a treatment system in accordance with the applicable requirements of 7.5.3.4 or 7.9.3.

7.1.18.3.2.2
The termination point for the release of purged gases resultant from the purging of piping systems out of service, other than those in accordance with 7.1.18.3.2.1, shall not be required to be in accordance with Section 6.15 where the contained volume of the piping system (when released to indoor areas) does not result in a concentration in the room or area that will reduce the oxygen concentration in the room or area below a level of 19.5 percent or that exceeds any of the following limits:

1. Ceiling limit
2. Permissible exposure limit
3. Short-term exposure limit
4. Twenty-five percent of the lower flammable limit

7.2 Storage.

7.2.1 General.

7.2.1.1 Applicability.
The storage of compressed gas cylinders, containers, and tanks shall be in accordance with Section 7.2.

7.2.1.2 Upright Storage Flammable Gas in Solution and Liquefied Flammable Gas.
Cylinders, containers, and tanks containing liquefied flammable gases and flammable gases in solution shall be positioned in the upright position.

7.2.1.2.1 Cylinders and Containers of 1.3 Gal (5 L) or Less.
Containers with a capacity of 1.3 gal (5 L) or less shall be permitted to be stored in a horizontal position.

7.2.1.2.2 Cylinders, Containers, and Tanks Designed for Horizontal Use.
Cylinders, containers, and tanks designed for use in a horizontal position shall be permitted to be stored in a horizontal position.

7.2.1.2.3 Palletized Cylinders, Containers, and Tanks.
Cylinders, containers, and tanks, with the exception of those containing flammable liquefied compressed gases, that are palletized for transportation purposes shall be permitted to be stored in a horizontal position.

7.2.1.3 Classification of Weather Protection as an Indoor Versus an Outdoor Area.
For other than explosive materials and hazardous materials presenting a detonation hazard, a weather protection structure shall be permitted to be used for sheltering outdoor storage or use areas without requiring such areas to be classified as indoor storage.

7.2.2 Material-Specific Regulations.

7.2.2.1 Indoor Storage.
Indoor storage of compressed gases shall be in accordance with the material-specific provisions of Sections 7.4 through 7.10.

7.2.2.2 Exterior Storage.

7.2.2.2.1 General.
Exterior storage of compressed gases shall be in accordance with the material-specific provisions of Sections 7.4 through 7.10.

7.2.2.2.2 Separation.
Distances from property lines, buildings, and exposures shall be in accordance with the material-specific provisions of Sections 7.4 through 7.10.

7.3 Use and Handling.

7.3.1 General.

7.3.1.1 Applicability.
The use and handling of compressed gas cylinders, containers, tanks, and systems shall be in accordance with 7.3.1.

7.3.1.2 Controls.

7.3.1.2.1 Compressed gas system controls shall be designed to prevent materials from entering or leaving the process at an unintended time, rate, or path.

7.3.1.2.2 Automatic controls shall be designed to be fail-safe.

7.3.1.3 Piping Systems.
Piping, tubing, fittings, and related components shall be designed, fabricated, and tested in accordance with the requirements of the applicable parts ASME B31.3, Code for Process Piping, or other approved standards.

7.3.1.3.1 Integrity.
Piping, tubing, pressure regulators, valves, and other apparatus shall be kept gastight to prevent leakage.

7.3.1.3.2 Backflow Prevention.
Backflow prevention or check valves shall be provided where the backflow of hazardous materials could create a hazardous condition or cause the unauthorized discharge of hazardous materials.

7.3.1.4 Valves.

7.3.1.4.1 Valves utilized on compressed gas systems shall be designed for the gas or gases and pressure intended and shall be accessible.

7.3.1.4.2 Valve handles or operators for required shutoff valves shall not be removed or otherwise altered to prevent access.

7.3.1.5 Vent Pipe Termination.

7.3.1.5.1 Venting of gases shall be directed to an approved location.
7.3.1.5.2

The termination point for piped vent systems serving cylinders, containers, tanks, and gas systems used for the purpose of operational or emergency venting shall be in accordance with Section 6.15.

7.3.1.6 Upright Use.

7.3.1.6.1

Compressed gas cylinders, containers, and tanks containing flammable liquefied gas, except those designed for use in a horizontal position and those compressed gas cylinders, containers, and tanks containing nonliquefied gases, shall be used in a “valve end up” upright position.

7.3.1.6.2

An upright position shall include a position in which the cylinder, container, or tank axis is inclined as much as 45 degrees from the vertical and in which the relief device is always in direct communication with the gas phase.

7.3.1.7 Inverted Use.

Cylinders, containers, and tanks containing nonflammable liquefied gases shall be permitted to be used in the inverted position when the liquid phase is used.

7.3.1.7.1

Flammable liquefied gases at processing plants shall be permitted to use this inverted position method while transfilling.

7.3.1.7.2

The cylinder, container, or tank shall be secured, and the dispensing apparatus shall be designed for use with liquefied gas.

7.3.1.8 Cylinders and Containers of 1.3 Gal (5 L) or Less.

Cylinders or containers with a water volume of 1.3 gal (5 L) or less shall be permitted to be used in a horizontal position.

7.3.1.9 Transfer.

Transfer of gases between cylinders, containers, and tanks shall be performed by qualified personnel using equipment and operating procedures in accordance with CGA P-1, Safe Handling of Compressed Gases in Containers.

7.3.1.10 Use of Compressed Gases for Inflation.

Inflatable equipment, devices, or balloons shall only be pressurized or filled with compressed air or inert gases.

7.3.1.11 Emergency Shutoff Valves.

7.3.1.11.1

Accessible manual or automatic emergency shutoff valves shall be provided to shut off the flow of gas in case of emergency.

7.3.1.11.1.1

Manual emergency shutoff valves or the device that activates an automatic emergency shutoff valve on a bulk source or piping system serving the bulk supply shall be identified by means of a sign.

7.3.1.11.2

Emergency shutoffs shall be located at the point of use and at the tank, cylinder, or bulk source, and at the point where the system piping enters the building.
7.3.1.12 Excess Flow Control

Excess Flow Control

7.3.1.12.1*

Where compressed gases having a hazard ranking in one or more of the following hazard classes in accordance with NFPA 704 are carried in pressurized piping above a gauge pressure of 15 psi (103 kPa), an approved means of either leak detection with emergency shutoff or excess flow control/emergency isolation shall be provided:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>Health hazard Class 3 or Class 4</td>
</tr>
<tr>
<td>(2)</td>
<td>Instability Class 3 or Flammability Class 4</td>
</tr>
</tbody>
</table>

7.3.1.12.2

Approved means of meeting the requirements for emergency isolation shall include any of the following:

(1) Automatic shutoff valves, located as close to the bulk source as practical, tied to leak detection systems

(2) Attended control stations where trained personnel can monitor alarms or supervisory signals and can trigger emergency responses

(3) A constantly-monitored control station with an alarm and remote shut off of the gas supply system

(4) Excess flow valves at the bulk source

7.3.1.12.3

The controls required by requirements of 7.3.1.12 shall not be required for the following:

(1) Piping for inlet connections designed to prevent backflow at the source

(2) Piping for pressure relief devices

(3) Where the source of the gas is not in excess of the quantity threshold indicated in Table 6.3.1.1

7.3.1.12.4 Location Exemptions.

The requirements of 7.3.1.12 shall not apply to the following:

(1) Piping for inlet connections designed to prevent backflow

(2) Piping for pressure relief devices

(3) Systems containing 430 scf (12.7 Nm³) or less of flammable gas

7.3.2 Material-Specific Regulations.

7.3.2.1 Indoor Use.

Indoor use of compressed gases shall be in accordance with the requirements of Sections 7.4 through 7.10.

7.3.2.2 Exterior Use.

7.3.2.2.1 General.

Exterior use of compressed gases shall be in accordance with the requirements of Sections 7.4 through 7.10.

7.3.2.2.2 Separation.
Distances from property lines, buildings, and exposure hazards shall be in accordance with the material-specific provisions of Sections 7.4 through 7.10.

7.3.3 Handling.

7.3.3.1 Applicability.

The handling of compressed gas cylinders, containers, and tanks shall be in accordance with 7.3.3.

7.3.3.2 Carts and Trucks.

7.3.3.2.1 Cylinders, containers, and tanks shall be moved using an approved method.

7.3.3.2.2 Where cylinders, containers, and tanks are moved by hand cart, hand truck, or other mobile device, such carts, trucks, or devices shall be designed for the secure movement of cylinders, containers, and tanks.

7.3.3.3 Lifting Devices.

Ropes, chains, or slings shall not be used to suspend compressed gas cylinders, containers, and tanks unless provisions at time of manufacture have been made on the cylinder, container, or tank for appropriate lifting attachments, such as lugs.

7.4 Medical Gas Systems.

Medical gas systems for health care shall be in accordance with NFPA 99.

7.5 Corrosive Gases.

7.5.1 General.

The storage or use of corrosive compressed gases exceeding the quantity thresholds for gases requiring special provisions as specified in Table 6.3.1.1 shall be in accordance with Chapters 1 through 6 and Sections 7.1 through 7.3 and 7.5.

7.5.2 Distance to Exposures.

The outdoor storage or use of corrosive compressed gas shall not be within 20 ft (6.1 m) of buildings not associated with the manufacture or distribution of corrosive gases, lot lines, streets, alleys, public ways, or means of egress.

7.5.2.1 A 2-hour fire barrier wall without openings or penetrations and that extends not less than 30 in. (762 mm) above and to the sides of the storage or use area shall be permitted in lieu of the 20 ft (6.1 m) distance.

7.5.2.1.1 Where a fire barrier is used to protect compressed gas systems, the system shall terminate downstream of the source valve.

7.5.2.1.2 The fire barrier wall shall be either an independent structure or the exterior wall of the building adjacent to the storage or use area.

7.5.2.1.3 The 2-hour fire barrier shall be located at least 5 ft (1.5 m) from any exposure.

7.5.2.1.4
The 2-hour fire barrier wall shall not have more than two sides at approximately 90 degree (1.57 rad) directions or not more than three sides with connecting angles of approximately 135 degrees (2.36 rad).

7.5.3 Indoor Use.

The indoor use of corrosive gases shall be provided with a gas cabinet, exhausted enclosure, or gas room.

7.5.3.1 Gas Cabinets.

Gas cabinets shall be in accordance with Section 6.17.

7.5.3.2 Exhausted Enclosures.

Exhausted enclosures shall be in accordance with Section 6.18.

7.5.3.3 Gas Rooms.

Gas rooms shall be in accordance with Section 6.4.

7.5.3.4 Treatment Systems.

Treatment systems, except as provided for in 7.5.3.4.1, gas cabinets, exhausted enclosures, and gas rooms containing corrosive gases in use shall be provided with exhaust ventilation, with all exhaust directed to a treatment system designed to process the accidental release of gas.

7.5.3.4.1

Treatment systems shall not be required for corrosive gases in use where provided with the following:

(1) Gas detection in accordance with 7.9.3.2.1.1

(2) Fail-safe automatic closing valves in accordance with 7.9.3.2.2

7.5.3.4.2

Treatment systems shall be capable of diluting, adsorbing, absorbing, containing, neutralizing, burning, or otherwise processing the release of corrosive gas in accordance with 7.9.3.4.1.

7.5.3.4.3

Treatment system sizing shall be in accordance with 7.9.3.4.

7.6 Flammable Gases.

7.6.1 Storage, Use, and Handling.

7.6.1.1*

The storage or use of flammable gases exceeding the quantity thresholds for gases requiring special provisions as specified in Table 6.3.1.1 shall be in accordance with Chapters 1 through 6 and Sections 7.1 through 7.3 and Section 7.6.

7.6.1.2

Storage, use, and handling of gaseous hydrogen shall be in accordance with 7.6.1 and Chapter 10.

7.6.1.3

Storage, use, and handling of compressed natural gas shall be in accordance with 7.6.1.

7.6.2 Distance to Exposures.

The outdoor storage or use of non-bulk flammable compressed gas shall be located from lot lines, public streets, public alleys, public ways, or buildings not associated with the manufacture or distribution of such gases in accordance with Table 7.6.2.
### Table 7.6.2 Distance to Exposures for Non-Bulk Flammable Gases

<table>
<thead>
<tr>
<th>Maximum Amount per Storage Area (scf)</th>
<th>Minimum Distance Between Storage Areas (ft)</th>
<th>Minimum Distance to Lot Lines of Property That Can Be Built Upon (ft)</th>
<th>Minimum Distance to Public Streets, Public Alleys or Public Ways (ft)</th>
<th>Minimum Distance to Buildings on the Same Property</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–4225</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5, 0, 0</td>
</tr>
<tr>
<td>4226–21,125</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10, 5, 0</td>
</tr>
<tr>
<td>21,126–50,700</td>
<td>10</td>
<td>15</td>
<td>15</td>
<td>20, 5, 0</td>
</tr>
<tr>
<td>50,701–84,500</td>
<td>10</td>
<td>20</td>
<td>20</td>
<td>20, 5, 0</td>
</tr>
<tr>
<td>84,501–200,000</td>
<td>20</td>
<td>25</td>
<td>25</td>
<td>20, 5, 0</td>
</tr>
</tbody>
</table>

For SI units, 1 ft = 304.8 mm; 1 scf = 0.02832 Nm³.

Note: The minimum required distances does not apply where fire barriers without openings or penetrations having a minimum fire-resistant rating of 2 hours interrupt the line of sight between the storage and the exposure. The configuration of the fire barriers shall be designed to allow natural ventilation to prevent the accumulation of hazardous gas concentrations.

#### 7.6.2.1

Bulk hydrogen gas installations shall be in accordance with Chapter 10.

7.6.2.1.1

Where a protective structure is used to protect compressed gas systems, the system shall terminate downstream of the source valve.

7.6.2.1.2

The fire barrier wall shall be either an independent structure or the exterior wall of the building adjacent to the storage or use area.

#### 7.6.2.2

Bulk gas systems for flammable gases other than hydrogen shall be in accordance with Table 10.4.2.2.1(a), Table 10.4.2.2.1(b), or Table 10.4.2.2.1(c) where the quantity of flammable compressed gas exceeds 5000 scf (141.6 Nm³).

7.6.2.2.1

Where fire barriers are used as a means of distance reduction, fire barriers shall be in accordance with 10.4.2.2.4.

7.6.2.2.2

Mobile acetylene trailer systems (MATS) shall be located in accordance with 15.2.2.

7.6.2.3

The configuration of the protective structure shall be designed to allow natural ventilation to prevent the accumulation of hazardous gas concentrations.
7.6.2.4
Storage and use of flammable compressed gases shall not be located within 50 ft (15.2 m) of air intakes.

7.6.2.5
Storage and use of flammable gases outside of buildings shall also be separated from building openings by 25 ft (7.6 m). Fire barriers shall be permitted to be used as a means to separate storage areas from openings or a means of egress used to access the public way.

7.6.2.6
Vents from tube trailers and fixed storage systems under weather protection shall discharge outside the weather protection. Hydrogen tube trailers and fixed storage systems shall follow CGA G-5.5, Hydrogen Vent Systems, and vent outside the weather enclosure.

7.6.3 Ignition Source Control.
Ignition sources in areas containing flammable gases shall be in accordance with 7.6.3.

7.6.3.1 Static Producing Equipment.
Static producing equipment located in flammable gas areas shall be grounded.

7.6.3.2 No Smoking or Open Flame.
Signs shall be posted in areas containing flammable gases stating that smoking or the use of open flame, or both, is prohibited within 25 ft (7.6 m) of the storage or use area perimeter.

7.6.3.3 Heating.
Heating, where provided, shall be by indirect means. Equipment used for heating applications in rooms or areas where flammable gases are stored or used shall be listed and labeled for use in hazardous environments established by the gases present and shall be installed in accordance with the conditions of the listing and the manufacturer’s installation instructions.

7.6.4 Electrical.
Areas in which the storage or use of compressed gases exceeds the quantity thresholds for gases requiring special provisions shall be in accordance with NFPA 70.

7.6.5 Maintenance of Piping Systems.
7.6.5.1
Maintenance of flammable gas system piping and components shall be performed annually by a qualified representative of the equipment owner.

7.6.5.2
This maintenance shall include inspection for physical damage, leak tightness, ground system integrity, vent system operation, equipment identification, warning signs, operator information and training records, scheduled maintenance and retest records, alarm operation, and other safety-related features.

7.6.5.3
Scheduled maintenance and retest activities shall be formally documented, and records shall be maintained a minimum of 3 years.

7.7 Oxidizing Gases.
7.7.1 General.
The storage or use of oxidizing compressed gases exceeding the quantity thresholds for gases requiring special provisions as specified in Table 6.3.1.1 shall be in accordance with Chapters 1 through 6 and Sections 7.1 through 7.3 and 7.7.
7.7.2 Distance to Exposures.

The outdoor storage or use of oxidizing compressed gas shall be in accordance with Table 7.7.2.

Table 7.7.2 Distance to Exposures for Oxidizing Gases

<table>
<thead>
<tr>
<th>Quantity of Gas Stored (at NTP)</th>
<th>Minimum Distance Between Storage Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>scf</td>
<td>ft</td>
</tr>
<tr>
<td>0–50,000</td>
<td>5</td>
</tr>
<tr>
<td>50,001–100,000</td>
<td>10</td>
</tr>
<tr>
<td>≥100,001</td>
<td>15</td>
</tr>
</tbody>
</table>

7.7.2.1

The distances shall not apply where fire barriers having a minimum fire resistance of 2 hours interrupt the line of sight between the container and the exposure.

7.7.2.1.1

Where a fire barrier is used to protect compressed gas systems, the system shall terminate downstream of the source valve.

7.7.2.2

The fire barrier wall shall be either an independent structure or the exterior wall of the building adjacent to the storage or use area.

7.7.2.3

The configuration of the fire barrier shall allow natural ventilation to prevent the accumulation of hazardous gas concentrations.

7.8 Pyrophoric Gases.

7.8.1 General.

Pyrophoric compressed gases exceeding the quantity thresholds for gases requiring special provisions as specified in Table 6.3.1.1 shall be stored and used in accordance with Chapters 1 through 6 and Sections 7.1 through 7.3 and Section 7.8.

7.8.2 Silane and Silane Mixtures.

Silane and silane mixtures shall be stored, used, and handled in accordance with the provisions of ANSI/CGA G-13, Storage and Handling of Silane and Silane Mixtures.

7.8.3 Distance to Exposures.

The outdoor storage or use of pyrophoric compressed gas shall be in accordance with Table 7.8.3.

Table 7.8.3 Distance to Exposures for Pyrophoric Gases
<table>
<thead>
<tr>
<th>Maximum Amount per Storage Area</th>
<th>Minimum Distance Between Storage Areas</th>
<th>Minimum Distance to Property Lines</th>
<th>Minimum Distance to Public Ways</th>
<th>Minimum Distance to Buildings on the Same Property</th>
</tr>
</thead>
<tbody>
<tr>
<td>scf</td>
<td>ft</td>
<td>m</td>
<td>ft</td>
<td>m</td>
</tr>
<tr>
<td>250</td>
<td>5</td>
<td>1.5</td>
<td>25</td>
<td>7.6</td>
</tr>
<tr>
<td>&gt;250 to 2500</td>
<td>&gt;7</td>
<td>1.5</td>
<td>10</td>
<td>3.0</td>
</tr>
<tr>
<td>&gt;2500 to 7500</td>
<td>&gt;71</td>
<td>1.5</td>
<td>20</td>
<td>6.0</td>
</tr>
</tbody>
</table>

7.8.3.1
The distances shall be allowed to be reduced to 5 ft (1.5 m) where fire barriers having a minimum fire resistance of 2 hours interrupt the line of sight between the container and the exposure.

7.8.3.1.1 *
Where a fire barrier is used to protect compressed gas systems, the system shall terminate downstream of the source valve.

7.8.3.1.2
The fire barrier shall be either an independent structure or the exterior wall of the building adjacent to the storage or use area.

7.8.3.1.3
The fire barrier shall be at least 5 ft (1.5 m) from the storage or use area perimeter.

7.8.3.1.4
The configuration of the fire barrier shall allow natural ventilation to prevent the accumulation of hazardous gas concentrations.

7.8.3.2
Storage and use of pyrophoric gases outside buildings shall be separated from building openings by 25 ft (7.6 m).

7.8.3.2.1
Fire barriers shall be permitted to be used as a means to separate storage areas from building openings that are used to access the public way.

7.9 Toxic and Highly Toxic Gases.

7.9.1 General.
The storage or use of toxic or highly toxic gases exceeding the quantity thresholds for gases that require special provisions as specified in Table 6.3.1.1 shall be in accordance with Chapters 1 through 6 and Sections 7.1 through 7.3 and Section 7.9.

7.9.2 Ventilation and Arrangement.

7.9.2.1 Indoors.
The indoor storage or use of highly toxic gases or toxic gases shall be provided with a gas cabinet, exhausted enclosure, or gas room.
7.9.2.1.1
Gas cabinets shall be in accordance with Section 6.17.

7.9.2.1.2
Exhausted enclosures shall be in accordance with Section 6.18.

7.9.2.1.3
Gas rooms shall be in accordance with Section 6.4.

7.9.2.2 Distance to Exposures.

The outdoor storage or use of toxic or highly toxic compressed gases shall not be within 75 ft (23 m) of lot lines, streets, alleys, public ways or means of egress, or buildings not associated with such storage or use.

7.9.2.2.1
A 2-hour fire barrier wall without openings or penetrations that extends not less than 30 in. (762 mm) above and to the sides of the storage or use area and that interrupts the line of sight between the storage or use area and the exposure shall be permitted in lieu of the 75 ft (23 m) distance.

7.9.2.2.1.1*
Where a fire barrier is used to protect compressed gas systems, the system shall terminate downstream of the source valve.

7.9.2.2.1.2
The fire barrier wall shall be either an independent structure or the exterior wall of the building adjacent to the storage or use area.

7.9.2.2.1.3
The 2-hour fire barrier wall shall be located at least 5 ft (1.5 m) from any exposure.

7.9.2.2.1.4
The 2-hour fire barrier wall shall not have more than two sides at approximately 90 degree (1.5 rad) directions or more than three sides with connecting angles of approximately 135 degrees (2.36 rad).

7.9.2.2.2
Where the storage or use area is located closer than 75 ft (23 m) to a building not associated with the manufacture or distribution of toxic or highly toxic compressed gases, openings in the building other than for piping shall not be permitted above the height of the top of the 2-hour fire barrier wall or within 50 ft (15 m) horizontally from the storage area, regardless of whether the openings are shielded by a fire barrier.

7.9.2.3 Air Intakes.

Storage and use of toxic or highly toxic compressed gases shall not be located within 75 ft (23 m) of air intakes.

7.9.3 Treatment Systems.

Except as provided in 7.9.3.1 and 7.9.3.2, gas cabinets, exhausted enclosures, and gas rooms containing toxic or highly toxic gases shall be provided with exhaust ventilation, with all exhaust directed to a treatment system designed to process accidental release of gas.

7.9.3.1 Storage of Toxic or Highly Toxic Gases.
Treatment systems shall not be required for toxic or highly toxic gases in storage where cylinders, containers, and tanks are provided with the controls specified in 7.9.3.1.1 through 7.9.3.1.3.

7.9.3.1.1 Valve Outlets Protected.
Valve outlets shall be equipped with outlet plugs or caps, or both, rated for the container service pressure.

7.9.3.1.2 Handwheels Secured.
Where provided, handwheel-operated valves shall be secured to prevent movement.

7.9.3.1.3 Containment Devices Provided.
Approved cylinder containment vessels or cylinder containment systems shall be provided at an approved location.

7.9.3.2 Use of Toxic Gases.
Treatment systems shall not be required for toxic gases in use where cylinders, containers, and tanks are provided with the controls specified in 7.9.3.2.1 and 7.9.3.2.2.

7.9.3.2.1 Gas Detection.

7.9.3.2.1.1 A gas detection system with a sensing interval not exceeding 5 minutes shall be provided.

7.9.3.2.2 Fail-Safe Automatic Closing Valve.
An approved automatic-closing fail-safe valve shall be located on or immediately adjacent to and downstream of active cylinder, container, or tank valves.

7.9.3.2.2.1 The fail-safe valve shall close when gas is detected at the permissible exposure limit, short-term exposure limit (STEL), or ceiling limit by the gas detection system.

7.9.3.2.2.2 For attended operations, a manual closing valve shall be permitted when in accordance with 7.9.3.4.3.

7.9.3.2.2.3 For gases used at unattended operations for the protection of public health, such as chlorine at water or wastewater treatment sites, the automatic valve shall close if the concentration of gas detected by a gas detection system reaches one-half of the IDLH.

7.9.3.2.2.4 The gas detection system shall also alert persons on-site and a responsible person off-site when the gas concentration in the storage/use area reaches the OSHA PEL, OSHA ceiling limit, or OSHA STEL for the gas employed.

7.9.3.3 Treatment System Design and Performance.
Treatment systems shall be capable of diluting, adsorbing, absorbing, containing, neutralizing, burning, or otherwise processing stored or used toxic or highly toxic gas, or both.

7.9.3.3.1
Where a total containment system is used, the system shall be designed to handle the maximum anticipated pressure of release to the system when it reaches equilibrium.

7.9.3.3.2
Treatment systems shall be capable of reducing the allowable discharge concentrations to one-half the IDLH threshold at the point of discharge.

7.9.3.4 Treatment System Sizing.

7.9.3.4.1 Worst-Case Release of Gas.
Treatment systems shall be sized to process the maximum worst-case release of gas based on the maximum flow rate of release from the largest vessel utilized in accordance with 7.9.3.4.2.

7.9.3.4.2 Largest Compressed Gas Vessel.
The entire contents of the single largest compressed gas vessel shall be considered.

7.9.3.4.3 Attended Operations — Alternative Method of System Sizing.

7.9.3.4.3.1 Where source cylinders, containers, and tanks are used in attended process operations, with an operator present at the enclosure where the activity occurs, the volume of the release shall be limited to the estimated amount released from the process piping system within a period not to exceed 5 minutes.

7.9.3.4.3.2 Such process piping systems shall comply with the requirements of 7.9.3.4.3.2(A) through 7.9.3.4.3.2(E).

(A) Local Exhaust. All gas transfer operations shall be conducted within a zone of local exhaust that is connected to a treatment system.

(B) Gas Detection. Gas detection shall be used to provide a warning to alert the operators to emission of gas into the zone of local exhaust, and the following requirements also shall apply:

(1) The system shall be capable of detecting gas at the PEL or the ceiling limit for the gas being processed.

(2) Activation of the gas detection system shall provide a local alarm.

(C) Process Shutdown. Operations involving the gas detected shall be shut down and leaks repaired.

(D) Piping System Construction. Piping systems used to convey gases shall be of all-welded construction throughout, with the exception of fittings used to connect cylinders, containers, or tanks, or any combination thereof, to the process system.

(E) Piping System Accessibility. Piping systems shall be designed to provide for readily accessible manual shutdown controls.

7.9.3.5 Rate of Release.
The time release shall be in accordance with Table 7.9.3.5 for the type of container indicated.
Table 7.9.3.5 Rate of Release

<table>
<thead>
<tr>
<th>Container Type</th>
<th>Nonliquefied Gases</th>
<th>Liquefied Gases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cylinders without restrictive flow orifices</td>
<td>5 minutes</td>
<td>30 minutes</td>
</tr>
<tr>
<td>Portable tanks without restrictive flow orifices</td>
<td>40 minutes</td>
<td>240 minutes</td>
</tr>
<tr>
<td>All others</td>
<td>Based on peak flow from maximum valve orifice</td>
<td>Based on peak flow from maximum valve orifice</td>
</tr>
</tbody>
</table>

7.9.3.6* Maximum Flow Rate of Release.

7.9.3.6.1

For portable cylinders, containers, and tanks, the maximum flow rate of release shall be calculated based on assuming the total release from the cylinder or tank within the time specified.

7.9.3.6.2*

When portable cylinders, containers, or tanks are equipped with reduced flow orifices, the worst-case rate of release shall be determined by the maximum achievable flow from the valve based on the following formula:

\[ 7.9.3.6.2 \]

where:

\[
\begin{align*}
CFM &= \text{standard cubic feet per minute of gas of concern under flow conditions} \\
A &= \text{area of orifice in square inches (See Table A.7.9.3.6 for areas of typical restricted flow orifices.)} \\
P &= \text{supply pressure of gas at NTP in pounds per square inch absolute} \\
MW &= \text{molecular weight}
\end{align*}
\]

7.9.3.6.3

For mixtures, the average of the molecular weights shall be used.

7.9.4 Leaking Cylinders, Containers, and Tanks.

When cylinders, containers, or tanks are used outdoors in excess of the quantities specified in Table 6.3.1.1 in the column for unsprinklered areas (unprotected by gas cabinets or exhausted enclosures), a gas cabinet, exhausted enclosure, or containment vessel or system shall be provided to control leaks from leaking cylinders, containers, and tanks in accordance with 7.9.4.1 through 7.9.4.2.3.

7.9.4.1 Gas Cabinets or Exhausted Enclosures.

Where gas cabinets or exhausted enclosures are provided to handle leaks from cylinders, containers, or tanks, exhaust ventilation shall be provided that is directed to a treatment system in accordance with the provisions of 7.9.3.

7.9.4.2 Containment Vessels or Systems.
Where containment vessels or containment systems are provided, they shall comply with the requirements of 7.9.4.2.1 through 7.9.4.2.3.

**7.9.4.2.1 Performance.**

Containment vessels or containment systems shall be capable of fully containing or terminating a release.

**7.9.4.2.2 Personnel.**

Trained personnel capable of operating the containment vessel or containment system shall be available at an approved location.

**7.9.4.2.3 Location.**

Containment vessels or systems shall be capable of being transported to the leaking cylinder, container, or tank.

**7.9.5 Emergency Power.**

**7.9.5.1 General.**

Emergency power shall comply with the requirements of 7.9.5 in accordance with NFPA 70.

**7.9.5.2 Alternative to Emergency Power.**

Emergency power shall not be required where fail-safe engineering is provided for mechanical exhaust ventilation, treatment systems, and temperature control, and standby power is provided to alternative systems that utilize electrical energy.

**7.9.5.3 Where Required.**

Emergency power shall be provided for the following systems:

1. Exhaust ventilation
2. Treatment system
3. Gas detection system
4. Temperature control system
5. Required alarm systems

**7.9.5.4 Level.**

Emergency power systems shall comply with the requirements for a Level 2 system in accordance with NFPA 110.

**7.9.6 Gas Detection.**

Except as provided in 7.9.6.1, a continuous gas detection system in accordance with the requirements of 7.9.6.2 through 7.9.6.6 shall be provided for the indoor storage or use of toxic or highly toxic compressed gases.

**7.9.6.1 Where Gas Detection Is Not Required.**

A gas detection system shall not be required for toxic gases where the physiological warning properties for the gas are at a level below the accepted PEL or the ceiling limit for the gas.

**7.9.6.2 Local Alarm.**

The gas detection system shall initiate a local alarm that is both audible and visible.

**7.9.6.3 Alarm Monitored.**

The gas detection system shall transmit a signal to a constantly attended control station for quantities exceeding one toxic or highly toxic compressed gas cylinder.
7.9.6.4 Automatic Shutdown.

7.9.6.4.1
Activation of the gas detection system shall automatically shut off the flow of gas related to the system being monitored.

7.9.6.4.2
An automatic shutdown shall not be required for reactors utilized for the production of toxic or highly toxic gases when such reactors are operated at gauge pressures less than 15 psi (103.4 kPa), constantly attended, and provided with readily accessible emergency shutoff valves.

7.9.6.5 Detection Points.
Detection shall be provided at the locations specified in 7.9.6.5.1 through 7.9.6.5.4.

7.9.6.5.1 Treatment System Discharge.
Detection shall be provided at the discharge from the treatment system.

7.9.6.5.2 Point of Use.
Detection shall be provided in the room or area in which the gas is used.

7.9.6.5.3 Source.
Detection shall be provided at the source cylinder, container, or tank used for delivery of the gas to the point of use.

7.9.6.5.4 Storage.
Detection shall be provided in the room or area in which the gas is stored.

7.9.6.6 Level of Detection.
The gas detection system shall detect the presence of gas at or below the PEL or the ceiling limit of the gas for those points identified in 7.9.6.5.2 and 7.9.6.5.3 and at not less than one-half the IDLH level for points identified in 7.9.6.5.1.

7.9.7 Automatic Smoke Detection System.
An automatic smoke detection system shall be provided for the indoor storage or use of highly toxic compressed gases in accordance with NFPA 72.

7.10 Unstable Reactive Gases (Nondetonable).
The storage or use of unstable reactive (nondetonable) gases exceeding the quantity thresholds for gases requiring special provisions as specified in Table 6.3.1.1 shall be in accordance with Chapters 1 through 6 and Sections 7.1 through 7.3 and Section 7.10.

7.10.1 Distances to Exposures for Class 2.

7.10.1.1
The outdoor storage or use of unstable reactive Class 2 compressed gas shall not be within 20 ft (6 m) of buildings, lot lines, streets, alleys, or public ways or means of egress.

7.10.1.2
A 2-hour fire barrier wall without openings or penetrations shall be permitted in lieu of the 20 ft (6 m) distance required by 7.10.1.1.

7.10.1.2.1*
Where a fire barrier wall is used to protect compressed gas systems, the system shall terminate downstream of the source valve.

7.10.1.2.2
The fire barrier wall shall be either an independent structure or the exterior wall of the building.

7.10.1.2.3
The 2-hour fire barrier wall shall be located at least 5 ft (1.5 m) from any exposure.

7.10.1.2.4
The 2-hour fire barrier wall shall not have more than two sides at approximately 90 degree (1.57 rad) directions or not more than three sides with connecting angles of approximately 135 degrees (2.36 rad).

7.10.2 Distances to Exposures for Class 3.

7.10.2.1
The outdoor storage or use of unstable reactive Class 3 (nondetonable) compressed gas shall not be within 75 ft (23 m) of buildings, lot lines, streets, alleys, or public ways or means of egress.

7.10.2.2
A 2-hour fire barrier wall without openings or penetrations, extending not less than 30 in. (762 mm) above and to the sides of the storage or use area, that interrupts the line of sight between the storage or use and the exposure shall be permitted in lieu of the 75 ft (23 m) distance specified in 7.10.2.1.

7.10.2.2.1*
Where a fire barrier wall is used to protect compressed gas systems, the system shall terminate downstream of the source valve.

7.10.2.2.2
The fire barrier wall shall be either an independent structure or the exterior wall of the building adjacent to the storage or use area.

7.10.2.2.3
The 2-hour fire barrier wall shall be located at least 5 ft (1.5 m) from any exposure.

7.10.2.2.4
The 2-hour fire barrier wall shall not have more than two sides at approximately 90 degree (1.57 rad) directions or more than three sides with connecting angles of approximately 135 degrees (2.36 rad).

7.10.3 Storage Configuration.

7.10.3.1
Unstable reactive Class 3 compressed gases stored in cylinders, containers, or tanks shall be arranged to limit individual groups of cylinders, containers, or tanks to areas not exceeding 100 ft² (9.3 m²).

7.10.3.2
Multiple areas shall be separated by aisles.

7.10.3.3
Aisle widths shall not be less than the height of the cylinders, containers, or tanks or 4 ft (1.2 m), whichever is greater.

7.10.4 Basements.

Unstable reactive compressed gases shall not be stored in basements.

7.10.5 Unstable Reactive Gases (Detonable).
7.10.5.1 Storage or Use.

The storage or use of unstable reactive (detonable) gases exceeding the quantity thresholds for gases requiring special provisions as specified in Table 6.3.1.1 shall be in accordance with Chapters 1 through 6, Sections 7.1 through 7.3, and 7.10.5.

7.10.5.2 Location.

The location of storage areas shall be determined based on the requirements of the building code for explosive materials.
Chapter 10  Bulk Hydrogen Compressed Gas Systems

10.1  Applicability.

The storage, use, and handling of hydrogen in bulk compressed gas systems shall be
in accordance with the applicable provisions of Chapters 1 through 7 and Chapter 10.

10.1.1  Quantities Less Than or Equal to the MAQ.

This chapter shall not apply to individual systems each having a total hydrogen content of less
than 5000 scf (141.6 Nm³) or to systems located in control areas when the aggregate quantity
contained is less than the maximum allowable quantity per control area (MAQ). The storage, use,
and handling of hydrogen in gaseous hydrogen systems in quantities less than or equal to the
MAQ shall be in accordance with Sections 10.1 and 10.2.

10.1.2  Quantities Greater Than the MAQ.

The storage, use, and handling of hydrogen in gaseous hydrogen systems in quantities greater
than the MAQ shall be in accordance with Sections 10.1, 10.2, and 10.3.

10.1.3  Quantities Greater Than 5000 scf (141.6 Nm³).

The storage, use, and handling of hydrogen in gaseous hydrogen systems (bulk gaseous
hydrogen systems) in quantities greater than 5000 scf (141.6 Nm³) shall be in accordance with
Sections 10.1, 10.2, 10.3, and 10.4.

10.2  General.

10.2.1  Marking.

10.2.1.1  Hazard identification signs shall be provided in accordance with Section 6.12.

10.2.2  Piping Systems.

Piping, tubing, valves, and fittings shall be designed and installed in accordance with ASME
B31.12, Hydrogen Piping and Pipelines, 7.3.1.3, and Sections 704.1.2.3, 704.1.2.4, and
704.1.2.5 of the ICC International Fuel Gas Code (IFGC). Cast-iron pipe, valves, and fittings shall
not be used.

10.2.2.1  Prior to acceptance and initial operation, all piping installations shall be inspected and pressure
tested in accordance with ASME B31.12, Hydrogen Piping and Pipelines, and the ICC
International Fuel Gas Code (IFGC), Section 705.

10.2.2.2  In addition to the requirements of 7.3.1.3, brazing materials used for joints in piping and tubing
systems shall have a melting point above 1000°F (538°C).

10.2.2.3  Underground piping systems shall be in accordance with 7.1.17Z.1.17Z.1.19.

10.2.3  Hydrogen-Venting Systems.
Hydrogen-venting systems serving pressure relief devices discharging hydrogen to the atmosphere shall be in accordance with CGA G-5.5, Hydrogen Vent Systems.

10.2.3.1 Venting from the relief vents from the hydrogen supply piping serving listed fuel cell systems shall be permitted to be discharged into an enclosure integral to the fuel cell system where the concentration of hydrogen is diluted below 25 percent of the lower flammable limit (LFL) at the outlet of the enclosure.

10.2.3.1.1 The hydrogen supply piping system shall be designed to isolate the source of hydrogen from the relief vent in the event of loss of dilution ventilation or power.

10.2.3.2 Cleaning and purging of piping systems shall be in accordance with 7.1.187.1.20.

10.2.4 Equipment Assembly.

10.2.4.1 Valves, gauges, regulators, and other accessories used for bulk hydrogen compressed gas systems shall be specified for hydrogen service by the manufacturer or the hydrogen supplier.

10.2.4.1.1 Storage containers, piping, valves, regulating equipment, and other appurtenances serving bulk hydrogen compressed gas systems shall be accessible and shall be protected against physical damage and tampering.

10.2.4.2 Cabinets or enclosures containing hydrogen control or operating equipment shall be ventilated to prevent the accumulation of hydrogen.

10.2.4.3 Mobile hydrogen supply units used as part of a bulk hydrogen compressed gas system shall be secured to prevent movement.

10.2.5 Compression and Processing Equipment.

10.2.5.1 Compression and gas processing equipment shall have pressure relief devices that limit each stage pressure to the maximum allowable working pressure for the compression cylinder and piping associated with that stage of compression.

10.2.5.2 Where GH₂ compression equipment is operated unattended, it shall be equipped with a high discharge and a low suction pressure automatic shutdown control.

10.2.5.3 Control circuits that automatically shut down shall remain down until manually activated or reset after a safe shutdown is performed.

10.2.5.4 Stationary Compressors.

10.2.5.4.1 Valves.
10.2.5.4.1.1 Valves shall be installed such that each compressor is able to be isolated for maintenance.

10.2.5.4.1.2 The discharge line shall be equipped with a check valve to prevent the backflow of gas from high-pressure sources located downstream of the compressor.

10.2.5.5 Foundations.

10.2.5.5.1 Foundations used for supporting equipment shall be designed and constructed to prevent frost heaving.

10.2.5.5.2 The structural aspects of such foundations shall be designed and constructed in accordance with the provisions of the building code.

10.2.5.6 Emergency Shutdown.

When an emergency shutdown system is required, activation of the emergency shutdown system shall shut down operation of all compressors serving a single gas installation.

10.2.5.7 Relief Valves.

10.2.5.7.1 Each compressor shall be provided with a vent or relief device that will prevent overpressurizing of the compressor under normal or upset conditions.

10.2.5.7.2 Pressure relief devices used to serve pumps or compression equipment shall be connected to a vent pipe system in accordance with 10.2.3.

10.2.5.8 Pressure Monitoring.

The pressure on the compressor discharge shall be monitored by a control system.

10.2.5.8.1 Discharge pressures in excess of the equipment design pressures shall cause the compressor to shut down.

10.2.5.9 Protection.

Transfer piping and compressors shall be protected from vehicular damage.

10.2.6 Operation and Maintenance.

10.2.6.1 Operating Instructions.

10.2.6.1.1 For installations that require any operation of equipment by the user, the user shall be instructed in the operation of the equipment and emergency shutdown procedures.

10.2.6.1.2 Instructions shall be maintained at the operating site at a location acceptable to the authority having jurisdiction.

10.2.6.2 Maintenance.

10.2.6.2.1 Maintenance shall be performed annually by a qualified representative of the equipment owner.
10.2.6.2.2
The maintenance shall include inspection for physical damage, leak tightness, ground system integrity, vent system operation, equipment identification, warning signs, operator information and training records, scheduled maintenance and retest records, alarm operation, and other safety-related features.

10.2.6.2.3
Scheduled maintenance and retest activities shall be formally documented, and records shall be maintained a minimum of 3 years.

10.2.7
Emergency isolation shall comply with the requirements in 7.3.1.12.

10.2.8
*Listed and Approved Hydrogen Equipment.*

10.2.8.1
Listed and approved hydrogen-generating and hydrogen-consuming equipment shall be in accordance with the listing requirements and manufacturers' instructions.

10.2.8.2
Such equipment shall not be required to meet the requirements of Chapter 7.

10.2.9
*Metal Hydride Storage Systems.*

10.2.9.1 General Requirements.

10.2.9.1.1 Metal Hydride Storage System Requirements.
The storage and use of metal hydride storage systems shall be in accordance with 10.2.9.1.6.

10.2.9.1.2 Metal Hydride Systems Storing or Supplying Hydrogen.
Those portions of the system that are used as a means to store or supply hydrogen shall also comply with Chapter 7 and Chapter 10 as applicable.

10.2.9.1.3 Classification.
The hazard classification of the metal hydride storage system, as required by 5.1.1 and 5.1.3, shall be based on the hydrogen stored without regard to the metal hydride content.

10.2.9.1.4 Listed or Approved Systems.
Metal hydride storage systems shall be listed or approved for the application and designed in a manner that prevents the addition or removal of the metal hydride by other than the original equipment manufacturer.

10.2.9.1.5 Containers, Design, and Construction.
Compressed gas cylinders, containers, and tanks used for metal hydride storage systems shall be designed and constructed in accordance with 7.1.5.17.1.7.1.

10.2.9.1.6 Service Life and Inspection of Containers.
Metal hydride storage system cylinders, containers, and tanks shall be inspected, tested, and requalified for service at not less than 5-year intervals.

10.2.9.1.7 Marking and Labeling.
Marking and labeling of cylinders, containers, tanks, and systems shall be in accordance with 7.1.5.17.1.7.1 through 10.2.9.1.7.1.7.1.4.

10.2.9.1.7.1 System Marking.

Commented [BS1]: Equipment can be listed or approved by the AHJ, it is not necessary to require the AHJ to approve listed equipment. It must meet the listing requirements and the manufacturer's instructions.

This was originally submitted as a PC to NFPA 2, this material was reviewed by the joint 2/55 TC.

This section is moving, in its entirety, from 7.1.5 to 10.2.8, as part of the Chapter 7 and 10 reorganization per PC-36 and PC-37.

The annex material associated with this section does not change. It is to move with the content.

Commented [BS2]: This section moves in its entirety from 7.1.6 to Chapter 10, Section 10.2.9. This is part of the reorganization of Chapters 7 and 10. Annex material associated with this section is to move with it and be renumbered.
Metal hydride storage systems shall be marked with the following:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Manufacturer’s name</td>
</tr>
<tr>
<td>2</td>
<td>Service life indicating the last date the system can be used</td>
</tr>
<tr>
<td>3</td>
<td>A unique code or serial number specific to the unit</td>
</tr>
<tr>
<td>4</td>
<td>System name or product code that identifies the system by the type of chemistry used in the system</td>
</tr>
<tr>
<td>5</td>
<td>Emergency contact name, telephone number, or other contact information</td>
</tr>
<tr>
<td>6</td>
<td>Limitations on refilling of containers to include rated charging pressure and capacity</td>
</tr>
</tbody>
</table>

10.2.9.1.7.2 Valve Marking.
Metal hydride storage system valves shall be marked with the following:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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</tr>
<tr>
<td>2</td>
<td>Service life indicating the last date the valve can be used</td>
</tr>
<tr>
<td>3</td>
<td>Metal hydride service in which the valve can be used or a product code that is traceable to this information</td>
</tr>
</tbody>
</table>

10.2.9.1.7.3 Pressure Relief Device Marking.
Metal hydride storage system pressure relief devices shall be marked with the following:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
<td>2</td>
<td>Metal hydride service in which the device can be used or a product code that is traceable to this information</td>
</tr>
<tr>
<td>3</td>
<td>Activation parameters to include temperature, pressure, or both</td>
</tr>
</tbody>
</table>

(A)
Pressure Relief Devices Integral to Container Valves. The required markings for pressure relief devices that are integral components of valves used on cylinders, containers, and tanks shall be allowed to be placed on the valve.

10.2.9.1.7.4 Pressure Vessel Markings.
Cylinders, containers, and tanks used in metal hydride storage systems shall be marked with the following:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Manufacturer’s name</td>
</tr>
<tr>
<td>2</td>
<td>Design specification to which the vessel was manufactured</td>
</tr>
<tr>
<td>3</td>
<td>Authorized body approving the design and initial inspection and test of the vessel</td>
</tr>
<tr>
<td>4</td>
<td>Manufacturer’s original test date</td>
</tr>
<tr>
<td>5</td>
<td>Unique serial number for the vessel</td>
</tr>
<tr>
<td>6</td>
<td>Service life identifying the last date the vessel can be used</td>
</tr>
<tr>
<td>7</td>
<td>System name or product code that identifies the system by the type of chemistry used in the system</td>
</tr>
</tbody>
</table>

10.2.9.1.8 Temperature Extremes.
Metal hydride storage systems, whether full or partially full, shall not be exposed to artificially created high temperatures exceeding 125°F (52°C) or subambient (low) temperatures unless designed for use under the exposed conditions.

10.2.9.1.9 Falling Objects.
Metal hydride storage systems shall not be placed in areas where they are capable of being damaged by falling objects.

10.2.9.1.10 Piping Systems.
Piping, including tubing, valves, fittings, and pressure regulators, serving metal hydride storage systems shall be maintained gastight to prevent leakage.

10.2.9.1.10.1 Leaking Systems.
Leaking systems shall be removed from service.

10.2.9.1.11 Refilling of Containers.
The refilling of listed or approved metal hydride storage systems shall be in accordance with the listing requirements and manufacturers’ instructions.

10.2.9.1.11.1 Industrial Trucks.
The refilling of metal hydride storage systems serving powered industrial trucks shall be in accordance with NFPA 2.

10.2.9.1.11.2 Hydrogen Purity.
The purity of hydrogen used for the purpose of refilling containers shall be in accordance with the listing and the manufacturers’ instructions.

10.2.9.1.12 Electrical.
Electrical components for metal hydride storage systems shall be designed, constructed, and installed in accordance with NFPA 70.

10.2.9.2 Portable Containers or Systems.

10.2.9.2.1 Securing Containers.
Cylinders, containers, and tanks shall be secured in accordance with 7.1.8.47.1.10.4.

10.2.9.2.1.1 Use on Mobile Equipment.
Where a metal hydride storage system is used on mobile equipment, the equipment shall be designed to restrain cylinders, containers, or tanks from dislodgement, slipping, or rotating when the equipment is in motion.

10.2.9.2.1.2 Motorized Equipment.
Metal hydride storage systems used on motorized equipment shall be installed in a manner that protects valves, pressure regulators, fittings, and controls against accidental impact.

(A)
Protection from Damage. Metal hydride storage systems, including cylinders, containers, tanks, and fittings, shall not extend beyond the platform of the mobile equipment.

10.2.9.2.2 Valves.
Valves on cylinders, containers, and tanks shall remain closed except when containers are connected to closed systems and ready for use.

10.3 Hydrogen Systems Having Quantities Greater Than the MAQ.

10.3.1
The storage, use, and handling of hydrogen in gaseous hydrogen systems in quantities greater than the MAQ shall be in accordance with Sections 10.1, 10.2, and 10.3.

10.3.2 Bonding and Grounding.

The bulk hydrogen compressed gas system shall be electrically bonded and grounded.

10.3.2.1 Mobile hydrogen supply units shall be electrically bonded to the storage system before hydrogen is discharged from the supply unit.

10.3.3 Cargo Transport Unloading.

10.3.3.1 Vehicular protection shall be provided in accordance with 7.1.8.3.

10.3.3.2 Unloading connections on delivery equipment shall not be positioned closer to any of the exposures cited in Table 10.3.2.1(a), Table 10.3.2.1(b), and Table 10.3.2.1(c) than the distances given for the bulk hydrogen compressed gas storage system.

10.3.3.3 During transfer of hydrogen from cargo vehicles to the bulk hydrogen compressed gas storage system, the hand or emergency brake of the vehicle shall be set, and chock blocks shall be used to prevent the vehicle from moving.

10.3.3.4 Cargo vehicles equipped with air-brake interlock in front of the unloading connection to protect against drive-aways shall be engaged such that the interlock is activated.

10.3.3.5 Mobile hydrogen supply units shall be electrically bonded to the bulk hydrogen compressed gas storage system before hydrogen is discharged from the supply unit.

10.3.3.6 Transfer System Depressurization.

10.3.3.6.1 The transfer systems shall be capable of depressurizing to facilitate disconnection.

10.3.3.6.2 Bleed connections shall be connected to a hydrogen venting system in accordance with 10.2.3.

10.3.3.7 Where required, check valves on delivery systems shall be in accordance with 7.3.1.3.2.

10.3.3.8 Prohibitions on smoking or the use of open flame shall be in accordance with 7.6.3.2.

10.3.3.9 An emergency shutoff valve shall be provided in accordance with 7.3.1.11.

10.3.4 Indoor Non-Bulk Hydrogen Compressed Gas System Location.

10.3.4.1 Hydrogen systems of less than 5000 scf (141.6 Nm³) and greater than the MAQ, where located inside buildings, shall be in accordance with the following:

1. In a ventilated area in accordance with the provisions of Section 6.16

Commented [BS3]: Move from 10.2.5 to section 10.3.2, part of section 10.3, titled Hydrogen systems having quantities greater than the MAQ. This is part of the response to PC-37, reorganizing chapter 7 and 10.

Commented [BS4]: Move from 10.2.8 to section 10.3 for quantities greater than the MAQ. This is in partial response to PC-37, the reorganization of chapters 7 and 10.

Commented [BS5]: Move from 7.6.3 to Chapter 10, section 10.3.4, titled Indoor Non-Bulk Hydrogen Compressed Gas System Location. This is a partial response to PC-37, which reorganizes Chapter 7 and 10 of NFPA 55.
(2) Separated from incompatible materials in accordance with the provisions of 7.1.10.2.

(3) A distance of 25 ft (7.6 m) from open flames and other sources of ignition.

(4) A distance of 50 ft (15 m) from intakes of ventilation, air-conditioning equipment, and air compressors located in the same room or area as the hydrogen system.

(a) The distance shall be permitted to be reduced to 10 ft (3.1 m) where the room or area in which the hydrogen system is installed is protected by a listed detection system per Article 500.7(K) of NFPA 70 and the detection system shuts down the fuel supply in the event of a leak that results in a concentration that exceeds 25 percent of the LFL.

(b) Emergency shutoff valves shall be provided in accordance with 7.3.1.11.

(5) A distance of 50 ft (15 m) from other flammable gas storage.

(6)Protected against damage in accordance with the provisions of 7.1.8.3.

10.3.4.2 Systems Installed in One Room.

10.3.4.2.1

More than one system of 5000 scf (141.6 Nm³) or less shall be permitted to be installed in the same room or area, provided the systems are separated by at least 50 ft (15 m) or a full-height fire-resistive partition having a minimum fire resistance rating of 2 hours is located between the systems.

10.3.4.2.2

The separation distance between multiple systems of 5000 scf (141.6 Nm³) or less shall be permitted to be reduced to 25 ft (7.6 m) in buildings where the space between storage areas is free of combustible materials and protected with a sprinkler system designed for Extra Hazard, Group 1 occupancies in accordance with the requirements of Section 6.10.

10.3.4.2.3

The required separation distance between individual portable systems in the process of being filled or serviced in facilities associated with the manufacture or distribution of hydrogen and its mixtures shall not be limited by 10.3.4.2.1 or 10.3.4.2.2 when such facilities are provided with Protection Level 2 controls and the applicable requirements of Chapters 1 through 7.

10.3.5 Outdoor Non-Bulk Hydrogen Compressed Gas Location.

10.3.5.1

The outdoor storage or use of non-bulk gaseous hydrogen shall be in accordance with 7.6.2.

10.4 Bulk Gaseous Hydrogen System.

10.4.1

The use, storage, and handling of hydrogen in gaseous hydrogen systems (bulk hydrogen systems) in quantities greater than 5000 scf (141.6 Nm³) shall be in accordance with Sections 10.1, 10.2, 10.3, and 10.4.

10.4.2 Outdoor Bulk Hydrogen Compressed Gas Systems.

10.4.2.1 General Requirements.

10.4.2.1.1 Bulk Hydrogen Compressed Gas.

Systems located above ground either at grade or above grade shall be in accordance with Section 10.4.2.

10.4.2.1.2 Electrical wiring and equipment shall be in accordance with Article 500 of NFPA 70.
10.4.2.1.2.1

Specific locations for Class 1, Division 1, Group B (hydrogen) and Class 1, Division 2, Group B (hydrogen) areas shall be in accordance with Table 10.4.2.1.2.1.

Table 10.4.2.1.2.1 Electrical Area Classification

<table>
<thead>
<tr>
<th>Location</th>
<th>Classification</th>
<th>Extent of Classified Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within 3 ft (1 m) of any vent outlet and any points where hydrogen is</td>
<td>Class 1, Division 1</td>
<td>Between 0 ft (0 m) and 3 ft (0.9 m) and measured horizontally within a vertical cylinder.</td>
</tr>
<tr>
<td>vented to the atmosphere under normal operations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between 3 ft (1 m) and 15 ft (4.6 m) of any vent outlet and any points</td>
<td>Class 1, Division 2</td>
<td>Between 3 ft (0.9 m) and 15 ft (4.6 m) and measured spherically from the vent outlet.</td>
</tr>
<tr>
<td>where hydrogen is vented to the atmosphere under normal operations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage equipment excluding the piping system downstream of the source</td>
<td>Class 1, Division 2</td>
<td>Between 0 ft (0 m) and 15 ft (4.6 m) and measured horizontally within a vertical cylinder.</td>
</tr>
<tr>
<td>valve</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

10.4.2.2 Location.

10.4.2.2.1 Minimum Distance.

The minimum distance from a bulk hydrogen compressed gas system located outdoors to specified exposures shall be in accordance with Table 10.4.2.2.1(a), Table 10.4.2.2.1(b), or Table 10.4.2.2.1(c). (See also Annex G.)

Table 10.4.2.2.1(a) Minimum Distance (D) from Outdoor Bulk Hydrogen Compressed Gas Systems to Exposures — Typical Maximum Pipe Size

<table>
<thead>
<tr>
<th>Pressure</th>
<th>&gt; 15 to ≤ 250 psig</th>
<th>&gt; 250 to ≤ 3000 psig</th>
<th>&gt; 3000 to ≤ 7500 psig</th>
<th>&gt; 7500 to ≤ 15000 psig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal Pipe Diameter (ID)</td>
<td>&gt;1724 kPa</td>
<td>20,684 kPa</td>
<td>51,711 kPa</td>
<td>103,421 kPa</td>
</tr>
<tr>
<td>( d_{\text{min}} )</td>
<td>( d = \frac{52.5}{\text{psig}} )</td>
<td>( d = \frac{18.97}{\text{psig}} )</td>
<td>( d = 7.31 )</td>
<td>( d = 7.16 )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Exposures Group 1</th>
<th>m</th>
<th>ft</th>
<th>m</th>
<th>ft</th>
<th>m</th>
<th>ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Lot lines</td>
<td>12</td>
<td>40</td>
<td>14</td>
<td>46</td>
<td>9</td>
<td>29</td>
</tr>
<tr>
<td>(b) Air intakes (HVAC, compressors, other)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(c) Operable openings in buildings and structures</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(d) Ignition sources such as open flames and welding</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Exposures Group 2</th>
<th>m</th>
<th>ft</th>
<th>m</th>
<th>ft</th>
<th>m</th>
<th>ft</th>
<th>m</th>
<th>ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Exposed persons other than those servicing the system</td>
<td>6</td>
<td>20</td>
<td>7</td>
<td>24</td>
<td>4</td>
<td>13</td>
<td>5</td>
<td>16</td>
</tr>
<tr>
<td>(b) parked cars</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Exposures Group 3</th>
<th>m</th>
<th>ft</th>
<th>m</th>
<th>ft</th>
<th>m</th>
<th>ft</th>
<th>m</th>
<th>ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Buildings of non-combustible non-combustible non-fire-rated construction</td>
<td>5</td>
<td>17</td>
<td>6</td>
<td>19</td>
<td>4</td>
<td>12</td>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td>Pressure</td>
<td>&gt;15 to ≤250 psig</td>
<td>&gt;250 to ≤3000 psig</td>
<td>&gt;3000 to ≤7500 psig</td>
<td>&gt;7500 to ≤15000 psig</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------</td>
<td>------------------</td>
<td>---------------------</td>
<td>---------------------</td>
<td>----------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal Pipe Diameter (ID)</td>
<td>&gt;103.4 to &gt;1724 to ≤20,684 kPa</td>
<td>&gt;1724 to ≤20,684 kPa</td>
<td>&gt;20,684 to ≤51,711 kPa</td>
<td>&gt;51,711 to ≤103,421 kPa</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$d_{mm}$</td>
<td>d = 52.5 mm</td>
<td>d = 18.97 mm</td>
<td>d = 7.31 mm</td>
<td>d = 7.16 mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(b) Buildings of combustible construction

(c) Flammable gas storage systems above or below ground

(d) Hazardous materials storage systems above or below ground

(e) Heavy timber, coal, or other slow-burning combustible solids

(f) Ordinary combustibles, including fast-burning solids such as ordinary lumber, excelsior, paper, or combustible waste and vegetation other than that found in maintained landscaped areas

(g) Unopenable openings in building and structures

(h) Encroachment by overhead utilities (horizontal distance from the vertical plane below the nearest overhead electrical wire of building service)

(i) Piping containing other hazardous materials

(j) Flammable gas metering and regulating stations such as natural gas or propane

Table 10.4.2.2.1(b) Minimum Distance (D) from Outdoor Bulk Hydrogen Compressed Gas Systems to Exposures by Maximum Pipe Size with Pressures >15 to ≤3000 psig

<table>
<thead>
<tr>
<th>Internal Pipe Diameter (ID)</th>
<th>&gt;15 to ≤250 psig</th>
<th>&gt;250 to ≤3000 psig</th>
<th>Exposures</th>
<th>Exposures</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID (in.)</td>
<td>d (mm)</td>
<td>Group 1</td>
<td>Group 2</td>
<td>Group 3</td>
</tr>
<tr>
<td>m</td>
<td>ft</td>
<td>m</td>
<td>ft</td>
<td>m</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>0.2</td>
<td>5.1</td>
<td>1</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>0.3</td>
<td>7.6</td>
<td>2</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>0.4</td>
<td>10.2</td>
<td>2</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>0.5</td>
<td>12.7</td>
<td>3</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>0.6</td>
<td>15.2</td>
<td>4</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>0.7</td>
<td>17.8</td>
<td>4</td>
<td>13</td>
<td>2</td>
</tr>
<tr>
<td>0.8</td>
<td>20.3</td>
<td>5</td>
<td>15</td>
<td>2</td>
</tr>
<tr>
<td>Internal Pipe Diameter (ID)</td>
<td>Exposures</td>
<td>Exposures</td>
<td>Exposures</td>
<td></td>
</tr>
<tr>
<td>---------------------------</td>
<td>-----------</td>
<td>-----------</td>
<td>-----------</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Group 1</td>
<td>Group 2</td>
<td>Group 3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>D = 0.231d</td>
<td>D = 0.12584d - 0.47129</td>
<td>D = 0.096d</td>
<td></td>
</tr>
<tr>
<td></td>
<td>m ft</td>
<td>m ft</td>
<td>m ft</td>
<td></td>
</tr>
<tr>
<td>0.9</td>
<td>5 17 2 8 2 7</td>
<td>17 55 9 30 7 23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.0</td>
<td>6 19 3 9 2 8</td>
<td>19 62 10 33 8 26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>6 21 3 10 3 9</td>
<td>21 68 11 37 9 28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td>7 23 3 11 3 10</td>
<td>22 74 12 41 9 31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3</td>
<td>8 25 4 12 3 10</td>
<td>24 80 13 44 10 33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4</td>
<td>8 27 4 13 3 11</td>
<td>26 86 15 48 11 36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td>9 29 4 14 4 12</td>
<td>28 92 16 52 12 38</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.6</td>
<td>9 31 5 15 4 13</td>
<td>30 98 17 55 12 41</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.7</td>
<td>10 33 5 16 4 14</td>
<td>32 105 18 59 13 43</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.8</td>
<td>11 35 5 17 4 14</td>
<td>34 111 19 62 14 46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.9</td>
<td>11 37 6 18 5 15</td>
<td>36 117 20 66 15 49</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.0</td>
<td>12 39 6 19 5 16</td>
<td>37 123 21 70 16 51</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>12 40 6 20 5 17</td>
<td>39 129 22 73 16 54</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Linear interpolation of internal pipe diameters and distances between table entries is allowed.
*For a list of exposures in each exposure group see Column 1 of Table 10.3.2.1(a).
†When calculating the minimum separation distance (D) using the formulas indicated, based on the exposure group and pressure indicated, the internal pipe diameter (d) is entered in millimeters (mm). The calculated distance (D) is expressed in units of measure in meters (m). To convert distance (D) to units of measure in feet, multiply the value of (D) in meters by 3.2808 and round to the nearest whole foot.

Table 10.4.2.2.1(c) Minimum Distance (D) from Outdoor Bulk Hydrogen Compressed Gas Systems to Exposures by Maximum Pipe Size with Pressures >3000 to ≤15,000 psig

<table>
<thead>
<tr>
<th>Pressure</th>
<th>&gt;3000 to ≤7500 psig</th>
<th>&gt;7500 to ≤15,000 psig</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&gt;20,684 to ≤51,711 kPa</td>
<td>&gt;51,711 to ≤103,421 kPa</td>
</tr>
<tr>
<td>Internal Pipe Diameter (ID)</td>
<td>Exposures</td>
<td>Exposures</td>
</tr>
<tr>
<td>---------------------------</td>
<td>-----------</td>
<td>-----------</td>
</tr>
<tr>
<td></td>
<td>Group 1</td>
<td>Group 2</td>
</tr>
<tr>
<td></td>
<td>D = 1.105d</td>
<td>D = 0.68311d - 1.3123</td>
</tr>
<tr>
<td></td>
<td>m ft</td>
<td>m ft</td>
</tr>
<tr>
<td>0.2</td>
<td>6 18 2 7 2 8</td>
<td>7 24 3 10 3 10</td>
</tr>
<tr>
<td>0.3</td>
<td>8 28 4 13 3 11</td>
<td>11 36 5 18 5 15</td>
</tr>
<tr>
<td>0.4</td>
<td>11 37 6 18 5 15</td>
<td>15 48 8 25 6 20</td>
</tr>
<tr>
<td>Pressure</td>
<td>Exposures†</td>
<td>Exposures†</td>
</tr>
<tr>
<td>----------</td>
<td>------------</td>
<td>------------</td>
</tr>
<tr>
<td></td>
<td>&gt;3000 to ≤7500 psig</td>
<td>&gt;7500 to ≤15,000 psig</td>
</tr>
<tr>
<td></td>
<td>&gt;20,684 to ≤51,711 kPa</td>
<td>&gt;51,711 to ≤103,421 kPa</td>
</tr>
<tr>
<td>Internal Pipe Diameter (ID)</td>
<td>Group 1</td>
<td>Group 2</td>
</tr>
<tr>
<td>ID (in.)</td>
<td>d (mm)</td>
<td>m ft</td>
</tr>
<tr>
<td>0.5</td>
<td>12.7</td>
<td>14</td>
</tr>
<tr>
<td>0.6</td>
<td>15.2</td>
<td>17</td>
</tr>
<tr>
<td>0.7</td>
<td>17.8</td>
<td>20</td>
</tr>
<tr>
<td>0.8</td>
<td>20.3</td>
<td>22</td>
</tr>
<tr>
<td>0.9</td>
<td>22.9</td>
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Note: Linear interpolation of internal pipe diameters and distances between table entries is allowed.

For a list of exposures in each exposure group see Column 1 of Table 10.3.2.1(a).

When calculating the minimum separation distance (D) using the formulas indicated, based on the exposure group and pressure indicated, the internal pipe diameter (d) is entered in millimeters (mm). The calculated distance (D) is expressed in units of measure in meters (m). To convert distance (D) to units of measure in feet, multiply the value of (D) in meters by 3.2808 and round to the nearest whole foot.

10.4.2.2.1.1

The separation distance for piping systems with internal diameters other than those specified in Table 10.4.2.2.1(a) for the pressure range selected shall be permitted with tabular distances determined based on the use of Table 10.4.2.2.1(b) or Table 10.4.2.2.1(c).

10.4.2.2.2 Maximum Internal Diameter of Interconnecting Piping.

The maximum internal diameter of the piping system used for interconnecting piping between the shutoff valve on any single storage container to the point of connection to the system source valve shall not be required to be in accordance with the values shown in Table 10.4.2.2.1(a) when in accordance with Table 10.4.2.2.1(b) or Table 10.4.2.2.1(c).

10.4.2.2.2.1 Determination of Internal Diameter.
The internal diameter of the piping system shall be determined by the diameter of the piping serving that portion of a storage array with content greater than 5000 scf (141.6 Nm³). The piping system size used in the application of Table 10.4.2.2.1(a), Table 10.4.2.2.1(b), or Table 10.4.2.2.1(c) shall be determined based on that portion of the system with the greatest maximum internal diameter.

10.4.2.2.2
Separation distances determined based on the use of Table 10.4.2.2.1(b) or Table 10.4.2.2.1(c) shall be subject to review and approval by the AHJ.

10.4.2.2.3*
**Determination of System Pressure.** The system pressure shall be determined by the maximum operating pressure of the storage array with content greater than 5000 scf (141.6 Nm³), irrespective of those portions of the system elevated to a higher pressure.

10.4.2.2.4* **Reduction of Distance by Mitigation Means.**

10.4.2.2.4.1* **Passive Means.**
Except for distances to air intakes, the distances to Group 1 and 2 exposures shown in Table 10.4.2.2.1(a), Table 10.4.2.2.1(b), and Table 10.4.2.2.1(c) shall be permitted to be reduced by one-half and shall not apply to Group 3 exposures where fire barrier walls are located between the system and the exposure and constructed in accordance with the following:

(1) Fire barrier walls shall have a minimum fire resistance rating of not less than 2 hours.

(2) The fire barrier wall shall interrupt the line of sight between the bulk hydrogen compressed gas system and the exposure.

(3) The configuration of the fire barrier shall allow natural ventilation to prevent the accumulation of hazardous gas concentrations.

(4) The number of fire barrier walls used to separate individual systems shall be limited to three.

(5) The fire barrier wall shall not have more than two sides at 90 degrees (1.57 rad) directions or not more than three sides with connecting angles of 135 degrees (2.36 rad).

(a) *The connecting angles between fire barrier walls shall be permitted to be reduced to less than 135 degrees (2.36 rad) for installations consisting of three walls when in accordance with 8.13.2.7.2.*

(6) Fire barrier walls shall be designed and constructed as a structure in accordance with the requirements of the building code without exceeding the specified allowable stresses for the materials of construction utilized. Structures shall be designed to resist the overturning effects caused by lateral forces due to wind, soil, flood, and seismic events.

(7) Where clearance is required between the bulk hydrogen compressed gas system and the barrier wall for the performance of service or maintenance-related activities, a minimum horizontal clearance of 5 ft (1.5 m) shall be provided between the structure and the system.

(8) The fire barrier wall shall be either an independent structure or the exterior wall of the building adjacent to the storage or use area when the exterior building wall meets the requirements for fire barrier walls.

10.4.2.2.4.2* **Active Means.**
Active control systems that mitigate the risk of system leaks and failures shall be permitted to be used as a means to reduce separation distances where approved by the AHJ under the authority as granted by Section 1.5.

10.4.2.2.5 **Required Separation Distance for All Systems.**
Separation distances shall be required for bulk hydrogen compressed gas systems independent of system pressure or internal diameter of piping systems in accordance with 10.4.2.2.5.1 through 10.4.2.2.5.3.

10.4.2.2.5.1
Unloading connections on delivery equipment shall not be positioned closer to any of the exposures cited in Table 10.4.2.2.1(a), Table 10.4.2.2.1(b), or Table 10.4.2.2.1(c) than the distances given for the storage system.

10.4.2.2.5.2
The minimum separation distance between gaseous and liquid systems integrated into a single system where the liquid source is vaporized, compressed, and stored in the gaseous state shall be 15 ft (4.6 m).

10.4.2.2.5.3
Systems within 50 ft (15 m) of aboveground storage of all classes of flammable and combustible liquids shall 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.

10.4.2.2.6*
Bulk hydrogen compressed gas systems shall be allowed to integrate or co-locate other nonliquefied flammable gas systems as a component of the hydrogen gas system without separation, where the output of the system is designed to deliver a product in which the gases are mixed or blended for delivery into the user's system.

10.4.2.2.6.1
The following provisions shall apply in order to allow adjacent storage:

(1) The tubes shall be designed, built, and stamped in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 or approved by the DOT or the TC for use as an exempted compressed gas shipping container.

(2) Hydrogen manifolds shall be designed and tested in accordance with ASME B31.12, Hydrogen Piping and Pipelines, to ensure initial leaktightness. Other gas manifolds shall be designed and tested in accordance with ASME B31.3, Process Piping.

(3) Pressure relief devices protecting storage vessels excluding cylinders with a water volume less than 20 ft$^3$ (566 L) shall meet design requirements and be piped to a vent system that has been designed and installed in accordance with CGA G-5.5, Hydrogen Vent Systems.

(4) Where systems are provided with an emergency shutdown device, the device shall be common to all the co-located flammable gases. An event that causes the shutdown or isolation of the hydrogen system shall simultaneously shut down or isolate the other flammable gas system.

10.4.3 Underground Bulk Hydrogen Compressed Gas Systems.

10.4.3.1 Underground Systems.
Bulk hydrogen compressed gas systems installed underground where compressed gas containers are to be buried in contact with earth or fill shall be in accordance with 10.4.3.1.

10.4.3.1.1 Design.
Pressure compressed gas containers installed underground using burial methods shall be of seamless construction in accordance with Part UF or Appendix 22 of the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
Compressed gas containers shall be designed to include cyclic pressure life calculations using fracture mechanics methods.

10.4.3.1.2 Compressed Gas Container Examination.

(A) Compressed gas containers shall be examined for internal and external surface flaws and inclusions before burial or at the time of manufacture.

(B) Compressed gas containers with flaws or inclusions exceeding the lesser of 5 percent of the wall thickness or 0.12 in. (3 mm) shall not be used.

10.4.3.1.2 Composite Containers. (Reserved)

10.4.3.1.3 Corrosion Protection.

Compressed gas containers and underground piping shall be protected from corrosion in accordance with 7.1.10.9, 7.1.15, or 7.1.17 as applicable.

10.4.3.1.4 Outlet Connections.

10.4.3.1.4.1 Threaded compressed gas container outlet connections shall be designed with primary and secondary seals that shall be tested for functionality.

10.4.3.1.4.2 The seal design shall include a method of detecting a leak in the primary seal.

10.4.3.1.5 Piping Systems.

10.4.3.1.5.1 Joints in the piping system shall be installed and inspected in accordance with the requirements of ASME B31.12, Hydrogen Piping and Pipelines, or other approved standards.

10.4.3.1.5.2 Valves, controls, safety devices, and instrumentation shall be above ground and accessible to authorized personnel.

10.4.3.1.6 Location.

Compressed gas containers shall be located in accordance with 10.4.3.1.6.1 through 10.4.3.1.6.6.

10.4.3.1.6.1 Underground compressed gas containers shall not be located beneath buildings.

10.4.3.1.6.2 Compressed gas containers and associated equipment shall be located with respect to foundations and supports of other structures such that the loads carried by such structures cannot be transmitted to the tank.

10.4.3.1.6.3 The distance from any part of the compressed gas container to the nearest wall of a basement, pit, cellar, or lot line shall not be less than 10 ft (3.1 m).

10.4.3.1.6.4
A structure or foundation of a structure on the same property shall not be erected or constructed within 10 ft (3.1 m) of any point on the container surface, unless the footings extend to the bottom of the container or the container's foundation.

10.4.3.1.6.5
A minimum distance of 1 ft (0.3 m), shell to shell, shall be maintained between adjacent underground containers.

10.4.3.1.6.6
A minimum distance of 3 ft (0.9 m) shall be maintained between compressed gas containers and buried utilities.

10.4.3.1.7 Foundations.
Underground compressed gas containers shall be set on foundations constructed in accordance with the building code, and surrounded with not less than 6 in. (152 mm) of noncorrosive inert material.

10.4.3.1.7.1
The concrete shall extend a minimum of 1 ft (0.3 m) horizontally beyond the footprint of the tank in all directions.

10.4.3.1.8 Depth, Cover, and Fill.
Containers shall be buried such that the top of the container is covered with a minimum of 1 ft (0.3 m) of earth and with concrete a minimum of 4 in. (101 mm) thick placed over the earthen cover.

10.4.3.1.9* Anchorage and Security.
Compressed gas containers installed underground in flood hazard areas shall be anchored to prevent flotation, collapse, or lateral movement resulting from hydrostatic loads, including the effects of buoyancy, during conditions of the design flood.

10.4.3.1.10 Venting of Underground Compressed Gas Containers.
Vent pipes for underground compressed gas containers shall be in accordance with 10.2.2.

10.4.3.1.11 Overfill Protection and Prevention Systems.
An approved means or method shall be provided to prevent the overfilling of the storage containers.

10.4.3.1.12 Physical Protection.
Piping and control equipment ancillary to underground containers that is located above ground shall be protected from physical damage in accordance with 7.1.8.3.

10.4.4 Installation in Vaults Above and Below Ground. (Reserved)
10.4.5 Indoor Bulk Hydrogen Compressed Gas Systems.
10.4.5.1 General.

10.4.5.1.1
The location of bulk hydrogen compressed gas systems shall be in accordance with Table 10.4.5.1.1.

Table 10.4.5.1.1 Location of Bulk Hydrogen Compressed Gas Systems
<table>
<thead>
<tr>
<th>Location</th>
<th>≥5000 to &lt;15,000 scf (≥142 to &lt;425 Nm³)</th>
<th>≥15,000 scf (≥425 Nm³)</th>
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<td>In a detached building</td>
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<tr>
<td>In a gas room, in accordance with Section 6.4</td>
<td>A</td>
<td>Detached building required</td>
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<tr>
<td>Not in a gas room</td>
<td>NA</td>
<td>Detached building required</td>
</tr>
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</table>

A: Allowed. NA: Not allowed.

10.4.5.1.2* Fire Protection.

Fire protection shall be in accordance with the requirements of Section 6.10.

10.4.5.2 Detached Buildings.

10.4.5.2.1

Detached buildings shall be constructed of noncombustible or limited-combustible materials in accordance with the requirements of Section 6.5.

10.4.5.2.2

Ventilation shall be provided in accordance with the requirements of Section 6.16.

10.4.5.2.2.1

Outlet openings shall be located at the high point of the room in exterior walls or the roof.

10.4.5.2.2.2

Inlet and outlet openings shall each have a minimum total area of 1 ft²/1000 ft³ (1 m²/305 m³) of room volume.

10.4.5.2.2.3

Discharge from outlet openings shall be directed or conducted to the atmosphere.

10.4.5.2.3*

Explosion control shall be provided in accordance with the requirements of Section 6.9.

10.4.5.2.4

Electrical equipment shall be in accordance with Article 501 of NFPA 70 for Class I, Division 2 locations.

10.4.5.2.5

Heating, if provided, shall be by steam, hot water, or other indirect means except that electrical heating shall be permitted to be used if in compliance with 10.4.5.2.4.

10.4.5.3 Hydrogen Gas Rooms.

10.4.5.3.1

Floors, walls, and ceilings shall be constructed of noncombustible or limited-combustible materials in accordance with the requirements of the building code.

10.4.5.3.1.1

Interior walls or partitions shall have a fire resistance rating of not less than 2 hours, shall be continuous from floor to ceiling, and shall be anchored to resist movement.

10.4.5.3.1.2
Not less than 25 percent of the perimeter wall shall be an exterior wall.

10.4.5.3.1.3
Openings to other parts of the building shall not be permitted.

10.4.5.3.1.4
Windows and doors shall be in exterior walls only.

10.4.5.3.2
Ventilation shall be as provided in Section 6.16.

10.4.5.3.3
Explosion control shall be provided in accordance with the requirements of Section 6.9.

10.4.5.3.4
There shall be no sources of ignition from open flames, electrical equipment, or heating equipment.

10.4.5.3.5
Electrical equipment shall be in accordance with Article 501 of NFPA 70, for Class I, Division 2 locations.

10.4.5.3.6
Heating, if provided, shall be by steam, hot water, or indirect means except that electrical heating shall be permitted to be used if in compliance with 10.4.5.3.5.

10.4.6 Security.

10.4.6.1*
User storage sites shall be fenced or otherwise secured and posted to prevent entry by unauthorized personnel.

10.4.6.2
Administrative controls shall be allowed to be used to control access to individual storage, use, and handling areas located in secure facilities not accessible by the general public.

10.4.6.3
At least two means of egress shall be provided from any fenced area.
Update chapter references in Chapter 8 (plus annex material) according to attached file.

Supplemental Information

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Submitter Information Verification

Submitter Full Name: Susan Bershad
Organization: National Fire Protection Assoc
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Fri Oct 17 09:32:56 EDT 2014

Committee Statement

Committee Statement: Due to the addition of Chapter 13 and Chapter 16 in this edition, editorial changes need to be made to material in Chapter 8 and the annex to reference the material in these new chapters. See the attached table for these changes. They are reflected in Chapter 8 and the annex material.

Response Message:
8.13.2.7.2 Stationary containers shall be sited so that they are open to the surrounding environment except that encroachment by building walls of unlimited height shall be permitted when in accordance with the distances specified by Table 8.7.2 or the material-specific tables in Chapters 9 through 11, 13, and 16.

8.14.1.4.1 Cryogenic fluid storage systems shall be inspected and maintained by a qualified representative of the equipment owner as required by the material-specific requirements of Chapters 9, 11, 13, and 16.

8.14.11.1 Indoor use of cryogenic fluids shall be in accordance with the material-specific provisions of Chapters 9, 11, 13, and 16 or with ANSI/CGA P-18, Standard for Bulk Inert Gas Systems at Consumer Sites, and 8.14.2.

8.14.11.2.1 Outdoor use of cryogenic fluids shall be in accordance with the material-specific provisions of Chapters 9, 11, 13, and 16 or with ANSI/CGA P-18, Standard for Bulk Inert Gas Systems at Consumer Sites, and 8.14.2.

8.14.11.3.3 Distances from property lines, buildings, and exposure hazards shall be in accordance with Table 8.7.2 and Table 8.7.3 and the material-specific provisions of Chapters 9, 11, 13, and 16 or with ANSI/CGA P-18, Standard for Bulk Inert Gas Systems at Consumer Sites.

8.14.11.3.4 Loading and unloading areas shall be constructed in accordance with the requirements of Chapter 9 for liquid oxygen, Chapter 11 for liquid hydrogen, Chapter 13 for liquid carbon dioxide, and Chapter 16 for liquid nitrous oxide or ANSI/CGA P-18, Standard for Bulk Inert Gas Systems at Consumer Sites, for inert cryogenic fluids, as applicable.

A.8.13.2.7.2.1 A noncombustible, delivery vehicle spill pad shall be provided when required by the material-specific requirements of Chapter 9 for liquid oxygen, Chapter 11 for liquid hydrogen, Chapter 13 for liquid carbon dioxide, and Chapter 16 for liquid nitrous oxide or ANSI/CGA P-18, Standard for Bulk Inert Gas Systems at Consumer Sites.

A.8.13.2.7.2.1 The separation distances shown in Figure A.8.13.2.7.2.1 are required to provide ventilation in the space in order to avoid creating a confined space. Chapter 8 is a generic chapter used to establish minimum requirements for all cryogens. Material-specific requirements for oxygen, hydrogen, or other gases might require greater separation distances based on the type of construction or the related exposure. For example, wall number 3 shown in Figure A.8.13.2.7.2.1 could be an exterior building wall, and the gas could be hydrogen. Refer to Table 8.7.2, Table 9.3.2, Table 11.3.2.2, Table 13.9.1 and Table 16.2 for specific details regarding building walls, wall openings, air intakes, and similar conditions.
Modify Table 10.3.1.2.1 (Electrical Area Classification) with attached file.

Supplemental Information

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Submitter Information Verification

Submitter Full Name: Sonia Barbosa
Organization: [ Not Specified ]
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Thu Oct 02 15:22:38 EDT 2014

Committee Statement

Committee Statement: The committee has modified the original public comment to show spherical classified areas around vent areas and other sources. This is consistent with the material in NFPA 497 for hydrogen. Since this concept is clearer than that originally in the first draft, the figures proposed in PC-41 are not necessary. PC-41 will be rejected.

Response Message: 

Committee Statement:

The committee has modified the original public comment to show spherical classified areas around vent areas and other sources. This is consistent with the material in NFPA 497 for hydrogen. Since this concept is clearer than that originally in the first draft, the figures proposed in PC-41 are not necessary. PC-41 will be rejected.

Response Message:
### Table 10.3.1.2.1 Electrical Area Classification

<table>
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<tr>
<th>Location</th>
<th>Classification</th>
<th>Extent of Classified Area</th>
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<tr>
<td>Within 3 ft (1 m) of any vent outlet and any points where hydrogen is</td>
<td>Class 1, Division 1</td>
<td>Between 0 ft (0 m) and 345 ft (0.946 m) and measured horizontally within a vertical cylinder.</td>
</tr>
<tr>
<td>Between 3 ft (1 m) and 15 ft (4.6 m) of any vent outlet and any point</td>
<td>Class 1, Division 2</td>
<td>Between 3 ft (0.9 m) and 15 ft (4.6 m) and measured spherically from the vent outlet.</td>
</tr>
<tr>
<td>Storage equipment excluding the piping system downstream of the source</td>
<td>Class I, Division 2</td>
<td>Between 0 ft (0 m) and 15 ft (4.6 m) and measured spherically from the source horizontally within a vertical cylinder.</td>
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</table>
2.3.3 ASTM Publications.
ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

Submitter Information Verification

Submitter Full Name: [ Not Specified ]
Organization: [ Not Specified ]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jul 14 10:34:52 MDT 2014

Committee Statement

Committee Statement: Update year dates
Response Message:
Public Comment No. 39-NFPA 55-2014 [Section No. 2.3.3]
Public Comment No. 45-NFPA 55-2014 [Section No. 2.3.3]
### Section 2.3.4

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


### Submitter Information Verification

- **Submitter Full Name:** [Not Specified]
- **Organization:** [Not Specified]
- **Street Address:**
- **City:**
- **State:**
- **Zip:**
- **Submittal Date:** Wed Jun 18 09:04:00 EDT 2014

### Committee Statement

- **Committee Statement:** Update of reference publication dates and titles.
- **Response Message:**
Second Revision No. 2-NFPA 55-2014 [ Section No. 2.3.6 ]

<table>
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<tr>
<td>International Association of Plumbing and Mechanical Officials, 5001 4755 E. Philadelphia Street, Ontario, CA 91761.</td>
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Submitter Information Verification

- **Submitter Full Name:** [Not Specified]
- **Organization:** [Not Specified]
- **Street Address:**
- **City:**
- **State:**
- **Zip:**

**Submittal Date:** Wed Jun 18 09:12:09 EDT 2014

Committee Statement

- **Committee Statement:** Change in address for IAPMO
- **Response Message:**
# Second Revision No. 3-NFPA 55-2014 [ Section No. 2.3.7 ]

## 2.3.7 ICC Publications.

International Code Council, 5203 Leesburg Pike, Suite 600, Falls Church, VA 22041 500 New Jersey Avenue, NW, 6th Floor, Washington, DC 20001.


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## Submitter Information Verification

- **Submitter Full Name:** [Not Specified]
- **Organization:** [Not Specified]
- **Street Address:**
- **City:**
- **State:**
- **Zip:**
- **Submittal Date:** Wed Jun 18 09:15:26 EDT 2014

## Committee Statement

- **Committee Statement:** Address change for ICC
- **Response Message:**

[Link to National Fire Protection Association Report](http://submittals.nfpa.org/TerraViewWeb/ContentFetcher?commentPara...
2.4 References for Extracts in Mandatory Sections.


Submitter Information Verification

**Submitter Full Name:** [Not Specified]

**Organization:** [Not Specified]

**Street Address:**

**City:**

**State:**

**Zip:**

**Submittal Date:** Wed Jun 18 09:27:10 EDT 2014

Committee Statement

**Committee Statement:** Update of publication dates for extracted NFPA documents

**Response Message:**
3.3.23 Constantly Monitored Control Station.
A facility where alarm or supervisory signals are monitored and the means are provided to notify emergency services.

Submitter Information Verification
Submitter Full Name: [ Not Specified ]
Organization: [ Not Specified ]
Street Address: [ Not Specified ]
City: [ Not Specified ]
State: [ Not Specified ]
Zip: [ Not Specified ]
Submittal Date: Tue Jul 15 10:23:45 MDT 2014

Committee Statement
Committee Statement: FR 19 received several negative comments during the First Draft Ballot, specifically in regard to removing the requirement for excess flow valves for Flammability Class 4. This Public Comment addresses the concerns in the negative comment, and provides a degree of latitude in providing means of Emergency Isolation in 55:7.3.1.12
Response Message: Public Comment No. 27-NFPA 55-2014 [New Section after 3.3.22]
### 3.3.43 Fire Barrier

A continuous membrane or a membrane with discontinuities created by protected openings with a specified fire protection rating, where such membrane is designed and constructed with a specified fire resistance rating to limit the spread of fire, that also restricts the movement of smoke. [5000, 2012, 2015]

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### Supplemental Information

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Submittal Date: Wed Jun 18 10:22:03 EDT 2014

### Committee Statement

Committee Statement: Update of extracted material to the 2015 edition of NFPA 5000. See attached file for revisions to annex material.
Annex Material for SR-8 NFPA 55

A.3.3.42 Fire Barrier.

A fire barrier, such as a wall or floor assembly, might be aligned vertically or horizontally. Although the continuity of a fire barrier will often limit the transfer of smoke, it should not be confused with either a smoke barrier or a smoke partition. [5000, 2012, 2015]
3.3.94.11  Non-Bulk Flammable Gas System.
A system consisting of cylinders or other storage systems, with each individual cylinder and each individual set of connected cylinders having less than 5000 scf (141.6 Nm$^3$).

### Supplemental Information

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### Submitter Information Verification

- **Submitter Full Name:** Not Specified
- **Organization:** Not Specified
- **Street Address:**
- **City:**
- **State:**
- **Zip:**
- **Submittal Date:** Tue Jul 15 17:55:19 MDT 2014

### Committee Statement

- **Committee Statement:** Added definition that was missing from main body of text. Part of modifying chapters 7 and 10 to include all gas hydrogen requirements in chapter 10 as part of committee inputs 104 and 105. See attachment to SR-49 for annex material from PC-32
- **Response Message:** Public Comment No. 31-NFPA 55-2014 [New Section after 3.3.93.10.1]
Annex Material for SR 49

A.3.3.93.11 Non-bulk flammable gas system

Bulk Flammable Gas System.

Non-bulk systems may have more than 5,000 SCF as long as the volume of any individual container or connected system is less than 5,000 SCF. Table 7.6.2 shows exposure distances for non-bulk flammable gases with a total storage of up to 200,000 SCF.
Second Revision No. 50-NFPA 55-2014 [ Section No. 3.3.93.10.1 ]

3.3.94.10.1* Bulk Liquefied Hydrogen System.
A liquefied hydrogen (LH$_2$) system with a storage capacity of more than 39.7 gal (150 L) of liquefied hydrogen.

Submitter Information Verification

Submitter Full Name: [ Not Specified ]
Organization: [ Not Specified ]
Street Address: [ Not Specified ]
City:
State:
Zip:
Submittal Date: Tue Jul 15 17:59:43 MDT 2014

Committee Statement

Committee Statement: Corrects error in first draft and completes sentence.
Response Message:
4.2.1.2
The plan shall be available for inspection by the AHJ and shall include the following information:

(1) The type of emergency equipment available and its location
(2) A brief description of any testing or maintenance programs for the available emergency equipment
(3) An indication that hazard identification labeling is provided for each storage area
(4) The location of posted emergency procedures
(5) A material safety data sheet (MSDS) or equivalent for each compressed gas or cryogenic fluid stored or used on the site
(6) A list of personnel who are designated and trained to be liaison personnel for the fire department and who are responsible for the following:
   (a) Aiding the emergency responders in pre-emergency planning
   (b) Identifying the location of the compressed gases and cryogenic fluids stored or used
   (c) Accessing MSDSs
   (d) Knowing the site emergency procedures
(7) A list of the types and quantities of compressed gases and cryogenic fluids and their respective control areas, storage areas, gas rooms, and detached buildings found within the facility.

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Mon Jul 14 10:39:59 MDT 2014

Committee Statement

Committee Statement: This listing is too broad and conflicts with 4.2.1.1. Per 2013 NFPA 55 4.2.1.1 an emergency plan is required when a facility has >MAQ quantities. It is more logical for 4.2.1.2 (7) to revert to the text before the revision by FR-10 or to the text suggested here. Control areas are only applicable at <MAQ quantities and per 4.2.1.1 would not require an emergency plan. In addition, specifying the other areas is not needed. If a facility has >MAQ quantities then all they need to list is what and where.

Response Message: Public Comment No. 46-NFPA 55-2014 [Section No. 4.2.1.2]
4.5.3 Material Safety Data Sheets (MSDS) Safety Data Sheets (SDS).

Material safety data sheets (MSDS) Safety data sheets (SDS) shall be available on the premises for hazardous materials regulated by this code. When approved, MSDSs SDSs shall be permitted to be retrievable by electronic access. [400:6.1.2]

Submitter Information Verification

Submitter Full Name: [ Not Specified ]
Organization: [ Not Specified ]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 18 10:45:48 EDT 2014

Committee Statement

Committee Statement: Changed MSDS to SDS to be consistent with NFPA 400.
Response Message:
4.6.1 Prohibited Releases.
Hazardous materials shall not be released into a sewer, storm drain, ditch, drainage canal, lake, river, or tidal waterway; upon the ground, a sidewalk, a street, or a highway; or into the atmosphere, unless such release is permitted by the following:

(1) Federal, state, or local governing regulations
(2) Permits of the jurisdictional air quality management board
(3) National Pollutant Discharge Elimination System permit
(4) Waste discharge requirements established by the jurisdictional water quality control board
(5) Local sewer pretreatment requirements for publicly or privately owned treatment works

Submitter Information Verification

Submitter Full Name: [ Not Specified ]
Organization: [ Not Specified ]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 18 10:48:46 EDT 2014

Committee Statement

Committee Statement: Update of extracted text to match NFPA 400.
Response Message:
4.7.1.2 Hazard Communications.
Training shall be provided prior to beginning work in the work area to enable personnel to recognize and identify hazardous materials stored, dispensed, handled, or used on site and where to find safety information pertaining to the hazards of the materials employed. [400:6.1.4.1.2]

Submitter Information Verification

Submitter Full Name: [ Not Specified ]
Organization: [ Not Specified ]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 18 10:53:49 EDT 2014

Committee Statement

Committee Statement: Update of extract material to match NFPA 400
Response Message:
4.7.2.1 Physical and Health Hazard Properties.
Operations personnel shall be trained in the chemical nature of the materials, including their physical hazards and the symptoms of acute or chronic exposure as provided by the material safety data sheet (MSDS) furnished by the manufacturer or other authoritative sources.

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address: [Not Specified]
City:
State:
Zip:
Submittal Date: Wed Jun 18 10:55:29 EDT 2014

Committee Statement

Committee Statement: Change MSDS to SDS in extracted material from NFPA 400.
Response Message:
### Second Revision No. 63-NFPA 55-2014 [Section No. 4.7.3.2]

**4.7.3.2**
Emergency response liaison personnel shall do the following:

1. Aid emergency responders in pre-planning responses to emergencies
2. Identify locations where hazardous materials are located
3. Have access to material safety data sheets
4. Be knowledgeable in the site emergency response procedures

---

### Submitter Information Verification

**Submitter Full Name:** Susan Bershad  
**Organization:** National Fire Protection Assoc  
**Street Address:**  
**City:**  
**State:**  
**Zip:**  
**Submittal Date:** Wed Aug 06 11:22:23 EDT 2014

---

### Committee Statement

**Committee Statement:** Update of extract from 400. Error in first draft

**Response Message:**
4.8.1 Responsible persons shall be designated and trained to be emergency response (ER) liaison personnel.

4.8.2 Emergency response liaison personnel shall do the following:

1. Aid emergency responders in pre-planning responses to emergencies
2. Identify locations where hazardous materials are located
3. Have access to material safety data sheets
4. Be knowledgeable in the site emergency response procedures

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 18 11:05:40 EDT 2014

Committee Statement

Committee Statement: Changed title of section to be consistent with NFPA 400 material.
Response Message:
4.9.3.1* Powered Industrial Trucks.
Powered industrial trucks shall be operated and maintained in accordance with NFPA 505.
4.12.1* Noncombustible Material.

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 Degrees C, shall be considered a noncombustible material.

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 Degrees C, shall be considered a noncombustible material.

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 18 11:12:14 EDT 2014

Committee Statement

Committee Statement: Update of extracted material.
Response Message:
4.12.2.4

The material shall have composed of materials that, in the form and thickness used, neither exhibit 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 ANSI/UL 723, and shall be of such composition that all surfaces that would be exposed by cutting through the material on any plane would neither exhibit a flame spread index greater than 25 nor exhibit evidence of continued progressive combustion when tested in accordance with ASTM E84 or ANSI/UL 723.

6.2 Control Areas.

6.2.1 Construction Requirements.
Control areas shall be separated from each other by fire barriers in accordance with Table 6.2.1.

Table 6.2.1 Design and Number of Control Areas

<table>
<thead>
<tr>
<th>Floor Level</th>
<th>Maximum Allowable Quantity per Control Area(%)†*</th>
<th>Number of Control Areas per Floor</th>
<th>Fire Resistance Rating for Fire Barriers† (hr)</th>
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<tbody>
<tr>
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<tr>
<td>&gt;9</td>
<td>5</td>
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<td>7–9</td>
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<td>4–6</td>
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</tr>
<tr>
<td>lower than 2</td>
<td>NP</td>
<td>NP</td>
<td>N/A</td>
</tr>
</tbody>
</table>

NP: Not Permitted.
N/A: Not Applicable.
†* Percentages represent the maximum allowable quantities MAQ per control area shown in Table 6.3.1.1, with all of the increases permitted in the footnotes of that table.
† Fire barriers are required to include floors and walls, as necessary, to provide a complete separation from other control areas.

6.2.2 Number of Control Areas.
The maximum number of control areas within a building shall be in accordance with Table 6.2.1.

6.2.3 Where only one control area is present in a building, no special construction provisions shall be required.

6.2.4 Quantities Less Than or Equal to the MAQ.
Indoor control areas with compressed gases or cryogenic fluids stored or used in quantities less than or equal to those shown in Table 6.3.1.1 shall be in accordance with 6.3.1.6 and 6.3.1.7 and Sections 6.1, 6.7, 6.8, 6.12, 6.15, and 6.16, and the applicable provisions of Chapters 1 through 5 and Chapters 7 through 16.

Supplemental Information

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<th>Description</th>
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Submitter Information Verification
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<td>Submittal Date:</td>
<td>Wed Jun 18 11:37:12 EDT 2014</td>
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</tbody>
</table>

**Committee Statement**

Committee Statement: NFPA 5000 extracts this material from NFPA 400, which is the original document. Extract tags have been changed to reflect the material in 400.
### Table 6.2.1 Design and Number of Control Areas

<table>
<thead>
<tr>
<th>Floor Level</th>
<th>Maximum Allowable Quantity per Control Area(%)†‡</th>
<th>Number of Control Areas per Floor</th>
<th>Fire Resistance Rating for Fire Barriers‡‡ (hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above grade</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>plane</td>
<td></td>
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<td>&gt;9</td>
<td>5</td>
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<tr>
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<td>100</td>
<td>4</td>
<td>1</td>
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<tr>
<td>Below grade</td>
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<tr>
<td>plane</td>
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</tr>
<tr>
<td>Lower than 2</td>
<td>NP</td>
<td>NP</td>
<td>N/A</td>
</tr>
</tbody>
</table>

NP: Not Permitted.

N/A: Not Applicable.

†‡Percentages represent the maximum allowable quantities (MAQ) per control area shown in Table 6.3.1.1, with all of the increases permitted in the footnotes of that table.

†‡‡Fire barriers are required to include floors and walls, as necessary, to provide a complete separation from other control areas. [5000: Table 34.2.5.1.1][400: Table 5.2.2.1]
6.10.2.1
Where sprinkler protection is required, the area in which compressed gases or cryogenic fluids are stored or used shall be protected with a sprinkler system designed to be not less than that required by 11.2.3.1.1 of NFPA 13 for the Ordinary Hazard Group 2 density/area curve.

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submitral Date: Mon Jul 14 10:58:45 MDT 2014

Committee Statement

Committee Statement:

There is no such thing as an Ordinary Hazard Group 2 Occupancy. NFPA 13 uses that term but it is misleading and is not something NFPA 55 should strive to correlate with. The term occupancies, as used elsewhere in NFPA 55, refers to the occupancy classification assigned to a structure and from which all building and fire code requirements can be determined. Examples are business, storage or industrial. These are common occupancies. NFPA 13 is referring to a particular level of combustible loading presented. It is better to leave the 55 text as is or to be consistent with the text developed for the MATS systems and refer to the curve in NFPA 13. That text was suggested by an NFPA 13 member. NFPA 55 is less confusing without making the proposed change presented here.

Response Message:

Public Comment No. 47-NFPA 55-2014 [Section No. 6.10.2.1]
6.10.2.2
Where sprinkler protection is required, the area in which the flammable or pyrophoric compressed gases or cryogenic fluids are stored or used shall be protected with a sprinkler system designed to be not less than that required by 11.2.3.1.1 of NFPA 13 for the Extra Hazard Group 1 occupancies density/area curve.

Submitter Information Verification

<table>
<thead>
<tr>
<th>Submitter Full Name:</th>
<th>[Not Specified]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organization:</td>
<td>[Not Specified]</td>
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<td>Street Address:</td>
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<td>Zip:</td>
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<tr>
<td>Submittal Date:</td>
<td>Mon Jul 14 10:59:58 MDT 2014</td>
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Committee Statement

| Committee Statement: | There is no such thing as an Ordinary Hazard Group 2 Occupancy. NFPA 13 uses that term but it is misleading and is not something NFPA 55 should strive to correlate with. The term occupancies, as used elsewhere in NFPA 55, refers to the occupancy classification assigned to a structure and from which all building and fire code requirements can be determined. Examples are business, storage or industrial. These are common occupancies. NFPA 13 is referring to a particular level of combustible loading presented. It is better to leave the 55 text as is or to be consistent with the text developed for the MATS systems and refer to the curve in NFPA 13. That text was suggested by an NFPA 13 member. NFPA 55 is less confusing without making the proposed change presented here. |

Response Message:
Public Comment No. 48-NFPA 55-2014 [Section No. 6.10.2.2]
6.16.5 Recirculation of Exhaust.
Exhaust ventilation shall not be recirculated within the room or building if the cylinders, containers, or tanks stored are capable of releasing hazardous gases.

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address: [Not Specified]
City: [Not Specified]
State: [Not Specified]
Zip: [Not Specified]
Submittal Date: Mon Jul 14 11:12:54 MDT 2014

Committee Statement

Committee Statement: The committee is rejecting both public comments received on this section and is providing alternate text to make it clear that exhaust ventilation shall not be recirculated.

Response Message:
Public Comment No. 44-NFPA 55-2014 [Section No. 6.16.5]
Public Comment No. 57-NFPA 55-2014 [Section No. 6.16.5]
7.1.4 Insulated Liquid Nitrous Oxide Systems. (Reserved)

Insulated liquid nitrous oxide systems shall be in accordance with Chapter 16.

Submitter Information Verification

Submitter Full Name: Sonia Barbosa
Organization: [ Not Specified ]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Oct 21 16:43:12 EDT 2014

Committee Statement

Committee Statement: Adds reference to new Chapter 16. Existing annex material to be deleted.
Response Message:
Section No. 7.1.19.10

Two or more levels of piping within the same trench shall be separated vertically by a minimum 6 in. (150 mm) of well-compacted bedding material. [30:27.6.5.8]
Piping, tubing, fittings, and related components shall be designed, fabricated, and tested in accordance with the requirements of the applicable parts in the ASME B31.3, Code for Process Piping, or other approved standards.

Submitter Information Verification

Submitter Full Name: Susan Bershad
Organization: National Fire Protection Assoc
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Wed Aug 06 10:39:04 EDT 2014

Committee Statement

Committee Statement: The committee changed this to reference B31.3 generically. This material was originally submitted to NFPA 2 and was reviewed by the joint 2/55 TC.
7.3.1.12 Excess Flow Control Emergency Isolation

7.3.1.12.1 Where compressed gases having a hazard ranking in one or more of the following hazard classes in accordance with NFPA 704 are carried in pressurized piping above a gauge pressure of 15 psi (103 kPa), an approved means of either leak detection with emergency shutoff or excess flow control emergency isolation shall be provided:

(1) Health hazard Class 3 or Class 4
(2) Instability Class 3 or Flammability Class 4
(3) Instability Class 3 or Class 4

7.3.1.12.1.1 Excess Flow Control Location with Hazardous Material Storage.
Where the piping originates from within a hazardous material storage room or area, the excess flow control shall be located within the storage room or area.

7.3.1.12.1.2 Excess Flow Control Location with Bulk Storage.
Where the piping originates from a bulk source, the excess flow control shall be located at the bulk source at a point immediately downstream of the source valve.

7.3.1.12.2 Approved means of meeting the requirements for emergency isolation shall include any of the following:

(1) Automatic shutoff valves, located as close to the bulk source as practical, tied to leak detection systems
(2) Attended control stations where trained personnel can monitor alarms or supervisory signals and can trigger emergency responses
(3) A constantly monitored control station with an alarm and remote shut off of the gas supply system
(4) Excess flow valves at the bulk source

7.3.1.12.3 The controls required by requirements of 7.3.1.12 shall not be required for the following:

(1) Piping for inlet connections designed to prevent backflow at the source
(2) Piping for pressure relief devices
(3) Where the source of the gas is not in excess of the quantity threshold as indicated in Table 6.3.1.1

7.3.1.12.3.1 Location.
The location of excess flow control shall be as specified in 7.3.1.12.1.1 and 7.3.1.12.1.2.

7.3.1.12.3.2 Where piping originates from a source located in a room or area, the excess flow control shall be located within the room or area.

7.3.1.12.4 Location Exemptions.
The requirements of 7.3.1.12 shall not apply to the following:

(1) Piping for inlet connections designed to prevent backflow
(2) Piping for pressure relief devices
(3) Systems containing 430 scf (12.7 Nm$^3$) or less of flammable gas
Committee Statement

Committee Statement: FR-19 received several negative comments during the First Draft Ballot. This SR reinstates the requirement for emergency isolation for flammability class 4. This incorporates PC-49. 21, 22, and 24. The material originally proposed as annex material for this section has been modified and incorporated as part of the mandatory requirements. It gives several alternatives for emergency isolation. Annex material for the deleted sections will be deleted as well.
Second Revision No. 27-NFPA 55-2014 [Section No. 7.6.2.2.2]

7.6.2.2.2
Mobile acetylene trailer systems (MATS) shall be located in accordance with 15.2.2 15.2.3.

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jul 14 11:36:55 MDT 2014

Committee Statement

Committee Statement: This is an editorial change from the last edition.
Response Message:
Public Comment No. 28-NFPA 55-2014 [Section No. 7.6.2.2.2]
Submitter Information Verification

Submitter Full Name: Susan Bershad
Organization: National Fire Protection Assoc
Street Address:
City:
State:
Zip:
Submittal Date: Wed Aug 06 10:44:12 EDT 2014

Committee Statement

Committee Statement: Change in title of Chapter 10. This is a part of the response to PC-37
Response Message:
10.1.1 Quantities Less Than or Equal to the MAQ.
This chapter shall not apply to individual systems each having a total hydrogen content of less than 5000 scf (141.6 Nm$^3$) or to systems located in control areas when the aggregate quantity contained is less than the maximum allowable quantity per control area (MAQ). The storage, use, and handling of hydrogen in gaseous hydrogen systems in quantities less than or equal to the MAQ shall be in accordance with Sections 10.1 and 10.2.

10.1.2 Quantities Greater Than the MAQ.
The storage, use, and handling of hydrogen in gaseous hydrogen systems in quantities greater than the MAQ shall be in accordance with Sections 10.1, 10.2, and 10.3.

10.1.3 Quantities Greater Than 5000 scf (141.6 Nm$^3$).
The storage, use, and handling of hydrogen in gaseous hydrogen systems (bulk gaseous hydrogen systems) in quantities greater than 5000 scf (141.6 Nm$^3$) shall be in accordance with Sections 10.1, 10.2, 10.3, and 10.4.
10.3 Hydrogen Systems Having Quantities Greater Than the MAQ

10.3.1 The storage, use, and handling of hydrogen in gaseous hydrogen systems in quantities greater than the MAQ shall be in accordance with Sections 10.1, 10.2, and 10.3.

10.3.2 Bonding and Grounding.

Mobile hydrogen supply units shall be electrically bonded to the storage system before hydrogen is discharged from the supply unit.

10.3.3 Cargo Transport Unloading.

Vehicular protection shall be provided in accordance with 7.1.8.3.

Unloading connections on delivery equipment shall not be positioned closer to any of the exposures cited in Table 10.3.2.1(a), Table 10.3.2.1(b), or Table 10.3.2.1(c) than the distances given for the bulk hydrogen compressed gas storage system.

During transfer of hydrogen from cargo vehicles to the bulk hydrogen compressed gas storage system, the hand or emergency brake of the vehicle shall be set, and chock blocks shall be used to prevent the vehicle from moving.

Cargo vehicles equipped with air-brake interlock in front of the unloading connection to protect against drive-aways shall be engaged such that the interlock is activated.

Mobile hydrogen supply units shall be electrically bonded to the bulk hydrogen compressed gas storage system before hydrogen is discharged from the supply unit.

10.3.6 Transfer System Depressurization.

The transfer systems shall be capable of depressurizing to facilitate disconnection.

Bleed connections shall be connected to a hydrogen venting system in accordance with 10.2.3.

Where required, check valves on delivery systems shall be in accordance with 7.3.1.3.2.

Prohibitions on smoking or the use of open flame shall be in accordance with 7.6.3.2.

An emergency shutoff valve shall be provided in accordance with 7.3.1.11.

10.3.4 Indoor Non-Bulk Hydrogen Compressed Gas System Location.
10.3.4.1

Hydrogen systems of less than 5000 scf (141.6 Nm$^3$) and greater than the MAQ, where located inside buildings, shall be in accordance with the following:

1. In a ventilated area in accordance with the provisions of Section 6.16
2. Separated from incompatible materials in accordance with the provisions of 7.1.10.2
3. A distance of 25 ft (7.6 m) from open flames and other sources of ignition
4. A distance of 50 ft (15 m) from intakes of ventilation, air-conditioning equipment, and air compressors located in the same room or area as the hydrogen system
   a. The distance shall be permitted to be reduced to 10 ft (3.1 m) where the room or area in which the hydrogen system is installed is protected by a listed detection system per Article 500.7(K) of NFPA 70 and the detection system shuts down the fuel supply in the event of a leak that results in a concentration that exceeds 25 percent of the LFL.
   b. Emergency shutoff valves shall be provided in accordance with 7.3.1.11.
5. A distance of 50 ft (15 m) from other flammable gas storage
6. Protected against damage in accordance with the provisions of 7.1.8.3

10.3.4.2 Systems Installed in One Room.

10.3.4.2.1

More than one system of 5000 scf (141.6 Nm$^3$) or less shall be permitted to be installed in the same room or area, provided the systems are separated by at least 50 ft (15 m) or a full-height fire-resistive partition having a minimum fire resistance rating of 2 hours is located between the systems.

10.3.4.2.2

The separation distance between multiple systems of 5000 scf (141.6 Nm$^3$) or less shall be permitted to be reduced to 25 ft (7.6 m) in buildings where the space between storage areas is free of combustible materials and protected with a sprinkler system designed for Extra Hazard, Group 1 occupancies in accordance with the requirements of Section 6.10.

10.3.4.2.3

The required separation distance between individual portable systems in the process of being filled or serviced in facilities associated with the manufacture or distribution of hydrogen and its mixtures shall not be limited by 10.3.4.2.1 or 10.3.4.2.2 when such facilities are provided with Protection Level 2 controls and the applicable requirements of Chapters 1 through 7.

10.3.5 Outdoor Non-Bulk Hydrogen Compressed Gas Location.

10.3.5.1

The outdoor storage or use of non-bulk gaseous hydrogen shall be in accordance with 7.6.2.
Second Revision No. 61-NFPA 55-2014 [ New Section after 10.2.7.2.3 ]

10.4 Bulk Gaseous Hydrogen System.

10.4.1 The use, storage, and handling of hydrogen in gaseous hydrogen systems (bulk hydrogen systems) in quantities greater than 5000 scf (141.6 Nm$^3$) shall be in accordance with Sections 10.1, 10.2, 10.3, and 10.4.

10.4.2 Outdoor Bulk Hydrogen Compressed Gas Systems.

10.4.2.1 General Requirements.

10.4.2.1.1 Bulk Hydrogen Compressed Gas.

Systems located above ground either at grade or above grade shall be in accordance with Section 10.4.2.

10.4.2.1.2 Electrical wiring and equipment shall be in accordance with Article 500 of NFPA 70.

### Table 10.4.2.1.2.1 Electrical Area Classification

<table>
<thead>
<tr>
<th>Location</th>
<th>Classification</th>
<th>Extent of Classified Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within 3 ft (1 m) of any vent outlet and any points where hydrogen is</td>
<td>Class 1, Division 1</td>
<td>Between 0 ft (0 m) and 15 ft (4.6 m) and measured horizontally within a vertical cylinder</td>
</tr>
<tr>
<td>vented to the atmosphere under normal operations</td>
<td></td>
<td>spherically from the outlet.</td>
</tr>
<tr>
<td>Between 3 ft (1 m) and 15 ft (4.6 m) of any vent outlet and any points</td>
<td>Class 1, Division 2</td>
<td>Between 3 ft (0.9 m) and 15 ft (4.6 m) and measured spherically from the vent outlet.</td>
</tr>
<tr>
<td>where hydrogen is vented to the atmosphere under normal operations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage equipment excluding the piping system downstream of the source</td>
<td>Class 1, Division 2</td>
<td>Between 0 ft (0 m) and 15 ft (4.6 m) and measured horizontally within a vertical cylinder</td>
</tr>
<tr>
<td>valve</td>
<td></td>
<td>spherically from the source.</td>
</tr>
</tbody>
</table>

10.4.2.2 Location.

10.4.2.2.1 Minimum Distance.
The minimum distance from a bulk hydrogen compressed gas system located outdoors to specified exposures shall be in accordance with Table 10.4.2.2.1(a), Table 10.4.2.2.1(b), or Table 10.4.2.2.1(c). (See also Annex G.)

Table 10.4.2.2.1(a) Minimum Distance (D) from Outdoor Bulk Hydrogen Compressed Gas Systems to Exposures — Typical Maximum Pipe Size

<table>
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<tr>
<th>Pressure</th>
<th>Internal Pipe Diameter (ID)</th>
<th>d (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 15 to 250 psig</td>
<td>&gt; 103.4 to 1724 kPa</td>
<td>d = 52.5 mm</td>
</tr>
<tr>
<td>&gt; 250 to 3000 psig</td>
<td>&gt; 1724 to 20,684 kPa</td>
<td>d = 18.97 mm</td>
</tr>
<tr>
<td>&gt; 3000 to 7500 psig</td>
<td>&gt; 20,684 to 51,711 kPa</td>
<td>d = 7.31 mm</td>
</tr>
<tr>
<td>&gt; 7500 to 15000 psig</td>
<td>&gt; 51,711 to 103,421 kPa</td>
<td>d = 7.16 mm</td>
</tr>
</tbody>
</table>

**Exposures Group 1**

(a) Lot lines
(b) Air intakes (HVAC, compressors, other)
(c) Operable openings in buildings and structures
(d) Ignition sources such as open flames and welding

<table>
<thead>
<tr>
<th>m</th>
<th>ft</th>
<th>m</th>
<th>ft</th>
<th>m</th>
<th>ft</th>
<th>m</th>
<th>ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>40</td>
<td>14</td>
<td>46</td>
<td>9</td>
<td>29</td>
<td>10</td>
<td>34</td>
</tr>
</tbody>
</table>

**Exposures Group 2**

(a) Exposed persons other than those servicing the system
(b) parked cars

<table>
<thead>
<tr>
<th>m</th>
<th>ft</th>
<th>m</th>
<th>ft</th>
<th>m</th>
<th>ft</th>
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<th>ft</th>
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</thead>
<tbody>
<tr>
<td>6</td>
<td>20</td>
<td>7</td>
<td>24</td>
<td>4</td>
<td>13</td>
<td>5</td>
<td>16</td>
</tr>
</tbody>
</table>

**Exposures Group 3**

(a) Buildings of non-combustible noncombustible non-fire-rated construction
(b) Buildings of combustible construction
(c) Flammable gas storage systems above or below ground
(d) Hazardous materials storage systems above or below ground
(e) Heavy timber, coal, or other slow-burning combustible solids
(f) Ordinary combustibles, including fast-burning solids such as ordinary lumber, excelsior, paper, or combustible waste and vegetation other than that found in maintained landscaped areas
(g) Unopenable openings in building and structures
(h) Encroachment by overhead utilities (horizontal distance from the vertical plane below the nearest overhead electrical wire of building service)
(i) Piping containing other hazardous materials
(j) Flammable gas metering and regulating stations such as natural gas or propane

<table>
<thead>
<tr>
<th>Pressure</th>
<th>&gt;15 to ≤250 psig</th>
<th>&gt;250 to ≤3000 psig</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>&gt;103.4 to ≤1724 kPa</td>
<td>&gt;1724 to ≤20,684 kPa</td>
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**Exposures**

<table>
<thead>
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<th>Exposures</th>
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<td>*†</td>
<td>*†</td>
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<th>m</th>
<th>ft</th>
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</table>

Note: Linear interpolation of internal pipe diameters and distances between table entries is allowed.

* For a list of exposures in each exposure group see Column 1 of Table 10.3.2.1(a) Table 10.4.2.2.1(a).

†When calculating the minimum separation distance (D) using the formulas indicated, based on the exposure group and pressure indicated, the internal pipe diameter (d) is entered in millimeters (mm). The calculated distance (D) is expressed in units of measure in meters (m). To convert distance (D) to units of measure in feet, multiply the value of (D) in meters by 3.2808 and round to the nearest whole foot.

Table 10.4.2.2.1(c) Minimum Distance (D) from Outdoor Bulk Hydrogen Compressed Gas Systems to Exposures by Maximum Pipe Size with Pressures >3000 to ≤15,000 psig
### Pressure Exposures

<table>
<thead>
<tr>
<th>Pressure</th>
<th>Exposures</th>
<th>Exposures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&gt;3000 to ≤7500 psig</td>
<td>&gt;7500 to ≤15,000 psig</td>
</tr>
<tr>
<td></td>
<td>&gt;20,684 to ≤51,711 kPa</td>
<td>&gt;51,711 to ≤103,421 kPa</td>
</tr>
</tbody>
</table>

### Internal Pipe Diameter (ID)

<table>
<thead>
<tr>
<th>ID (in.)</th>
<th>d (mm)</th>
<th>D = 1.105d</th>
<th>D = 0.68311d - 1.3123</th>
<th>D = 0.459d</th>
<th>D = 1.448d</th>
<th>D = 0.92909d - 1.6813</th>
<th>D = 0.602d</th>
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<tbody>
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</table>

Note: Linear interpolation of internal pipe diameters and distances between table entries is allowed.

* For a list of exposures in each exposure group see Column 1 of Table 10.3.2.1(a).
† When calculating the minimum separation distance (D) using the formulas indicated, based on the exposure group and pressure indicated, the internal pipe diameter (d) is entered in millimeters (mm). The calculated distance (D) is expressed in units of measure in meters (m). To convert distance (D) to units of measure in feet, multiply the value of (D) in meters by 3.2808 and round to the nearest whole foot.

---

**10.4.2.2.1.1**

The separation distance for piping systems with internal diameters other than those specified in Table 10.4.2.2.1(a) for the pressure range selected shall be permitted with tabular distances determined based on the use of Table 10.4.2.2.1(b) or Table 10.4.2.2.1(c).

**10.4.2.2.2** Maximum Internal Diameter of Interconnecting Piping.

The maximum internal diameter of the piping system used for interconnecting piping between the shutoff valve on any single storage container to the point of connection to the system source valve shall not be required to be in accordance with the values shown in Table 10.4.2.2.1(a) when in accordance with Table 10.4.2.2.1(b) or Table 10.4.2.2.1(c).

**10.4.2.2.2.1** Determination of Internal Diameter.

The internal diameter of the piping system shall be determined by the diameter of the piping serving that portion of a storage array with content greater than 5000 scf (141.6 Nm³). The piping system size used in the application of Table 10.4.2.2.1(a), Table 10.4.2.2.1(b), or Table 10.4.2.2.1(c) shall be determined based on that portion of the system with the greatest maximum internal diameter.

**10.4.2.2.2** Separation distances determined based on the use of Table 10.4.2.2.1(b) or Table 10.4.2.2.1(c) shall be subject to review and approval by the AHJ.
**10.4.2.2.3**

**Determination of System Pressure.** The system pressure shall be determined by the maximum operating pressure of the storage array with content greater than 5000 scf (141.6 Nm$^3$), irrespective of those portions of the system elevated to a higher pressure.

**10.4.2.2.4**

**Reduction of Distance by Mitigation Means.**

**10.4.2.2.4.1**

**Passive Means.**

Except for distances to air intakes, the distances to Group 1 and 2 exposures shown in Table 10.4.2.2.1(a), Table 10.4.2.2.1(b), and Table 10.4.2.2.1(c) shall be permitted to be reduced by one-half and shall not apply to Group 3 exposures where fire barrier walls are located between the system and the exposure and constructed in accordance with the following:

1. Fire barrier walls shall have a minimum fire resistance rating of not less than 2 hours.
2. The fire barrier wall shall interrupt the line of sight between the bulk hydrogen compressed gas system and the exposure.
3. The configuration of the fire barrier shall allow natural ventilation to prevent the accumulation of hazardous gas concentrations.
4. The number of fire barrier walls used to separate individual systems shall be limited to three.
5. The fire barrier wall shall not have more than two sides at 90 degrees (1.57 rad) directions or not more than three sides with connecting angles of 135 degrees (2.36 rad).
   
   (a) The connecting angles between fire barrier walls shall be permitted to be reduced to less than 135 degrees (2.36 rad) for installations consisting of three walls when in accordance with 8.13.2.7.2.

6. Fire barrier walls shall be designed and constructed as a structure in accordance with the requirements of the building code without exceeding the specified allowable stresses for the materials of construction utilized. Structures shall be designed to resist the overturning effects caused by lateral forces due to wind, soil, flood, and seismic events.
7. Where clearance is required between the bulk hydrogen compressed gas system and the barrier wall for the performance of service or maintenance-related activities, a minimum horizontal clearance of 5 ft (1.5 m) shall be provided between the structure and the system.
8. The fire barrier wall shall be either an independent structure or the exterior wall of the building adjacent to the storage or use area when the exterior building wall meets the requirements for fire barrier walls.

**10.4.2.2.4.2**

**Active Means.**

Active control systems that mitigate the risk of system leaks and failures shall be permitted to be used as a means to reduce separation distances where approved by the AHJ under the authority as granted by Section 1.5.

**10.4.2.2.5**

**Required Separation Distance for All Systems.**

Separation distances shall be required for bulk hydrogen compressed gas systems independent of system pressure or internal diameter of piping systems in accordance with 10.4.2.2.5.1 through 10.4.2.2.5.3.

**10.4.2.2.5.1**

Unloading connections on delivery equipment shall not be positioned closer to any of the exposures cited in Table 10.4.2.2.1(a), Table 10.4.2.2.1(b), or Table 10.4.2.2.1(c) than the distances given for the storage system.

**10.4.2.2.5.2**

The minimum separation distance between gaseous and liquid systems integrated into a single system where the liquid source is vaporized, compressed, and stored in the gaseous state shall be 15 ft (4.6 m).

**10.4.2.2.5.3**

Systems within 50 ft (15 m) of aboveground storage of all classes of flammable and combustible liquids shall 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.
Bulk hydrogen compressed gas systems shall be allowed to integrate or co-locate other nonliquefied flammable gas systems as a component of the hydrogen gas system without separation, where the output of the system is designed to deliver a product in which the gases are mixed or blended for delivery into the user's system.

**10.4.2.6.1**

The following provisions shall apply in order to allow adjacent storage:

1. The tubes shall be designed, built, and stamped in accordance with the ASME *Boiler and Pressure Vessel Code*, Section VIII, Division 1 or approved by the DOT or the TC for use as an exempted compressed gas shipping container.

2. Hydrogen manifolds shall be designed and tested in accordance with ASME B31.12, *Hydrogen Piping and Pipelines*, to ensure initial leaktightness. Other gas manifolds shall be designed and tested in accordance with ASME B31.3, *Process Piping*.

3. Pressure relief devices protecting storage vessels excluding cylinders with a water volume less than 20 ft$^3$ (566 L) shall meet design requirements and be piped to a vent system that has been designed and installed in accordance with CGA G-5.5, *Hydrogen Vent Systems*.

4. Where systems are provided with an emergency shutdown device, the device shall be common to all the co-located flammable gases. An event that causes the shutdown or isolation of the hydrogen system shall simultaneously shut down or isolate the other flammable gas system.

**10.4.3 Underground Bulk Hydrogen Compressed Gas Systems.**

**10.4.3.1 Underground Systems.**

Bulk hydrogen compressed gas systems installed underground where compressed gas containers are to be buried in contact with earth or fill shall be in accordance with 10.4.3.1.

**10.4.3.1.1 Design.**

Pressure compressed gas containers installed underground using burial methods shall be of seamless construction in accordance with Part UF or Appendix 22 of the ASME *Boiler and Pressure Vessel Code*, Section VIII, Division 1.

**10.4.3.1.1.1**

Compressed gas containers shall be designed to include cyclic pressure life calculations using fracture mechanics methods.

**10.4.3.1.2 Compressed Gas Container Examination.**

(A) Compressed gas containers shall be examined for internal and external surface flaws and inclusions before burial or at the time of manufacture.

(B) Compressed gas containers with flaws or inclusions exceeding the lesser of 5 percent of the wall thickness or 0.12 in. (3 mm) shall not be used.

**10.4.3.1.2 Composite Containers. (Reserved)**

**10.4.3.1.3 Corrosion Protection.**

Compressed gas containers and underground piping shall be protected from corrosion in accordance with 7.1.10.9, 7.1.15, or 7.1.17 as applicable.

**10.4.3.1.4 Outlet Connections.**

Threaded compressed gas container outlet connections shall be designed with primary and secondary seals that shall be tested for functionality.

**10.4.3.1.4.2**

The seal design shall include a method of detecting a leak in the primary seal.

**10.4.3.1.5 Piping Systems.**

**10.4.3.1.5.1**

Joints in the piping system shall be installed and inspected in accordance with the requirements of ASME B31.12, *Hydrogen Piping and Pipelines*, or other approved standards.

**10.4.3.1.5.2**

Valves, controls, safety devices, and instrumentation shall be above ground and accessible to authorized personnel.

**10.4.3.1.6 Location.**
Compressed gas containers shall be located in accordance with 10.4.3.1.6.1 through 10.4.3.1.6.6.

10.4.3.1.6.1
Underground compressed gas containers shall not be located beneath buildings.

10.4.3.1.6.2
Compressed gas containers and associated equipment shall be located with respect to foundations and supports of other structures such that the loads carried by such structures cannot be transmitted to the tank.

10.4.3.1.6.3
The distance from any part of the compressed gas container to the nearest wall of a basement, pit, cellar, or lot line shall not be less than 10 ft (3.1 m).

10.4.3.1.6.4
A structure or foundation of a structure on the same property shall not be erected or constructed within 10 ft (3.1 m) of any point on the container surface, unless the footings extend to the bottom of the container or the container’s foundation.

10.4.3.1.6.5
A minimum distance of 1 ft (0.3 m), shell to shell, shall be maintained between adjacent underground containers.

10.4.3.1.6.6*
A minimum distance of 3 ft (0.9 m) shall be maintained between compressed gas containers and buried utilities.

10.4.3.1.7 Foundations.
Underground compressed gas containers shall be set on foundations constructed in accordance with the building code, and surrounded with not less than 6 in. (152 mm) of noncorrosive inert material.

10.4.3.1.7.1
The concrete shall extend a minimum of 1 ft (0.3 m) horizontally beyond the footprint of the tank in all directions.

10.4.3.1.8 Depth, Cover, and Fill.
Containers shall be buried such that the top of the container is covered with a minimum of 1 ft (0.3 m) of earth and with concrete a minimum of 4 in. (101 mm) thick placed over the earthen cover.

10.4.3.1.9* Anchorage and Security.
Compressed gas containers installed underground in flood hazard areas shall be anchored to prevent flotation, collapse, or lateral movement resulting from hydrostatic loads, including the effects of buoyancy, during conditions of the design flood.

10.4.3.1.10 Venting of Underground Compressed Gas Containers.
Vent pipes for underground compressed gas containers shall be in accordance with 10.2.2.

10.4.3.1.11 Overfill Protection and Prevention Systems.
An approved means or method shall be provided to prevent the overfilling of the storage containers.

10.4.3.1.12 Physical Protection.
Piping and control equipment ancillary to underground containers that is located above ground shall be protected from physical damage in accordance with 7.1.8.3.

10.4.4 Installation in Vaults Above and Below Ground. (Reserved)

10.4.5 Indoor Bulk Hydrogen Compressed Gas Systems.

10.4.5.1 General.
10.4.5.1.1
The location of bulk hydrogen compressed gas systems shall be in accordance with Table 10.4.5.1.1.

<table>
<thead>
<tr>
<th>Quantity of Hydrogen</th>
<th>Location</th>
<th>A</th>
<th>NA</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥5000 to &lt;15,000 scf</td>
<td>In a detached building</td>
<td>A</td>
<td>Detached building required</td>
</tr>
<tr>
<td></td>
<td>In a gas room, in accordance with Section 6.4</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>≥15,000 scf</td>
<td>Not in a gas room</td>
<td>NA</td>
<td>Detached building required</td>
</tr>
</tbody>
</table>

A: Allowed. NA: Not allowed.

10.4.5.1.2* Fire Protection.
Fire protection shall be in accordance with the requirements of Section 6.10.

10.4.5.2 Detached Buildings.
10.4.5.2.1 Detached buildings shall be constructed of noncombustible or limited-combustible materials in accordance with the requirements of Section 6.5.

10.4.5.2.2 Ventilation shall be provided in accordance with the requirements of Section 6.16.
10.4.5.2.2.1 Outlet openings shall be located at the high point of the room in exterior walls or the roof.

10.4.5.2.2.2 Inlet and outlet openings shall each have a minimum total area of 1 ft²/1000 ft³ (1 m²/305 m³) of room volume.

10.4.5.2.2.3 Discharge from outlet openings shall be directed or conducted to the atmosphere.

10.4.5.2.3* Explosion control shall be provided in accordance with the requirements of Section 6.9.

10.4.5.2.4 Electrical equipment shall be in accordance with Article 501 of NFPA 70 for Class I, Division 2 locations.

10.4.5.2.5 Heating, if provided, shall be by steam, hot water, or other indirect means except that electrical heating shall be permitted to be used if in compliance with 10.4.5.2.4.

10.4.5.3 Hydrogen Gas Rooms.
10.4.5.3.1 Floors, walls, and ceilings shall be constructed of noncombustible or limited-combustible materials in accordance with the requirements of the building code.
10.4.5.3.1.1 Interior walls or partitions shall have a fire resistance rating of not less than 2 hours, shall be continuous from floor to ceiling, and shall be anchored to resist movement.

10.4.5.3.1.2 Not less than 25 percent of the perimeter wall shall be an exterior wall.

10.4.5.3.1.3 Openings to other parts of the building shall not be permitted.

10.4.5.3.1.4 Windows and doors shall be in exterior walls only.

10.4.5.3.2 Ventilation shall be as provided in Section 6.16.

10.4.5.3.3 Explosion control shall be provided in accordance with the requirements of Section 6.9.
10.4.5.3.4
There shall be no sources of ignition from open flames, electrical equipment, or heating equipment.

10.4.5.3.5
Electrical equipment shall be in accordance with Article 501 of NFPA 70, for Class I, Division 2 locations.

10.4.5.3.6
Heating, if provided, shall be by steam, hot water, or indirect means except that electrical heating shall be permitted to be used if in compliance with 10.4.5.3.5.

10.4.6  Security.

10.4.6.1*
User storage sites shall be fenced or otherwise secured and posted to prevent entry by unauthorized personnel.

10.4.6.2
Administrative controls shall be allowed to be used to control access to individual storage, use, and handling areas located in secure facilities not accessible by the general public.

10.4.6.3
At least two means of egress shall be provided from any fenced area.

Submitter Information Verification

Submitter Full Name: Susan Bershad
Organization: National Fire Protection Assoc
Street Address:  
City:  
State:  
Zip:  
Submittal Date: Wed Aug 06 10:54:55 EDT 2014

Committee Statement

Committee Statement: Partial response to PC-37. This is the reorganization of Chapters 7 and 10. 10.4 and 10.4.1 are a title and charging statement for 10.4.
### Second Revision No. 39-NFPA 55-2014 [ New Section after 10.2.8.9 ]

10.2.7

Emergency isolation shall comply with the requirements in **7.3.1.12**.

### Submitter Information Verification

<table>
<thead>
<tr>
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<th>[ Not Specified ]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organization:</td>
<td>[ Not Specified ]</td>
</tr>
</tbody>
</table>

### Committee Statement

**Committee Statement:**

FR 19 received several negative comments during the First Draft Ballot, specifically in regard to removing the requirement for excess flow valves for Flammability Class 4. This Public Comment addresses the concerns in the negative comment, and provides a degree of latitude in providing means of Emergency Isolation in 55:7.3.1.12.

**Response Message:**

Public Comment No. 26-NFPA 55-2014 [New Section after 10.2.8.9]
11.1.1
The storage, use, and handling of bulk liquefied hydrogen in liquefied hydrogen storage systems shall be in accordance with the provisions of Chapters 1 through 6 and Chapters 8 and 11 as applicable.

Submitter Information Verification

Submitter Full Name: [ Not Specified ]
Organization: [ Not Specified ]
Street Address: [ Not Specified ]
City: [ Not Specified ]
State: [ Not Specified ]
Zip: [ Not Specified ]
Submittal Date: Tue Jul 15 13:59:31 MDT 2014

Committee Statement

Committee Statement: This restores the text to be per the 2013 edition. Chapter 7 should not be omitted as there could be portions of the system to which these requirements apply.
Response Message:
Public Comment No. 52-NFPA 55-2014 [Section No. 11.1.1]
11.2.6.2 Specific locations for Class 1, Division 1, Group B (hydrogen) and Class 1, Division 2, Group B (hydrogen) areas shall be in accordance with Table 11.2.6.2.

Table 11.2.6.2 Electrical Area Classification

<table>
<thead>
<tr>
<th>Location</th>
<th>Division</th>
<th>Extent of Classified Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>The bulk liquefied hydrogen system fill connection, pressure relief</td>
<td>1</td>
<td>Within 3 ft (1 m) in the horizontal plane measured vertically spherically from system fill</td>
</tr>
<tr>
<td>outlet(s), or other points on the system where hydrogen is vented to</td>
<td></td>
<td>connection, system pressure relief vent outlets, or other points of release when the</td>
</tr>
<tr>
<td>the atmosphere under the designed operating conditions</td>
<td></td>
<td>system is operating as designed.</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Between 3 ft (1 m) and 25 ft (7.6 m) in the horizontal plane measured vertically</td>
</tr>
<tr>
<td></td>
<td></td>
<td>spherically from the system fill connection, any vent outlet, and within 25 ft (7.6 m)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>of any portion of the bulk supply system that contains liquefied hydrogen.</td>
</tr>
</tbody>
</table>

Supplemental Information

File Name: 55-Table_11_2_6_2_for_SR_48.docx

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Tue Jul 15 14:00:51 MDT 2014

Committee Statement

Committee Statement: To be consistent with the approach taken for gaseous hydrogen in Chapter 10.
Response Message: Public Comment No. 43-NFPA 55-2014 [Section No. 11.2.6.2]
<table>
<thead>
<tr>
<th>Location</th>
<th>Division</th>
<th>Extent of Classified Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>The bulk liquefied hydrogen system fill connection, pressure relief vent</td>
<td></td>
<td>Within 3 ft (1 m) in the horizontal plane measured vertically spherically from system fill connection, system pressure relief vent outlets, or other points of release when the system is operating as designed.</td>
</tr>
<tr>
<td>or other points on the system where hydrogen is vented to the atmosphere</td>
<td>1</td>
<td>Between 3 ft (1 m) and 25 ft (7.6 m) in the horizontal plane measured spherically vertically from the system fill connection, any vent outlet, and within 25 ft (7.6 m) of any portion of the bulk supply system that contains liquefied hydrogen.</td>
</tr>
</tbody>
</table>
11.2.9 Emergency Shutdown System.

An emergency shutdown system shall be provided at the bulk source to stop the flow of liquid and gas into the use line when actuated.

11.2.9.1 Emergency isolation shall comply with the requirements in 7.3.1.12.1, 11.2.4.2, and 11.2.9.

11.2.9.2 An emergency shutdown system shall be provided at the bulk source to stop the flow of liquid and gas into the use line when actuated.

11.2.9.3 The ESD system shall be operated by a remotely located, manually activated shutdown control located not less than 15 ft (4.5 m) from the source of supply.

11.2.9.4 Reactivation of the ESD system after ESD shall require that the ESD system be manually reset.

11.2.9.5 The ESD system shall be identified by means of a sign.

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jul 15 10:27:52 MDT 2014

Committee Statement

Committee Statement: FR 19 received several negative comments during the First Draft Ballot, specifically in regard to removing the requirement for excess flow valves for Flammability Class 4. This Public Comment addresses the concerns in the negative comment, and provides a degree of latitude in providing means of Emergency Isolation in 55:7.3.1.12.

Response Message:
Public Comment No. 25-NFPA 55-2014 [Section No. 11.2.9]
15.3.9.1.1
An automatic deluge sprinkler system shall be provided for MATS fire areas used as indoor and outdoor charging and discharging stations.

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jul 14 12:41:16 MDT 2014

Committee Statement

Committee Statement: This change should be global throughout the document. A deluge sprinkler system is inherently designed for automatic operation. See Definition NFPA 13 3.4.4: NFPA 13-13 3.4.4 Deluge Sprinkler System. A sprinkler system employing open sprinklers or nozzles that are attached to a piping system that is connected to a water supply through a valve that is opened by the operation of a detection system installed in the same areas as the sprinklers or the nozzles. When this valve opens, water flows into the piping system and discharges from all sprinklers or nozzles attached thereto.

Response Message:
Public Comment No. 11-NFPA 55-2014 [Section No. 15.3.9.1.1]
15.3.9.1.2*
Automatic deluge sprinkler systems shall be designed in accordance with the requirements of NFPA 13 using the Extra Hazard Group 1 density curve/area with a minimum design area of 2500 ft² for the entire MATS fire area.

Supplemental Information

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Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address: 
City: 
State: 
Zip: 
Submittal Date: Mon Jul 14 12:47:50 MDT 2014

Committee Statement

Committee Statement: Per NFPA 13 22.10.1.1.
Response Message: Public Comment No. 12-NFPA 55-2014 [Section No. 15.3.9.1.2]
15.3.9.1.2*
Automatic deluge sprinkler systems shall be designed in accordance with the requirements of NFPA 13 using the Extra Hazard Group 1 with a minimum design area of 2500 ft² density curve/area for the entire MATS fire area.
15.3.9.1.3.1*
The manual pull station shall be distinctive from the standard fire alarm system manual pull stations if provided. It shall be identified as being for the MATS deluge system, positioned for use in an emergency, and marked with a sign that reads:

ACETYLENE TRAILER WATER DELUGE SYSTEM

(A)
The manual pull station shall be identified as being for the MATS deluge system and marked with a sign stating as such.

(B)
The manual pull station shall be positioned for use in an emergency.

Supplemental Information

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Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jul 14 12:55:06 MDT 2014

Committee Statement

Committee Statement: It is not necessary to specify the actual sign wording as a requirement; it can be included in the Annex for informational purposes.

Response Message:

Public Comment No. 13-NFPA 55-2014 [Section No. 15.3.9.1.3.1]
Public Comment No. 14-NFPA 55-2014 [New Section after A.15.3.10]
A.15.3.9.1.3.1

The sign may read: ACETYLENE TRAILER WATER DELUGE SYSTEM or similar wording to identify the pull/activation station is specifically for MATS.
15.3.9.1.3.1
The manual pull station shall be distinctive from the standard fire alarm system manual pull stations if provided. It shall be identified as being for the MATS deluge system, positioned for use in an emergency, and marked with a sign that reads: ACETYLENE TRAILER WATER DELUGE SYSTEM

(A)

- The manual pull stations shall be identified as being for the MATS deluge system and marked with a sign stating as such.

(B)

The manual pull station shall be positioned for use in an emergency.
Second Revision No. 31-NFPA 55-2014 [Section No. 15.3.9.1.4]

15.3.9.1.4
Adjacent MATS fire areas shall be separated by at least 30 ft (9.1 m) of clear distance with no intervening combustibles or, if such physical separation is not possible, in accordance with either 15.3.9.1.4.1 or 15.3.9.1.4.2.

15.3.9.1.4.1
The adjacent MATS fire areas shall be protected as a single MATS fire area in accordance with 15.3.9.1.3.

15.3.9.1.4.2
The adjacent MATS fire areas shall be separated by a 2-hr fire rated barrier with no openings and each MATS fire area protected in accordance with 15.3.9.1.3 separately.

Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jul 14 12:57:01 MDT 2014

Committee Statement

Committee Statement: All added information, 15.3.9.1.4, 15.3.9.1.4.1 and 15.3.9.1.4.2, is already included in 15.2.2.

Response Message:
Public Comment No. 15-NFPA 55-2014 [Section No. 15.3.9.1.4]
15.3.9.1.4.1
The requirements of 15.3.9.1.1 and 15.3.9.1.2 and 15.3.9.1.3 shall not apply to existing indoor or outdoor facilities, equipment, structures, or other installations where MATS are charged or discharged that existed or were approved for construction or installation prior to the effective date of this code, providing the MATS fire area is protected with an automatic sprinkler or deluge system with a minimum design density of not less than 0.25 gpm/ft² (10.1 L/min/m²).

Supplemental Information

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Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jul 14 12:59:47 MDT 2014

Committee Statement

Committee Statement: Exemption needs to be given for section 15.3.9.1.2 which gives the requirement of 0.3 gpm/ft², AND 15.3.9.1.3, which gives the fast acting detection system requirement. Both sections do not apply to existing systems since there are other means of fire detection system and automatic activation of deluge system already existing in old installations. Additionally, current existing systems in the industry include both sprinkler and deluge systems designed based on NFPA 51A requirements.

Response Message:
Public Comment No. 16-NFPA 55-2014 [Section No. 15.3.9.1.5.1]
15.3.9.1.5.1

The requirements of 15.3.9.1.1, 15.3.9.1.2, and 15.3.9.1.3 shall not apply to existing indoor or outdoor facilities, equipment, structures, or other installations where MATS are charged or discharged that existed or were approved for construction or installation prior to the effective date of this code, providing the MATS fire area is protected with an automatic sprinkler or deluge system with a minimum design density of not less than 0.25 gpm/ft² (10.1 L/min/m²).
Buildings or portions thereof, other than MATS, required to comply with protection level controls shall be protected by an approved automatic sprinkler system in accordance with Section 6.10.

Supplemental Information

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Submitter Information

Submitter Full Name: [ Not Specified ]
Organization: [ Not Specified ]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jul 14 13:05:11 MDT 2014

Committee Statement

Committee Statement: To exclude MATS from the requirements of 6.10 since section 15.3.9.1 covers MATS fire protection systems. The committee made minor editorial changes for clarity.
Response Message: Public Comment No. 29-NFPA 55-2014 [Section No. 15.3.9.2 [Excluding any Sub-Sections]]
15.3.9.2 Indoor Areas.

Buildings or portions thereof, other than MATS, required to comply with protection level controls shall be protected by an approved automatic sprinkler system in accordance with Section 6.10.
15.3.9.2.1.1
In areas where automatic sprinklers are otherwise required but prohibited by 15.3.9.2.1, the following additional requirements shall apply:

(1) An approved automatic fire detection system shall be installed, or

(2) An alternative automatic fire extinguishing system shall be installed

Supplemental Information

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Submitter Information Verification

Submitter Full Name: [Not Specified]
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jul 14 13:17:38 MDT 2014

Committee Statement

Committee Statement:
The original proposal made the items either or. Only one item need be provided. The term "or" was inadvertently left out in the draft.

Response Message:
Public Comment No. 2-NFPA 55-2014 [Section No. 15.3.9.2.1.1]
15.3.9.2.1.1

In areas where automatic sprinklers are otherwise required but prohibited by 15.3.9.2.1, the following additional requirements shall apply:

(1) An approved automatic fire detection system shall be installed, or
(2) An alternative automatic fire extinguishing system shall be installed.
Chapter 16 Liquid Nitrous Oxide Systems (Reserved)

16.1 General (Reserved)
The storage, use, and handling of liquid nitrous oxide in bulk systems shall be in accordance with the
provisions of this chapter and Chapters 1 through 8 as applicable.

16.1.1 Application
A bulk nitrous oxide system used in medical gas applications shall be in accordance with NFPA 99 in
addition to the provisions stated herein.
16.2 Location of Bulk Nitrous Oxide Systems (Reserved)
Bulk nitrous oxide systems shall be located in accordance with one of the following:

1. Above ground and outdoors in accordance with Table 16.2
2. Indoors or in courts in accordance with the following requirements:
   
   a. The pressure relief valve shall be sized for indoor installation and for possible engulfment in fire in accordance with the provisions of CGA S-1.3, *Pressure Relief Device Standards – Part 3 – Stationary Storage Containers for Compressed Gases*.
   
   b. All relief devices shall be vented outdoors to a location with sufficient ventilation to prevent the accumulation of nitrous oxide and to eliminate the hazard of asphyxiation.
   
   c. The minimum separation distances of the outlet of relief device vent piping from exposures in 16.2(2)(b) shall meet the requirements of Table 16.2.
   
   d. All relief devices and vents for installations in courts as defined in 3.3.27 shall be piped outdoors to a safe, well-ventilated area, and the area around the container shall be ventilated in accordance with Section 6.16.

Table 16.2 Minimum Separation Distance Between Outdoor Stationary Insulated Liquid Nitrous Oxide Containers and Exposures

<table>
<thead>
<tr>
<th>Exposure</th>
<th>Minimum Distance</th>
</tr>
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<tbody>
<tr>
<td>(1) Buildings of Types I and II construction as defined by the building code</td>
<td>1 ft, .3 m</td>
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<tr>
<td>(6) Public assembly</td>
<td>50 ft, 15 m</td>
</tr>
<tr>
<td>(7) Areas occupied by nonambulatory patients as measured from the primary pressure relief device discharge vent and from filling and vent connections</td>
<td>50 ft, 15 m</td>
</tr>
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<tr>
<td>(9) Exterior walls that encroach on the container to form a court with three or more sides. (See 8.13.2.7.)</td>
<td></td>
</tr>
<tr>
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<td></td>
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<tr>
<td>(a) 0 gal to 1000 gal (0 L to 3785 L)</td>
<td>25 ft, 7.5 m</td>
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<td>50 ft, 15 m</td>
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<td>(11) All classes of flammable and combustible liquids in belowground tanks or vaults</td>
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</tr>
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<td>(a) Horizontal distance from nitrous oxide storage container to tank or vault</td>
<td>15 ft, 4.6 m</td>
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<td>(b) Horizontal distance from nitrous oxide storage container to filling and vent connections or other openings to tank or vault</td>
<td>25 ft, 7.5 m</td>
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<td>(12) Flammable gases above ground</td>
<td></td>
</tr>
<tr>
<td>(a) Liquefied hydrogen (any quantity)</td>
<td>75 ft, 22.5 m</td>
</tr>
<tr>
<td>(b) Flammable liquefied gases not exceeding 1000 gal (3.78 m$^3$) or dissolved or nonliquefied gases not exceeding 25,000 ft$^3$ (693 m$^3$) at reference conditions</td>
<td>25 ft, 7.5 m</td>
</tr>
<tr>
<td>(c) Flammable gases or liquids at capacities greater than those given in 12(b)</td>
<td>50 ft, 15.2 m</td>
</tr>
<tr>
<td>(13) Rapidly burning solids including, but not limited to, excelsior, paper, or combustible waste</td>
<td>50 ft, 15 m</td>
</tr>
</tbody>
</table>
(14) Slowly burning solids including, but not limited to, heavy timber or coal  
(15) Horizontal distance from the vertical plane below the nearest overhead electrical wire

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<td>Horizontal distance from the vertical plane below the nearest overhead electrical wire</td>
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16.3* Container Design. (Reserved)

Storage vessels shall be designed, constructed, and tested in accordance with the appropriate requirements of the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, Rules for Construction of Pressure Vessels.

16.3.1 Pressure Relief Devices.

16.3.1.1 Containers used for liquid nitrous oxide shall be equipped with pressure relief devices piped from the uppermost part of the containers and communicating with the vapor space.

16.3.1.2 Containers shall have pressure relief devices designed and provided in accordance with CGA S-1.3, Pressure Relief Device Standards — Part 3 — Stationary Storage Containers for Compressed Gases, for stationary tanks.

16.3.1.3 Relief valves shall be sized, operated, and maintained per 7.1.5.5.

16.3.1.3.1 Each bulk tank shall have a minimum of two active safety relief devices sized per CGA S-1.3.

16.3.1.3.2 The relief valve system shall be designed to meet the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, Rules for Construction of Pressure Vessels requirements to allow for proper maintenance and servicing of the devices.

16.3.1.3.3 Non-reclosing relief devices shall not be used in nitrous oxide bulk tank service.

16.3.1.4 Pressure relief devices shall be located to minimize tampering, damage, and obstruction to flow.

16.3.1.5 The inlet and outlet of the relief devices shall not be blocked by a valve or plug during normal operation.

16.3.1.6 Vent Pipe Systems.

16.3.1.6.1 Pressure relief devices shall be piped to the outdoors where the discharge will not impinge on the structure, the personnel, or the means of egress and will not create a hazardous concentration of nitrous oxide.

16.3.1.6.2 Vent piping systems serving pressure relief devices shall be protected from water intrusion to prevent moisture or solid nitrous oxide from collecting and freezing and interfering with the operation of the pressure relief device.

16.3.1.6.3 Vent piping systems serving pressure relief devices shall be designed to prevent backflow restrictions exceeding 10 percent backpressure on the pressure relief device under full flow conditions.

16.3.2 Pressure Level Indicators and Fill Connections.

Containers shall be provided with a pressure gauge and a contents level gauge or other device capable of indicating the quantity of liquid nitrous oxide.

16.3.2.1 These devices shall be designed for the temperatures and pressures associated with liquid nitrous oxide service.

16.3.2.2 Where containers are in locations remote from the filling connection, a means to determine whether the containers have been filled to their design capacity shall be provided.
16.3.2.2.1
The liquid and vapor fill connections shall comply with CGA V-6, *Standard Bulk Refrigerated Liquid Transfer Connections*.

16.3.2.2.2
Dust covers and caps shall be provided for the fill connections to prevent contaminant infiltration.

16.3.2.2.3
The liquid fill connection shall be CGA N2O-15, and the vapor return connections shall be CGA N2O-10.

16.3.3 Insulation.

16.3.3.1
Insulated bulk liquid containers shall be vacuum insulated or mechanically insulated with an external vapor barrier.

16.3.3.2
Exposed insulating materials shall be noncombustible.

16.3.3.3*
Insulation such as polyurethane foam having a flame spread rating of 25 or less shall be permitted to be used if fully covered with a protective metal or other noncombustible jacket.

16.3.3.3.1
Non-vacuum-insulated tanks shall have an internal cooling coil operated with refrigerant to maintain nitrous oxide as a liquefied gas.

16.3.3.3.2*
The refrigerant shall not be allowed to come in contact with the nitrous oxide.

16.4 Container Installation.

16.4.1 Foundations and Supports.

16.4.1.1
Foundations shall be designed to withstand soil and frost conditions as well as any anticipated seismic, snow, wind, or hydrostatic loading under operating conditions.

16.4.1.2
Stationary containers shall be provided with noncombustible concrete or masonry foundations or structural steel supports on firm concrete or masonry foundations.

16.4.2
Containers shall be located so there is no fire or open flame within 25 ft (7.6 m) (see Table 16.2).

16.4.3
A concrete or noncombustible delivery vehicle unloading spill pad shall be provided.

16.4.3.1
The unloading spill pad shall be kept free of grease and oil or other hydrocarbons.

16.4.3.2
The unloading spill pad shall have minimum dimensions of 12 ft × 12 ft (3.6 m × 3.6 m).

16.4.4 Fire Barrier Walls.

16.4.4.1
The distances shown in items 2, 4, 5, 8, and 10 through 14 of Table 16.2 shall not apply where a fire barrier wall having a minimum fire resistance of 2 hours interrupts the line of sight between uninsulated portions of the bulk storage system and the exposure.

16.4.4.2
Fire barrier walls shall comply with the requirements of 8.7.2.1.1 through 8.7.2.1.5.

16.4.5* Security.

16.4.5.1
Nitrous oxide containers and systems shall limit access to authorized personnel only.

16.4.5.2
Locations shall be locked when not attended by authorized personnel.

16.4.5.3
Perimeter security shall have a minimum height of 6 ft (1.8 m) and lockable gates.

16.4.5.3.1*
A warning sign shall be installed to indicate the hazards of nitrous oxide on the perimeter security enclosure so it can be easily seen by anyone approaching the enclosure.
16.4.5.3 Enclosures shall be designed so as not to restrict or reduce natural air flow.

16.4.5.4 Bollards or barriers shall be used to prevent unauthorized vehicle intrusion in accordance with Section 4.11.

16.4.5.5 Area lighting shall be provided to provide night security and to facilitate night deliveries and maintenance.

16.5 Materials of Construction. (Reserved)

16.5.1 Materials in contact with nitrous oxide shall be suitable for the full range of temperatures and pressures to which they shall be subjected during operation.

16.5.2 Nonmetals.

16.5.2.1 Nonmetallic materials shall be compatible with nitrous oxide and shall be used only as required.

16.5.2.2 Nonmetallic materials used at pressures greater than 435 psi (3000 kPa) shall conform to CGA G-4.10, Design Considerations to Mitigate the Potential Risks of Toxicity When Using Nonmetallic Materials in High Pressure Oxygen Breathing Gas Systems.

16.5.3 Piping Systems.

16.5.3.1 Piping and tubing shall conform to ANSI B31.3, Standard Code for Chemical Plant and Petroleum Refinery Piping.

16.5.3.2 Nitrous oxide piping shall be located and supported to protect against damage from strain on piping and fittings, the effects of expansion, contraction, and vibration; mechanical damage; and heat sources.

16.5.3.3 Piping, tubing, and hoses and fittings shall be designed to a bursting pressure of at least 4 times the system design pressure.

16.5.4 Pressure Relief Devices.

16.5.4.1 Piping systems shall be protected by a pressure relief device set to function at no greater than 50 percent over the normal operating pressure of the system.

16.5.4.2 All pressure relief devices shall discharge outside in a well-ventilated area.

16.5.4.2.1 Pressure relief devices shall be installed so rain and condensation do not accumulate in the device.

16.5.4.2.2 Pressure relief devices shall be positioned so they will not injure people in the vicinity where they discharge.

16.5.4.3 Vaporizers and Heaters. (Reserved)

16.6.1 Vaporizers and heaters shall use only indirect means of heating such as steam, air, vapor, or other nonreactive materials such as solids or liquids.

16.6.2 The heating medium for nitrous oxide vaporizers shall be limited to 300°F (149°C).

16.6.3 Electric Vaporizers and Heaters.

16.6.3.1 Direct-contact electric heater elements shall not be permitted.

16.6.3.2 Electric vaporizers shall be electrically grounded.

16.7 Pumps. (Reserved)

16.7.1 Pump design and installation shall avoid sources of heat or sparks that could lead to an ignition or initiate a decomposition reaction.
16.7.2
Pump bearings shall not be lubricated with nitrous oxide.

16.7.3
Material combinations of moving and stationary parts shall be selected to ensure a low probability of ignition or spark generation.

16.7.4
The pump shall be separated from the pump motor or power source by an open air space.

16.7.5* Dry Run Protection.

16.7.5.1
Pump control systems shall have an interlock that authorizes operation only after the pump has been properly cooled down and filled with liquid.

16.7.5.2
The pump shutdown system shall be actuated by one or more of the following:

(1) Abnormal differential pressure
(2) Elevated temperature
(3) High motor current
(4) A suitable liquid flow measuring device

16.8 Strainers/Filter and Filters.

16.8.1
Strainers or filters shall be installed to prevent the migration of particles within specific devices (e.g., compressors, pumps).

16.8.2
Gaseous nitrous oxide shall be filtered using mesh sizes 30–100 (500–150 µm).

16.8.3
Mesh filters or strainers made from high nickel alloys such as Monel™, Inconel™, nickel 200 alloys, or high copper alloys, such as brass, shall be permitted because of their increased resistance to oxidizer fires.

16.8.3.1
Glue or other combustibles shall not be permitted to be used at pressures greater than 145 psi (1000 kPa).

16.9 Flow Meters.

16.9.1* Thermal mass flow meters with exposed heater elements shall not be used.

16.10 Cleaning.

16.10.1 Equipment used in a bulk nitrous oxide system shall be cleaned in accordance with the requirements of CGA G-4.1, Cleaning Equipment for Oxygen Service, to remove oil, grease, solvents, particulates, or other oxidizable materials before the system is placed in service.

16.10.2
Lubricants that can come in contact with nitrous oxide shall be oxygen compatible.

16.10.3
Carbon dioxide equipment shall not be used in nitrous oxide service unless a conversion process has been followed for the change of service.

16.10.3.1
Any conversion shall consider design, materials of construction, insulation, cleanliness, lubricants, seals, and potential contact with high temperatures in accordance with 16.6.2.

16.11 Maintenance Procedures.

16.11.1 Nitrous oxide equipment shall be maintained by qualified and properly trained personnel in a routine, controlled, and safe manner following written procedures.

16.11.2 Hot Work.
16.11.2.1  
A hot work permit shall be issued and approved by a person knowledgeable in the properties of nitrous oxide for welding or other hot work.

16.11.2.2  
The system shall be purged with air or inert gas prior to welding or other hot work.

16.11.2.3  
Hot work shall not be performed on any equipment containing nitrous oxide, and all equipment shall be purged with an inert gas or air prior to hot work.

16.11.2.3.1  
Medical installations shall be purged with medically certified inert gases prior to any hot work to prevent the formation of oxides.

16.11.2.4  
It shall not be permitted to weld, braze, or strike an arc on any pipe, cylinder, or vessel that contains nitrous oxide.

16.11.2.5  
Heat from an open flame or a hot air gun shall not be applied to any part of a nitrous oxide installation to de-ice or release threaded couplings.

16.11.2.6  
Hot work shall not be performed within 3 ft (1 m) of a section of piping that contains nitrous oxide.

16.12  Small Insulated Liquid Nitrous Oxide Indoor Systems. (Reserved)

### Supplemental Information

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<th>Description</th>
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<td>G55-40.jpg</td>
<td>Fig A.16.4.5.3.1</td>
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<td>G55-42.jpg</td>
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<td>NFPA_55_Proposed_Chapter_16-Final-clean.docx</td>
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### Submitter Information Verification

- **Submitter Full Name:** [Not Specified]
- **Organization:** [Not Specified]
- **Street Address:**
- **City:**
- **State:**
- **Zip:**
- **Submittal Date:** Mon Jul 14 13:49:08 MDT 2014

### Committee Statement

- **Committee Statement:** There is no material specific guidance in NFPA 55 regarding nitrous oxide installations. This chapter reflects information found in CGA documents and represents industry consensus for the safe handling of liquid nitrous oxide. The CGA language is not enforceable. Making this material part of NFPA 55 makes these requirements part of enforceable code.

- **Response Message:**
  - Public Comment No. 30-NFPA 55-2014 [Chapter 16]
A.16.3

A typical piping and instrumentation diagram for a nitrous oxide vacuum-insulated system is shown in Figure A.16.3.

![Typical Piping and Instrumentation Diagram of a Nitrous Oxide Vacuum-Insulated Stationary Tank](image)

**Figure A.16.3  Typical Piping and Instrumentation Diagram of a Nitrous Oxide Vacuum-Insulated Stationary Tank.**

A.16.3.1.3.2

Typical installations use a 3-way diverter valve similar to HV12 in Figure A.16.3. This allows routine maintenance and replacement of safety relief devices without requiring the tank to be removed from normal service. To meet the requirements of CGA S-1.3, *Pressure Relief Device Standards — Part 3 — Stationary Storage Containers for Compressed Gases*, HV15 shall be secured in the open position to provide a second relief device that is active at all times, unless the tank has two active relief devices at all times.
A16.3.1.3.3

Non-reclosing relief devices such as rupture discs should not be used in nitrous oxide service because the liquid will autorefrigerate to \(-127.4^\circ F (-88.56^\circ C)\) if depressurized to atmospheric pressure. In higher altitude locations, it is possible to form solid nitrous oxide at atmospheric pressure that could create plugs in liquid piping that could trap pressure. Many nitrous oxide containers have minimum design metal temperatures (MDMT) in the \(-20^\circ F \text{ to } -40^\circ F \text{ (}-28.8^\circ C \text{ to } -40^\circ C\) range, which could potentially cause embrittlement of the pressure vessel.

A.16.3.2.2

Nitrous oxide tanks typically require a two-hose fill. Where the vapor return line is not designed as a calibrated dip tube to act as a full trycock, there should be a dedicated full trycock connection that allows the person filling the container to determine when the container has been filled to its design capacity.

A.16.3.3.3


A.16.3.3.3.2

Typical refrigerants used in mechanical refrigeration systems are hydrocarbon based and also circulate hydrocarbon compressor lubricants. Nitrous oxide is an oxidizer and should not be allowed to mix with the refrigerants. The refrigeration system should have a high-pressure shutoff switch with a manual reset to stop the system from restarting automatically. The bulk nitrous oxide system pressure is higher than that of the evaporator of the refrigeration system. If a leak develops in the refrigeration coil, nitrous oxide could contaminate the refrigeration system, mixing an oxidizer with hydrocarbons. If not properly diagnosed, this could cause the refrigeration compressor to fail or explode.

A.16.4.5

Nitrous oxide is widely used as an illegal drug, and theft of the product is an ongoing concern. Therefore, nitrous oxide containers should be properly secured to prevent theft. Security methods include, but are not limited to, the following measures:

1. Access limited to authorized personnel only
2. Accurate inventory of bulk product and/or cylinders and portable containers (full and empty) maintained
3. Containers (full and empty) stored in a secured area
4. All discrepancies investigated
5. Incidents involving thefts, misuse, or inventory shortages reported to law enforcement and the supplier

Additional security guidance can be found in the following publications:
A16.4.5.3.1

A typical warning sign is approximately 8 in. (200 mm) wide and 6 in. (150 mm) high and contains text such as that in Figure 16.4.5.3.1.

A16.4.5.3.2

Slats are not recommended in security enclosures because they reduce normal air flow and tend to allow the accumulation of heavier-than-air nitrous oxide vapors. Where slats are used, they should be of noncombustible material and should have at least 25 percent open area at ground level.
A.16.5.1

Nitrous oxide is stored as a refrigerated liquid and if the internal pressure is decreased, it will autorefrigerate to −127°F (−88.5°C) at atmospheric pressure. The system designer should consider additional safeguards or procedures when using materials of construction that are not rated for this upset condition. Many bulk nitrous oxide storage tanks are fabricated using low alloy carbon steels with minimum design metal temperatures (MDMT) of −40°F (−40°C) or higher but are not subjected to operating temperatures outside the design limits unless the pressure is significantly reduced.

Common commercial metallic materials suitable for nitrous oxide installations include carbon steel, manganese steel, chrome molybdenum steel, stainless steel, brass, copper, copper alloys, and aluminum.

A.16.5.2.1

Nitrous oxide causes many elastomers and nonmetallic materials to permanently swell. Materials commonly used in nitrous oxide service include polytetrafluoroethylene (PTFE), polychlorotrifluoroethylene (PCTFE), fluorinated ethylene propylene (FEP), polyether ether ketone (PEEK™), and ethylene propylene diene monomer (EPDM). Others such as polyvinyl chloride (PVC), polyamide, Vespel™, and polypropylene can be used when external fire risk is considered.

A.16.5.4.2.1

Figure A.16.5.4.2.1 illustrates a typical safety valve installation on a refrigerated liquid pipe to avoid rain and condensation accumulation within the device.

![Figure A.16.5.4.2.1 Safety Valve Installation on an Insulated Liquid Pipe.](image)

A.16.6.1

Most nitrous oxide decomposition incidents have occurred in large pressure vessels such as storage tanks or cargo tanks. The risk is highest in a tank full of vapor (empty or near empty of liquid) under pressure. The decomposition reaction can be initiated at the vessel wall or on the vessel piping by welding or brazing or by heat generated by a pump running with inadequate liquid flow (dry running). If initiated in the piping, the reaction front can travel through the piping and into the vessel if it is operating above the decomposition propagation threshold. Once the reaction front is inside the vessel there is effectively no heat sink to quench the reaction. Since 1.5 moles of gas are created for each mole of decomposed nitrous oxide, the decomposing nitrous oxide compresses and heats the unreacted nitrous oxide as the reaction front moves into the vessel. Eventually the unreacted nitrous oxide reaches temperature and pressure high enough to auto-initiate, resulting in an explosion.
A.16.7.5
The primary hazard during nitrous oxide pump operation is running with inadequate liquid flow (dry running). This can lead to localized heating and damage to the pump. Overheated nitrous oxide can cause an exothermic decomposition reaction that can lead to an explosion. Dry running most often occurs at pump startup and at loss of prime during operation.

A.16.9.1
Thermal mass flow meters should not be used due to the internal heater element, unless a risk assessment is carried out to ensure that there is no risk of thermal decomposition. One application is the use of mass flow meters to measure any emissions to atmosphere through vents.

– A.16.11.2.5
– Heat from an open flame or a hot air gun should not be applied to any part of a nitrous oxide installation to de-ice or release threaded couplings or to increase pressure in cylinders. However, hot air guns are acceptable where systems are at atmospheric pressure. Use of water as a warming agent also is acceptable.
WARNING

NITROUS OXIDE — ASPHYXIANT
NO SMOKING — NO OPEN FLAME
RESTRICTED AREA

DO NOT APPROACH IF A
MASSIVE DISCHARGE
HAS OCCURRED
CALL 1-800-XXX-XXXX
Chapter 16  Liquid Nitrous Oxide Systems

16.1 General.

The storage, use, and handling of liquid nitrous oxide in bulk systems shall be in accordance with the provisions of this chapter and Chapters 1 through 7 as applicable.

16.1.1 Application.

A bulk nitrous oxide system used in medical gas applications shall be in accordance with NFPA 99 in addition to the provisions stated herein.

16.2 Location of Bulk Nitrous Oxide Systems.

Bulk nitrous oxide systems shall be located in accordance with one of the following:

(1) Above ground and outdoors in accordance with Table 16.2

(2) Indoors or in courts in accordance with the following requirements:

   (a) The pressure relief valve shall be sized for indoor installation and for possible engulfment in fire in accordance with the provisions of CGA S-1.3, Pressure Relief Device Standards – Part 3 – Stationary Storage Containers for Compressed Gases.

   (b) All relief devices shall be vented outdoors to a location with sufficient ventilation to prevent the accumulation of nitrous oxide and to eliminate the hazard of asphyxiation.

   (c) The minimum separation distances of the outlet of relief device vent piping from exposures in 16.2(2)(b) shall meet the requirements of Table 16.2.

   (d) All relief devices and vents for installations in courts as defined in 3.3.26 shall be piped outdoors to a safe, well-ventilated area, and the area around the container shall be ventilated in accordance with Section 6.16.
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<td>(3) Wall openings as measured from high-pressure gas or liquefied gas regulators, pressure relief devices, vaporizers, manifolds, and interconnected piping</td>
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<td>(b) Horizontal distance from nitrous oxide storage container to filling and vent connections or other openings to tank or vault</td>
<td>25 ft, 7.5 m</td>
</tr>
<tr>
<td>(12) Flammable gases above ground</td>
<td></td>
</tr>
<tr>
<td>(a) Liquefied hydrogen (any quantity)</td>
<td>75 ft, 22.5 m</td>
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<tr>
<td>(b) Flammable liquefied gases not exceeding 1000 gal (3.78 m³) or dissolved or nonliquefied gases not exceeding 25,000 ft³ (693 m³) at reference conditions</td>
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<tr>
<td>(c) Flammable gases or liquids at capacities greater than those given in 12(b)</td>
<td>50 ft, 15.2 m</td>
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<tr>
<td>(13) Rapidly burning solids including, but not limited to, excelsior, paper, or combustible waste</td>
<td>50 ft, 15 m</td>
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<tr>
<td>(14) Slowly burning solids including, but not limited to, heavy timber or coal</td>
<td>25 ft, 7.5 m</td>
</tr>
<tr>
<td>(15) Horizontal distance from the vertical plane below the nearest overhead electrical wire</td>
<td>5 ft, 1.5 m</td>
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16.3* Container Design.

Storage vessels shall be designed, constructed, and tested in accordance with the appropriate requirements of the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, Rules for Construction of Pressure Vessels.

16.3.1 Pressure Relief Devices.

16.3.1.1

Containers used for liquid nitrous oxide shall be equipped with pressure relief devices piped from the uppermost part of the containers and communicating with the vapor space.

16.3.1.2

Containers shall have pressure relief devices designed and provided in accordance with CGA S-1.3, Pressure Relief Device Standards–Part 3–Stationary Storage Containers for Compressed Gases, for stationary tanks.

16.3.1.3
Relief valves shall be sized, operated, and maintained per 7.1.5.5.

16.3.1.3.1

Each bulk tank shall have a minimum of two active safety relief devices sized per CGA S-1.3.

16.3.1.3.2*

The relief valve system shall be designed to meet the ASME *Boiler and Pressure Vessel Code*, Section VIII, Division 1, Rules for Construction of Pressure Vessels requirements to allow for proper maintenance and servicing of the devices.

16.3.1.3.3*

Non-reclosing relief devices shall not be used in nitrous oxide bulk tank service.

16.3.1.4

Pressure relief devices shall be located to minimize tampering, damage, and obstruction to flow.

16.3.1.5

The inlet and outlet of the relief devices shall not be blocked by a valve or plug during normal operation.

16.3.1.6 Vent Pipe Systems.

16.3.1.6.1

Pressure relief devices shall be piped to the outdoors where the discharge will not impinge on the structure, the personnel, or the means of egress and will not create a hazardous concentration of nitrous oxide.

16.3.1.6.2*

Vent piping systems serving pressure relief devices shall be protected from water intrusion to prevent moisture or solid nitrous oxide from collecting and freezing and interfering with the operation of the pressure relief device.

16.3.1.6.3

Vent piping systems serving pressure relief devices shall be designed to prevent backflow restrictions exceeding 10 percent backpressure on the pressure relief device under full flow conditions.

16.3.2 Pressure Level Indicators and Fill Connections.

Containers shall be provided with a pressure gauge and a contents level gauge or other device capable of indicating the quantity of liquid nitrous oxide.

16.3.2.1

These devices shall be designed for the temperatures and pressures associated with liquid nitrous oxide service.

16.3.2.2*
Where containers are in locations remote from the filling connection, a means to determine whether the containers have been filled to their design capacity shall be provided.

16.3.2.2.1
The liquid and vapor fill connections shall comply with CGA V-6, *Standard Bulk Refrigerated Liquid Transfer Connections*.

16.3.2.2.2
Dust covers and caps shall be provided for the fill connections to prevent contaminant infiltration.

16.3.2.2.3
The liquid fill connection shall be CGA N2O-15, and the vapor return connections shall be CGA N2O-10.

16.3 Insulation.

16.3.3.1
Insulated bulk liquid containers shall be vacuum insulated or mechanically insulated with an external vapor barrier.

16.3.3.2
Exposed insulating materials shall be noncombustible.

16.3.3.3*
Insulation such as polyurethane foam having a flame spread rating of 25 or less shall be permitted to be used if fully covered with a protective metal or other noncombustible jacket.

16.3.3.3.1
Non-vacuum-insulated tanks shall have an internal cooling coil operated with refrigerant to maintain nitrous oxide as a liquefied gas.

16.3.3.3.2*
The refrigerant shall not be allowed to come in contact with the nitrous oxide.

16.4 Container Installation.

16.4.1 Foundations and Supports.

16.4.1.1
Foundations shall be designed to withstand soil and frost conditions as well as any anticipated seismic, snow, wind, or hydrostatic loading under operating conditions.

16.4.1.2
Stationary containers shall be provided with noncombustible concrete or masonry foundations or structural steel supports on firm concrete or masonry foundations.
16.4.2 Containers shall be located so there is no fire or open flame within 25 ft (7.6 m) (see Table 16.2).

16.4.3 A concrete or noncombustible delivery vehicle unloading spill pad shall be provided.

16.4.3.1 The unloading spill pad shall be kept free of grease and oil or other hydrocarbons.

16.4.3.2 The unloading spill pad shall have minimum dimensions of 12 ft × 12 ft (3.6 m × 3.6 m).

16.4.4 Fire Barrier Walls.

16.4.4.1 The distances shown in items 2, 4, 5, 8, and 10 through 14 of Table 16.2 shall not apply where a fire barrier wall having a minimum fire resistance of 2 hours interrupts the line of sight between uninsulated portions of the bulk storage system and the exposure.

16.4.4.2 Fire barrier walls shall comply with the requirements of 8.7.2.1.1 through 8.7.2.1.5.

16.4.5* Security.

16.4.5.1 Nitrous oxide containers and systems shall limit access to authorized personnel only.

16.4.5.2 Locations shall be locked when not attended by authorized personnel.

16.4.5.3 Perimeter security shall have a minimum height of 6 ft (1.8 m) and lockable gates.

16.4.5.3.1* A warning sign shall be installed to indicate the hazards of nitrous oxide on the perimeter security enclosure so it can be easily seen by anyone approaching the enclosure.

16.4.5.3.2* Enclosures shall be designed so as not to restrict or reduce natural air flow.

16.4.5.4 Bollards or barriers shall be used to prevent unauthorized vehicle intrusion in accordance with Section 4.11.

16.4.5.5
Area lighting shall be provided to provide night security and to facilitate night deliveries and maintenance.

16.5 Materials of Construction.

16.5.1*

Materials in contact with nitrous oxide shall be suitable for the full range of temperatures and pressures to which they shall be subjected during operation.

16.5.2 Nonmetals.

16.5.2.1*

Nonmetallic materials shall be compatible with nitrous oxide and shall be used only as required.

16.5.2.2

Nonmetallic materials used at pressures greater than 435 psi (3000 kPa) shall conform to CGA G-4.10, *Design Considerations to Mitigate the Potential Risks of Toxicity When Using Nonmetallic Materials in High Pressure Oxygen Breathing Gas Systems.*

16.5.3 Piping Systems.

16.5.3.1


16.5.3.2

Nitrous oxide piping shall be located and supported to protect against damage from strain on piping and fittings; the effects of expansion, contraction, and vibration; mechanical damage; and heat sources.

16.5.3.3

Piping, tubing, and hoses and fittings shall be designed to a bursting pressure of at least 4 times the system design pressure.

16.5.4 Pressure Relief Devices.

16.5.4.1

Piping systems shall be protected by a pressure relief device set to function at no greater than 50 percent over the normal operating pressure of the system.

16.5.4.2

All pressure relief devices shall discharge outside in a well-ventilated area.

16.5.4.2.1*

Pressure relief devices shall be installed so rain and condensation do not accumulate in the device.

16.5.4.2.2
Pressure relief devices shall be positioned so they will not injure people in the vicinity where they discharge.

16.6 Vaporizers and Heaters.

16.6.1* Vaporizers and heaters shall use only indirect means of heating such as steam, air, vapor, or other nonreactive materials such as solids or liquids.

16.6.2 The heating medium for nitrous oxide vaporizers shall be limited to 300°F (149°C).

16.6.3 Electric Vaporizers and Heaters.

16.6.3.1 Direct-contact electric heater elements shall not be permitted.

16.6.3.2 Electric vaporizers shall be electrically grounded.

16.7 Pumps.

16.7.1 Pump design and installation shall avoid sources of heat or sparks that could lead to an ignition or initiate a decomposition reaction.

16.7.2 Pump bearings shall not be lubricated with nitrous oxide.

16.7.3 Material combinations of moving and stationary parts shall be selected to ensure a low probability of ignition or spark generation.

16.7.4 The pump shall be separated from the pump motor or power source by an open air space.

16.7.5* Dry Run Protection.

16.7.5.1 Pump control systems shall have an interlock that authorizes operation only after the pump has been properly cooled down and filled with liquid.

16.7.5.2

16.7.5.3 The pump shutdown system shall be actuated by one or more of the following:

(1) Abnormal differential pressure
(2) Elevated temperature
(3) High motor current
(4) A suitable liquid flow measuring device

16.8 Strainers and Filters.

16.8.1
Strainers or filters shall be installed to prevent the migration of particles within specific devices (e.g., compressors, pumps).

16.8.2
Gaseous nitrous oxide shall be filtered using mesh sizes 30–100 (500–150 μm).

16.8.3
Mesh filters or strainers made from high nickel alloys such as Monel™, Inconel™, nickel 200 alloys, or high copper alloys, such as brass, shall be permitted because of their increased resistance to oxidizer fires.

16.8.3.1
Glue or other combustibles shall not be permitted to be used at pressures greater than 145 psi (1000 kPa).

16.9 Flow Meters.

16.9.1*
Thermal mass flow meters with exposed heater elements shall not be used.

16.10 Cleaning.

16.10.1
Equipment used in a bulk nitrous oxide system shall be cleaned in accordance with the requirements of CGA G-4.1, Cleaning Equipment for Oxygen Service, to remove oil, grease, solvents, particulates, or other oxidizable materials before the system is placed in service.

16.10.2
Lubricants that can come in contact with nitrous oxide shall be oxygen compatible.

16.10.3
Carbon dioxide equipment shall not be used in nitrous oxide service unless a conversion process has been followed for the change of service.

16.10.3.1
Any conversion shall consider design, materials of construction, insulation, cleanliness, lubricants, seals, and potential contact with high temperatures in accordance with 16.6.2.

16.11 Maintenance Procedures.
16.11.1
Nitrous oxide equipment shall be maintained by qualified and properly trained personnel in a routine, controlled, and safe manner following written procedures.

6.11.2 Hot Work.

16.11.2.1
A hot work permit shall be issued and approved by a person knowledgeable in the properties of nitrous oxide for welding or other hot work.

16.11.2.2
The system shall be purged with air or inert gas prior to welding or other hot work.

16.11.2.3
Hot work shall not be performed on any equipment containing nitrous oxide, and all equipment shall be purged with an inert gas or air prior to hot work.

16.11.2.3.1
Medical installations shall be purged with medically certified inert gases prior to any hot work to prevent the formation of oxides.

16.11.2.4
It shall not be permitted to weld, braze, or strike an arc on any pipe, cylinder, or vessel that contains nitrous oxide.

16.11.2.5*
Heat from an open flame or a hot air gun shall not be applied to any part of a nitrous oxide installation to de-ice or release threaded couplings.

16.11.2.6
Hot work shall not be performed within 3 ft (1 m) of a section of piping that contains nitrous oxide.

16.12 Small Insulated Liquid Nitrous Oxide Indoor Systems. (Reserved)
### Second Revision No. 20-NFPA 55-2014 [Section No. A.3.3.57]

**A.3.3.58 Health Care Facilities.**

Health care facilities include, but are not limited to, hospitals, nursing homes, limited care facilities, clinics, medical and dental offices, and ambulatory health care centers, whether permanent or movable. This definition applies to normal, regular operations and does not pertain to facilities during declared local or national disasters. A health care facility is not a type of occupancy classification as defined by NFPA 101. Therefore, the term health care facility should not be confused with the term health care occupancy. All health care occupancies (and ambulatory health care occupancies) are considered health care facilities; however, not all health care facilities are considered health care occupancies, as health care facilities also include ambulatory health care occupancies and business occupancies. [99, 2012 2015]

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### Submitter Information Verification

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<td>Wed Jun 18 17:37:43 EDT 2014</td>
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### Committee Statement

Committee Statement: Update of extract material from NFPA 99. Note that only annex material is updated.

Response Message:
A.9.3.2

Figure A.9.3.2 serves to illustrate the separation distances between bulk oxygen systems and exposures.

These distances do not apply where fire barriers having a minimum fire resistance rating of 2 hours interrupt the line of sight between uninsulated portions of the bulk oxygen storage installation and the exposure. The fire barriers protect uninsulated oxygen storage containers or supports, control equipment, and system piping (or parts thereof) from external fire exposure. Liquid oxygen storage containers are insulated. Such containers can provide line-of-sight protection for uninsulated system components. Interruption of the line of sight means that an “eye” on any part of the uninsulated portion of the bulk oxygen storage installation cannot “see” any part of the exposure.

**Supplemental Information**

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<td>G55-3r2.jpg</td>
<td>Figure A.9.3.2--revised</td>
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- **Submitter Full Name:** [Not Specified]
- **Organization:** [Not Specified]
- **Street Address:**
- **City:**
- **State:**
- **Zip:**
- **Submittal Date:** Mon Jul 14 14:06:12 MDT 2014
Committee Statement

Committee Statement: Add walls in the diagram to match the requirements in the text of the code. 9.3.2.1

Add a wall in the 50' line to the rapidly burning solids dumpster.

Add a wall in the 50' line to the Buildings of Type III, IV, and V construction.

Spelling correction in lower left corner "paving and expansion joint fillers." joint

Response Message:
Public Comment No. 1-NFPA 55-2014 [Section No. A.9.3.2]
Additional requirements may be imposed by the AHJ (Authority Having Jurisdiction).

- **Horizontal distance from the vertical plane below the nearest overhead wire of an electric trolley, train, or bus line**
- **Piping containing other hazardous material**
- **Buildings of Type I, II construction as defined by the building code**
- **Buildings of Type III, IV, and V construction as defined by the building code**
- **Public assembly**

**Rapidly burning solids including, but not limited to, excelsior, paper, or combustible waste**

**Inlets to underground sewer or drainage systems from liquid delivery connections, pressure relief device outlets, mobile supply equipment, and liquid withdraw connections**

**Liquefied flammable gas >1000 gal (3785 L)**
**Liquefied flammable gas <1000 gal (3785 L)**
**Dissolved flammable gas >25,000 scf (708 Nm³)**
**Dissolved flammable gas <25,000 scf (708 Nm³)***

**Flammable gases above ground**
**Areas below connections where liquid can fall during loading or unloading operations and system operation from combustible surfaces including, but not limited to, asphalt or bitumastic paving and expansion joint fillers**

**Wall openings as measured from high-pressure gas or liquefied gas regulators, pressure relief devices, vaporizers, manifolds, and interconnected piping**

**Liquid hydrogen (any quantity)**

**Horizontal distance from the oxygen storage container to the tank or the vault**

**Horizontal distance from the oxygen storage container to tank or the vault**

**All classes of flammable and combustible liquids above ground [distances may be reduced to 15 ft (4.6 m) for Class IIIB combustible liquids]**

**Slowly burning solids including, but not limited to, heavy timber and coal**

**Property line**

**Nonambulatory patient areas**

Areas occupied by nonambulatory patients as measured from the primary pressure relief device discharge vent and from filling and vent connections

**Public sidewalk**

Public sidewalks and parked vehicles

*Exterior walls that encroach on the container to form a court with three or more sides*. **see 8.13.2.7**

*Slowly burning solids including, but not limited to, heavy timber and coal*
Second Revision No. 5-NFPA 55-2014 [Sections I.1.2.3, I.1.2.4, I.1.2.5, I.1.2.6, I.1.2.7]

I.1.2.2 API Publications.
American Petroleum Institute, 1220 L Street, NW, Washington, DC 20005-4070.


I.1.2.3 ASME Publications.
American Society of Mechanical Engineers, Three Two Park Avenue, New York, NY 10016-5990.


I.1.2.4 ASTM Publications.
ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.


I.1.2.5 BSI Publications.


I.1.2.6 CGA Publications.
Compressed Gas Association, 14501 George Carter Way, Suite 103, Chantilly, VA 20151-2923.

CGA G-1.6, Standard for Mobile Acetylene Trailer Systems, 2011.


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Committee Statement

Committee Statement: Update of reference documents.
Response Message:
Second Revision No. 6-NFPA 55-2014 [ Section No. I.2.2 ]

I.2.2 CGA Publications.

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Committee Statement

Committee Statement: Update of publication dates and titles for referenced documents.
Response Message:
Second Revision No. 7-NFPA 55-2014 [ Section No. I.3 ]

I.3 References for Extracts in Informational Sections.

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Committee Statement

Committee Statement: Update of publication dates for NFPA references.
Response Message: