MEMORANDUM

TO: NFPA Technical Committee on Industrial and Medical Gases

FROM: Patti Mucci, Administrative Assistant

DATE: March 2, 2011

SUBJECT: NFPA 55 ROP TC Letter Ballot (A2012)

The ROP letter ballot for NFPA 55 is attached. The ballot is for formally voting on whether or not you concur with the committee’s actions on the comments. Reasons must accompany all negative and abstention ballots.

Please do not vote negatively because of editorial errors. However, please bring such errors to my attention for action.

Please complete and return your ballot as soon as possible, but no later than Wednesday, March 16, 2011. As noted on the ballot form, please return the ballot to Patti Mucci either via e-mail to pmucci@nfpa.org or via fax to 617-984-7110. You may also mail your ballot to the attention of Patti Mucci at NFPA, 1 Batterymarch Park, Quincy, MA 02169.

The return of ballots is required by the Regulations Governing Committee Projects.

Attachment: Proposals
Letter Ballot
Submitter: Technical Committee on Industrial and Medical Gases,

Recommendation: Review entire document to: 1) Update any extracted material by preparing separate proposals to do so, and 2) review and update references to other organizations documents, by preparing proposal(s) as required.

Chapter 2 Referenced Publications

2.2 NFPA Publications.

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

2.3 Other Publications.

2.3.1 ASCE Publications.

American Society of Civil Engineers, 1801 Alexander Bell Drive, Reston, VA 20191-4400.

2.3.2 ASME Publications.

American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990.

2.3.3 ASTM Publications.

ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.
2.3.4 CGA Publications.

Compressed Gas Association, 4221 Walney Road, 5th floor, Chantilly, VA 20151-2923.


CGA P-1, Safe Handling of Compressed Gases in Containers, 2006.


CGA P-20, Standard for the Classification of Toxic Gas Mixtures, 2009.


CGA V-6, Standard Cryogenic Liquid Transfer Connections, 2008.

2.3.5* CTA Publications.

Canadian Transportation Agency, Queen’s Printer, Ottawa, Ontario, Canada. (Available from the Canadian Communications Group Publication Centre, Ordering Department, Ottawa, Canada K1A 0S9.)

Transportation of Dangerous Goods Regulations.

2.3.6 IAPMO Publications.

International Association of Plumbing and Mechanical Officials, 5001 E. Philadelphia Street, Ontario, CA 91761.


2.3.7 ICC Publications.

International Code Council, 5203 Leesburg Pike, Suite 600, Falls Church, VA 22041.


2.3.8 ISO Publications.

International Organization for Standardization Publications, 1 rue de Varembé, Case Postale 56, CH-1211 Geneva 20, Switzerland.

ISO 10156, Gases and gas mixtures — Determination of fire potential and oxidizing ability for the selection of cylinder valve outlets, 1996.

ISO 10298, Determination of toxicity of a gas or gas mixture, 2010.


2.3.9 U.S. Government Publications.


Title 16, Code of Federal Regulations, Part 1500, “Hazardous Substances and Articles”: 1500.41, Method of testing primary irritant substances, and 1500.42, Test for eye irritants.


2.3.10 Other Publications.


2.4 References for Extracts in Mandatory Sections.


Chapter 3 Definitions

3.3.9 Building. Any structure used or intended for supporting or sheltering any use or occupancy. [101, 2009]

3.3.35 DOT. U.S. Department of Transportation. [52, 2006]
Annex H  Informational References

H.1.1  NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.
NFPA 77,  Recommended Practice on Static Electricity, 2007 edition.

H.1.2  Other Publications.
H.1.2.1  ACGIH Publications. American Conference of Governmental Industrial Hygienists, 1330 Kemper Meadow Drive, Cincinnati, OH 45240.
TLVs® and BEIs®,  Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices, 2003 edition.

H.1.2.2  API Publications. American Petroleum Institute, 1220 L Street, NW, Washington, DC 20005-4070.
API RP 579,  Recommended Practice for Fitness for Service, June 2007.

H.1.2.3  ASME Publications. American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990.

H.1.2.4  ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.


H.1.2.6  ICC Publications. 500 New Jersey Avenue, NW, 6th Floor, Washington, DC 20001-2070.


H.2  Informational References.
The following documents or portions thereof are listed here as informational resources only. They are not a part of the
requirements of this document.

H.2.1 NFPA Publications.
National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

H.2.2 CGA Publications. Compressed Gas Association, 4221 Walney Road, 5th Floor, Chantilly, VA 20151-2923.

H.2.3 Other Publications.
“NIOSH Alert: Preventing Worker Injuries and Deaths from Explosions in Industrial Ethylene Oxide Sterilization Facilities.” Available at www.cdc.gov/niosh/homepage.html.

H.3 References for Extracts in Informational Sections.

Substantiation: To conform to the NFPA Regulations Governing Committee Projects.
Committee Meeting Action: Accept

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55-2 Log #CP3

(Entire Document) Final Action: Accept

Submitter: Technical Committee on Industrial and Medical Gases,
Recommendation: Revise all units of ft\(^3\) to scf when referring to an amount of gas as well as all m\(^3\) to Nm\(^3\) throughout the entire document wherever they are shown.
Substantiation: The committee seeks to create consistency throughout the document and to reflect an amount of gas in standard cubic feet (scf) and normal cubic meters (Nm3).
Committee Meeting Action: Accept

Printed on 3/1/2011 4
55-3 Log #128 Final Action: Reject
(Entire Document)

Submitter: Larry L. Fluer, Fluer, Inc. / Rep. Compressed Gas Association
Recommendation: The first edition of NFPA 2 is on the consent calendar for adoption as NFPA’s new hydrogen technology code due to be published in the fall of 2011. NFPA 55 has been used as the source document for fundamental requirements for hydrogen as they will appear in NFPA 2. In some cases extract text has been revised by the NFPA 2 Technical Committee either because further clarification was needed, or in cases where a potential conflict was apparent. NFPA 2 will contain a new annex on explosion control where the hazards of explosion are of concern including the phenomenon of deflagration to detonation transition.

A review of the NFPA 2 ROC draft should be conducted by the IMG TC where NFPA 55 extract material has been used, and where differences are found the changes must be evaluated to determine whether an additional change is warranted in NFPA 55, or whether the changes made by the NFPA 2 TC are appropriate.

Substantiation: To be developed.
Committee Meeting Action: Reject
Committee Statement: The committee perceives a need to update NFPA 55 based on revisions that were made in NFPA 2, Hydrogen Technologies Code. NFPA 2 being published only this month makes this an item that should be followed up on in the ROC phase. In the meantime, it should be noted that any differences in extract information in NFPA 2 will be potentially brought into NFPA 55 at the ROC.

55-4 Log #135 Final Action: Accept in Principle
(Entire Document)

Submitter: Larry L. Fluer, Fluer, Inc. / Rep. Compressed Gas Association
Recommendation: The term “cylinders, containers and tanks” is the terminology that needs to be used in a consistent fashion throughout the document when the term is intended to refer to the types of packages intended. In some cases the term that is used is “containers, cylinders and tanks” and at other times it may be cylinders, containers and tanks. One method needs to be used for consistency. The preferred order has been “cylinders, containers and tanks.” See the following sections for examples of “containers, cylinders and tanks”: 6.16.4; 7.1; 7.1.4.1.5; 7.1.4.2.1; 7.1.4.2.1.1; 7.1.4.2.2. For examples of “cylinders containers and tanks” see the following sections: 3.3.22.1; 4.4; 6.13.1; 6.15.2; 6.17.1.2; 7.1.4.1.7.3(A).

Substantiation: Editorial, but the use of the term should be consistent to add to the credibility of the document.
Committee Meeting Action: Accept in Principle
Revise throughout the document (anywhere that cylinders, containers, and tanks appear) to read:
Cylinders, Containers, and Tanks
Committee Statement: The committee is making this change to create a consistent editorial rule for the code.
Submittal: Larry L. Fler, Fler, Inc. / Rep. Compressed Gas Association

Recommendation: Revise text to read as follows:

2.3.2 ASME Publications. American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990.


Substantiation: Changed date of ASME A13.1 to latest revision.


Although ASME B31.12 is an “American National Standard” by declaration, the title is ASME B31.3. Similar changes may have occurred with other ASME documents.

Committee Meeting Action: Accept

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Submittal: Larry L. Fler, Fler, Inc. / Rep. Compressed Gas Association

Recommendation: Add new text to read as follows:

3.3.x Authorized Cylinder Requalifier (New)

Substantiation: Persons or facilities that meet the requirements of DOT or TC to inspect, test, certify, repair, or rebuild a cylinder in accordance with a DOT specification or a UN pressure receptacle under the regulations issued by these agencies must be approved under specified criteria in order to receive the issuance of a requalifier identification number (RIN). The RIN acts as the evidence of approval to requalify DOT/TC specification or special permit cylinders, or UN pressure receptacles if it is determined, based on the applicant’s submission and other available information, that the applicant’s qualifications and/or facility are adequate to perform the requested functions in accordance with the regulations.

Cylinder requalifiers are in effect an extension of the supply and distribution chain where containers are received, segregated, examined, serviced and processed. These containers may contain compressed gases when received, and the practices exercised by the suppliers including nesting, transport, security, etc. apply as the cylinders move through the process.

Section 7.1.5.4 and others provide direction to the handling of cylinders, containers and tanks that are being serviced. This definition works in concert with correlating changes to expand the requirements and exemptions granted to the gas manufacturers or distributors to include the category of requalifiers as those involved with cylinder servicing (other than the gas suppliers).

For additional information see 49 CFR 107.805.

Committee Meeting Action: Accept
A mechanical device used for increasing the pressure and the resultant density of a gas through the act of compression.

The term compressor is used without a definition as it relates to NFPA 55. Compressor has been defined in NFPA 853 with the definition extracted into NFPA 2. As defined there the term is limited to "A device used for increasing the pressure and density of a gas." Including a definition in NFPA 55 is appropriate to be used as the source document for requirements for all compressed gases including the definitions to be extracted into NFPA 2.

Committee Meeting Action: Accept
55-8 Log #39

Report on Proposals  –  June 2012

(3.3.x Emergency Shutdown System (ESD), A.3.3.x, 7.3.1.1, and A.7.3.1.13)

Submitter: Glenn Mahnken, FM Global

Recommendation: Add new text to read as follows:

3.3.x* Emergency Shutdown System (ESD) A control system composed of any combination of sensor(s), logic solver(s) and final element(s) dedicated to manually and/or automatically shutting down a process in a safe controlled manner in event of defined abnormal conditions.

A.3.3.x Emergency Shutdown System (ESD) is also commonly abbreviated as “ESS”. Other equivalent terms are Safety Shutdown System (SSD), and Safety Interlock System. The term Safety Instrumented System (SIS) typically refers to a type of ESD that meets formal requirements for safety and reliability according to ISA (Instrument Society of America) publication ANSI/ISA S84.01 Application of Safety Instrumented Systems for the Process Industries or IEC (International Electrotechnical Committee) Publication 61508- Functional Safety: Safety Related Systems.

7.3.1.13* Emergency Shutdown System (ESD)

7.3.1.13.1 Each compressed gas system shall be provided with an emergency shutdown system (ESD)

7.3.1.13.2 The ESD shall be designed based on a hazards analysis of the compressed gas supply and end user equipment and piping.

7.3.1.13.3 The ESD design shall be documented and a copy of the documentation kept available on site.

7.3.1.13.4 The ESD shall be proof-tested and inspected in a recorded format with records kept for at least 5 years.

7.3.1.13.5 Inspection and testing of the ESD shall be conducted at periodic intervals determined based on equipment manufacturer’s recommendations and plant experience.

7.3.1.13.6 The manual response function of the ESD shall be exercised periodically.

7.3.1.13.7 Operators shall be trained in the function of the ESD.

A 7.3.1.13 Emergency Shutdown System. The ESD can be manual only, or a combination of automatic and manual, as determined by the criticality of the compressed gas system and the exposures created by a loss of containment of the compressed gas.

Substantiation: An ESD is effectively currently required by NFPA 55 for all compressed gas systems. For example emergency shutoff valves (7.3.1.11) and excess flow control (7.3.1.12) are part of an ESD. The proposal would provide common requirements for design of the ESD as well as provide a better framework for ESD requirements for specific gases in later sections of the Code. This proposal is an initial attempt to introduce a consistent approach to Emergency Shutdown Systems in NFPA 55, 52 and other flammable gas codes.

A definition of Emergency Shutdown System is added to support a proposal for a new section 7.3.1.13 requiring ESD for compressed gas systems.

3.3.x above is an attempt at a definition corresponding to common usage and ISA-TR84.00.02-2002 - Part 1 - 22.

A.3.3.x The Appendix statement clarifies the other equivalent terms for ESD and other abbreviations in widespread use.

Committee Meeting Action: Reject

Committee Statement: No trigger quantities are provided in the proposal, making it applicable to all materials in all quantities (for example, individual compressed gas cylinders). This would create an excessive burden on the industry. The proponent made the statement that emergency shutdown is effectively the same as excess flow control. Emergency shutdown is not necessarily excess flow control.
A design arrangement incorporating one or more features that automatically counteracts the effect of an anticipated source of failure or which includes a design arrangement that eliminates or mitigates a hazardous condition by compensating automatically for a failure or malfunction. [1, 2012]

The term fail-safe is used throughout the code in describing systems that contain components that are to be designed in such a manner that should failure of the component occur the system enters a failure mode which creates or amplifies a hazardous condition. The definition has been proposed to be extracted from NFPA 1. It was accepted under the NFPA 1 ROP Item 1-20 Log #86. NFPA 1 will hold their ROC meeting December 14-15, 2010. A similar definition is used in the International Fire Code.

The terms “fire barrier” and fire barrier wall” are used throughout NFPA 55. The term fire barrier is defined differently by model building codes used by NFPA and other code publishers. In NFPA 5000 the term is used to describe a continuous membrane or membrane with discontinuities created by protected openings with a specified fire protection rating which also restricts the movement of smoke among other things.

The restriction on openings in these walls is to eliminate having windows, doors and similar penetrations that would require fire rated assemblies, automatic or self closing devices. Penetration of the wall by piping systems is not unusual and when protected penetrations are used fire stopping equivalent to the fire-resistance-rating of the wall is used in order to maintain the integrity of the wall. The term “through penetration” is common to any published building code and typically defined as an opening for penetrations that pass through both sides of a vertical or horizontal fire resistance-rated assembly or an opening that passes through an entire assembly.
A cryogenic fluid that forms flammable mixtures in air when in its vapor state. The term flammable cryogenic fluid is used in a number of places in the code including the MAQ tables. A definition is needed for this term as it is a specialized term designed for use within the context of NFPA 55 and related documents.

Committee Meeting Action: Accept

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A fully enclosed, noncombustible enclosure used to provide an isolated environment for compressed gas cylinders in storage or use. The term gas cabinet is a unique term and needs to be included in a definition that is controlled by NFPA 55. At the current time the definition has been extracted from NFPA 5000 and it also appears in NFPA 400 with an extract tag from NFPA 5000. The annex note included in both of these documents has not been included, i.e., access ports and doors, but it may be considered by the committee for inclusion.

This is not original material; its reference/source is as follows:
NFPA 5000 2009 Edition
Committee Meeting Action: Accept in Principle
Revise the definition 3.3.44 as follows:
3.3.44* Gas Cabinet. A fully enclosed, noncombustible enclosure used to provide an isolated environment for compressed gas cylinders in storage or use. [5000, 2009]
Committee Statement: It was noted that this definition was already in NFPA 55 as 3.3.44. The definition for Gas Cabinet should be derived from NFPA 55 as the source document. Removing the extract notation to NFPA 5000, Building Construction and Safety Code, seeks to resolve that.

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A cryogenic fluid which vaporizes to produce an inert gas when in its vapor state. The term inert cryogenic fluid is used in a number of places in the code including the MAQ tables. A definition is needed for this term as it is a specialized term designed for use within the context of NFPA 55 and related documents.

Committee Meeting Action: Accept in Principle
Revise the suggested new text to read as follows:
3.3.x Inert Cryogenic Fluid. A cryogenic fluid which vaporizes to produce an inert gas when in its vapor state.
Committee Statement: The committee editorially changed the word "produces" to "produce."
Submitter: Keith Ferrari, Praxair
Recommendation: Add new text to read as follows:

3.3.XX Micro Bulk Cryogenic System. An assembly of equipment, a container that is permanently installed through anchoring to a foundation, pressure regulators, pressure relief devices, vaporizers, manifolds, and interconnecting piping is designed to be filled at the health care facility with a cryogenic gas, that has a storage capacity equal to or under 20,000 ft$^3$ (566 m$^3$) of USP/NF gas, including unconnected reserves on hand at the site, and that terminates at the source valve.

Substantiation: MicroBulk Sources are being installed in the U.S. without guidance given by either the NFPA 55 or by the NFPA 99.

NFPA 55 and NFPA 99 do not address the unique requirements for MicroBulks Systems.

The microbulk seems to be a hybrid of a Bulk System and Dewar manifold system. The guidelines in both the NFPA 99 and NFPA 55 do not take into consideration microbulk systems.

This is not original material; its reference/source is as follows:
NFPA 55 and NFPA 99.

Committee Meeting Action: Reject

Committee Statement: The committee believes that this issue goes beyond a simple change and needs further study as it has broad ramifications on other codes and standards. The committee encourages further discussion and development on the proper method handling this issue.

Submitter: Larry L. Fluer, Fluer, Inc. / Rep. Compressed Gas Association
Recommendation: Add new text to read as follows:

3.3.xx Normal Cubic Meter (Nm$^3$) of Gas. A cubic meter of gas at an absolute pressure of 14.7 psi (101 kPa) and a temperature of 70°F (21°C).

Also: Where units of measure are indicated throughout the document in inch-pound units followed by SI units, and the inch-pound unit of measure is scf (standard cubic feet), the SI unit of measure should be shown as normal cubic meters (Nm$^3$).

Substantiation: In the United States, a standard cubic foot for industrial gas use is defined at 70°F (21.1°C) and 14.696 psia (101.325 kPa, abs). In other countries standard conditions may be at other conditions. For example, in Canada, a standard cubic meter for industrial gas use is defined at 15°C (59°F) and 101.325 kPa, abs (14.696 psia). The common term used for the metric expression is the "normal cubic meter" which indicates that the gas volume was measured at NTP (defined at 70°F (21°C) and 14.7 psia (101kPa, abs). 

Example sections where conversions are shown can be found in Sections 10.4.6.2.1 and 10.4.6.2.2, however, the use of scf in combination with m$^3$ can be found throughout the document.

Committee Meeting Action: Reject

Committee Statement: The committee wishes to review this for consideration in the ROC phase. It is recognized that "Normal" in Europe is established at 32°F and in the US, the temperature is at 70°F.
### 55-16 Log #69

**Final Action:** Reject

**3.3.x Pressure Vessel (New)**

**Submitter:** Larry L. Fluer, Fluer, Inc. / Rep. Compressed Gas Association

**Recommendation:** Add new text to read as follows:

3.3.xx **Pressure Vessel.** A container or other component designed in accordance with the ASME *Boiler and Pressure Vessel Code* or CSA B51, *Boiler, Pressure Vessel and Pressure Piping Code.*

**Substantiation:** The term pressure vessel is used in a number of places in the code without definition. A definition is needed for this term as it is a specialized term designed for use within the context of NFPA 55 and related documents. The proposed definition has been extracted from the 2010 Edition of NFPA 52; however, maintaining the extract tag is not proposed as the definition is a fundamental and should be under the purview of the IMG TC.

This is not original material; its reference/source is as follows:

NFPA 52 2010

**Committee Meeting Action:** Reject

**Committee Statement:** Pressure vessels as currently defined includes cylinders and cylinders as currently designed are not included in the ASME Boiler and Pressure Vessel Code.

### 55-17 Log #40

**Final Action:** Reject

**3.3.x Separation Distance (New)**

**Submitter:** Robert Wichert, FCHEA, and Chris Radley, Altergy

**Recommendation:** Add new text to read as follows:

3.3.XXX **Separation distance.** The path distance (string distance) that a gas or liquid could follow to reach from one exposure or point to another taking all barriers into account.

**Substantiation:** To remove questions of whether or not the separation distance is measured through walls and whether or not the separation distance includes elevation changes.

**Committee Meeting Action:** Reject

Revise the suggested new text to read as follows:

3.3.XXX **Separation Distance.** The shortest distance that a gas or liquid could follow to reach from one exposure or point to another taking all barriers into account.

**A 3.3.XXX Separation Distance.** Distance is to be measured horizontally and vertically around or over and not through walls, fire barriers, etc.

**Committee Statement:** There needs to be a distinction between dilution and radiant heat separation distances. Further analysis is required as to how other codes and standards apply these distances and considered for NFPA 55.
A location inside or outside of a building or structure where the material placed into use is situated.

Piping systems are used to transport gas (and liquids) from a point of storage to the actual point of use where the gas is deployed. Piping alone does not create a condition of “use” where the material is being consumed or otherwise released from a closed pipe system. On the other hand, piping that connects to “process equipment” which is acting to raise or lower the energy in the system, or which either consumes or releases the material must be viewed as “active,” and as a result the material is viewed as being “placed into action” at the point of delivery or connection to the process equipment.

The term “use area” is used throughout the code. It is currently found in Sections 4.5.1.1, 4.10.3, 4.11.1.1, 6.5.1, 6.5.2, 6.5.3, 6.5.4, 6.15 and many others. Without definition users can be confused as to what an area of use is intended to encompass; and it is not unusual for the code user to interpret that gas in any piping system is in “use” within the context of the code. The NEC through the use of fine print notes has established a system to designate when piping systems containing flammable gases or liquids are not likely to cause a hazard condition simply because of presence. Similar concepts can be included in NFPA 55 though the use of annex notes that describe similar conditions thereby harmonizing the approach between NFPA 55 and NFPA 70.

NFPA 70 in Section 500.5 (B)(2) FPN No. 2 in pertinent part provides comment on the general view of piping systems as follows:

FPN No. 2: Piping without valves, checks, meters, and similar devices would not ordinarily introduce a hazardous condition even though used for flammable liquids or gases.

That said there can be conditions, such as quantity where the hazard cannot be ignored, and the second sentence of FPN No. 2 addresses it by providing further guidance to the code user as follows:

Depending on factors such as the quantity and size of the containers and ventilation, locations used for the storage of flammable liquids or liquefied or compressed gases in sealed containers may be considered either hazardous (classified) or unclassified locations. See NFPA 30-2008, Flammable and Combustible Liquids Code, and NFPA 58-2008, Liquefied Petroleum Gas Code.

Assume that piping downstream of the source valve, on the system in question, was used to transport gas into a building where the piping passed through a mechanical room (room #1). The piping in the mechanical room has no points of connection and the piping simply passes through the room. In an adjacent room (room #2) the piping is then connected to a compressor or a pump and there it is connected to a small high pressure storage vessel. From there it travels to the next room (room #3) where it is put to use in a metals treating operation housed in a closed furnace. NFPA 55 would not impose the restrictions of “use area” on the mechanical room (room #1); however, the code would impose restrictions of use areas on (room #2) as well as the point where the material is being used in the process (room #3). In the case of room #2 the material is not being consumed, but it is being manipulated and energy of the system is being raised through the use of process equipment which is actively “processing” the gas. In room #3 the material is being consumed and additional controls are warranted. For use in a furnace NFPA 86 would likely be imposed as well.

Committee Meeting Action:  Accept
3.3.XXX* Microbulk system. A system in which a cryogenic fluid is stored, is typically filled by smaller transport vehicles, has a product specific fill connection which meets the requirements found in the CGA V-1 document, may or may not have a valve for bottom filling, a full trycock valve, or a connection for measuring the vacuum of the annular space.

A.3.3.XXX A microbulk system is a type of cryogenic fluid system that was purposely designed to minimize losses during filling. These systems are typically installed at locations where the gas use has increased beyond the practical use of portable containers but has not increased to justify a typical bulk system.

Substantiation: While microbulk cryogenic fluid systems are similar to bulk gas systems they do have some unique characteristics that need to be addressed in the code and a definition is needed to explain the difference.

Create a new section 3.3.11 Gas Systems and make all of the bulk systems definitions subcategories under it.

Committee Meeting Action: Reject
Committee Statement: The committee believes that this issue goes beyond a simple change and needs further study as it has broad ramifications on other codes and standards. The committee encourages further discussion and development on the proper method handling this issue. If the use of additional reference standards are required then the proponent needs to provide them for the committee.

55-12 Log #41 Final Action: Accept in Principle
(3.3.12 Bulk Hydrogen Compressed Gas System)

Submitter: Robert Wichert, FCHEA, and Chris Radley, Altergy
Recommendation: Revise text to read as follows:

3.3.12* Bulk Hydrogen Compressed Gas System. An assembly of equipment that consists of, but is not limited to, storage containers, pressure regulators, pressure relief devices, compressors, manifolds, and piping, with a storage capacity of more than 466,120,000 ft³ (scf) (13,334 m³) of compressed hydrogen gas, including unconnected reserves on hand at the site, and that terminates at the source valve.

Substantiation: The MAQ for flammable liquid in NFPA 1 section 60.1.3.1 is 30 gallons. 30 gallons of gasoline is equivalent to 30 kg of hydrogen. 30 kg of hydrogen gas amounts to 12,000 cubic feet.

Committee Meeting Action: Accept in Principle
Committee Statement: MAQ is a separate concept that is not regulated by NFPA 55 in terms of heat content. Comparisons of a flammable gas to a flammable liquid are not appropriate to make on assumption. The committee handled this issue with the action on 55-21 (Log #136) by establishing 5000ft³ for the gaseous bulk storage. The action taken here on 55-20 (Log #41) should not be considered to be a form of agreement to the rationale provided in this proposal. See 55-21 (Log #136).
3.3.12* Bulk Hydrogen Compressed Gas System. An assembly of equipment that consists of, but is not limited to, storage containers, pressure regulators, pressure relief devices, compressors, manifolds, and piping, with a storage capacity of more than 400 5000 ft³ (scf) (141.6 m³) of compressed hydrogen gas, including unconnected reserves on hand at the site, and that terminates at the source valve.

2. Revise Section 10.1.1 as follows:

10.1.1 This chapter shall not apply to individual systems using containers each having a total hydrogen content of less than 400 scf (11 m³) 5000 ft³ (scf) (141.6 m³), if each system is separated by a distance not less than 5 ft (1.5 m), or to systems located in control areas when the aggregate quantity contained is less than the Maximum Allowable Quantity per Control Area (MAQ).

3. Delete Section 10.1.2

10.1.2 Where individual systems, each having a total hydrogen content of less than 400 scf (11 m³), are located less than 5 ft (1.5 m) from each other, this code shall apply.

4. Revise the 400 scf quantity to 400 scf (11 m³) 5000 ft³ (scf) (141.6 m³) in the following sections: 10.3.2.2.1.1(E); A.10.3.2.2.1.1(E); 10.3.2.2.1.1(F); and A.10.3.2.2.1.1(F).

Substantiation: The threshold level established for “bulk hydrogen compressed gas systems” has become obsolete over time as the commercial use of hydrogen has grown. Several control strategies and methods have been developed over the last twenty years as a means to limit exposure. For example:

- The use of gas cabinets, used as a means to increase threshold quantities for a gas requiring special provisions, serve to isolate small cylinder systems one from the other as a means of compartmentalization. The maximum number of cylinders that can be placed into a single gas cabinet is limited to three (55:6.16.4).
- Exhausted enclosures, used as a means to increase threshold quantities for a gas requiring special provisions, in comparison to gas cabinets do not limit the number of cylinders; however, when exhausted enclosures are provided fire sprinkler systems internal to the enclosure are required (55:6.17.1.3).
- The use of Maximum Allowable Quantity per Control Area (MAQ), and the control area concept has been established to limit the quantity of hazardous materials, including hydrogen, within buildings or areas without the imposition of special controls.
- The aggregate quantity of non-liquefied flammable gas in a single control area without specialized controls is limited to 1,000 cubic feet.
- An increase to 2000 cubic feet is allowed when the cylinders, containers or tanks are located in a gas room, gas cabinet or exhausted enclosure.
- The MAQ can be increased to 4000 cubic feet if gas rooms, gas cabinets, or exhausted enclosures are used and the area in which they are located is fully sprinklered.

The use of gaseous hydrogen as an alternate fuel for automotive vehicles and powered industrial trucks is an emerging technology. In addition, the use of hydrogen as a fuel to power fuel cells in the production of electrical power to provide emergency power for the operation of critical equipment of all types.

A small forklift (industrial truck) may contain from 1 to 2 kg (423 to 847 cubic feet) of gaseous hydrogen with larger forklifts carrying up to 6 kg (2540 cubic feet) each. Automobiles can carry from 10 to 12 kg (4233 to 5080 cubic feet) each. While these vehicles may be exempt from the scope of NFPA 55 these examples serve to illustrate the broad range of quantities and uses of hydrogen that undoubtedly were not considered when NFPA 50A in the late 1950's. The Compressed Gas Association publication CGA H-5, Installation Standards for Bulk Hydrogen Supply Systems defines a bulk system in the scope of the document as follows:

A bulk gas hydrogen supply system is one that contains greater than 5000 scf (141.6 m³) of hydrogen. A bulk liquid supply system is one that contains greater than 500 gal (1890 L) of hydrogen. The requirements of this standard are limited to systems operating up to 15 000 psig (103.4 MPa).

The use of a 5000 cubic foot threshold in NFPA 55 will serve to coordinate concepts established by industry for the installation of bulk supplies. It will also recognize the practical limitations with today’s systems as hydrogen technology continues to evolve.

Including “unconnected reserves on hand at the site” is an unenforceable statement. On hand where? Study by Sandia National Laboratories and the joint task group attendant to NFPA 2 and 55 have determined that the size of a connected
load is not a critical factor in determining the impact in a leak or fire event. When a “connected” load is involved the
duration of an event can be prolonged; however, unconnected reserves do not have an impact in determining siting,
ingengineering controls, administrative controls or construction features to be employed. Deletion of the “unconnected
reserves” component of this definition will have little impact on determining the extent of a bulk system. If the provision
is not removed the storage of multiple cylinder packs, such as six packs, at supplier locations could be declared to be
bulk gas systems. It is not intended that the provisions for bulk gas systems apply to small portable systems of the type
described. Removing the term “unconnected reserves” serves to focus the definition on the active and connected
system which is the object of interest.

This is not original material; its reference/source is as follows:
NFPA 2 - NFPA 55 Joint Task Group 6
Committee Meeting Action: Accept
(3.3.14 Bulk Liquefied Hydrogen Gas System and A.3.3.14, 3.3.57 Liquefied Hydrogen System, and A.3.3.57, and 11.3.2.1)

Submitter: Larry L. Fluer, Fluer, Inc. / Rep. Compressed Gas Association

Recommendation: 1. Revise Section 3.3.14 in accordance with the following:

A.3.3.14 Bulk Liquefied Hydrogen Gas System. An assembly of equipment that consists of, but is not limited to, storage containers, pressure regulators, pressure relief devices, vaporizers, liquid pumps, compressors, manifolds, and piping, with a storage capacity of more than 39.7 gal (150 L) of liquefied hydrogen, including unconnected reserves on hand at the site, and that terminates at the source valve.

A.3.3.14 Bulk Liquefied Hydrogen Gas System. The bulk system terminates at the source valve, which is commonly the point where the gas supply, at service pressure, first enters the supply line or a piece of equipment that utilizes the gas or the liquid, such as a hydrogen dispenser. The containers are either stationary or movable, and the source gas for the system is stored as a cryogenic fluid.

A bulk liquefied hydrogen gas system can include a liquid source where the liquid is vaporized and subsequently compressed and transferred to storage in the compressed gaseous form. It is common for liquid hydrogen systems to be equipped with vaporizers that are used to gasify the cryogen for ultimate use in the compressed state; however, there are also systems that can be used to transfer liquid in the cryogenic state. Bulk liquefied hydrogen gas systems can be either in an all-liquid state or in a hybrid system that can consist of storage containers for gas in the liquid state and other containers for gas in the compressed state. For the purposes of the application of the code, a hybrid system is viewed as a bulk liquefied hydrogen gas system.

2. Delete the following definition:

A system into which liquefied hydrogen is delivered and stored and from which it is discharged in the liquid or gaseous form to a piping system. The system originates at the storage container fill connection and terminates at the point where hydrogen at service pressure first enters the supply line.

A.3.3.57 Liquefied Hydrogen System. The system includes stationary or portable containers, including unconnected reserves, pressure regulators, pressure relief devices, manifolds, interconnecting piping, and controls as required.

3. Revise Section 11.3.2.1 as follows:

11.3.2.1 The location of liquefied hydrogen systems storage, as determined by the MAQ quantity of liquefied hydrogen, shall be in accordance with Table 11.3.2.1.

4. In Chapter 11 (including the Chapter title) globally change the term liquefied hydrogen systems (or system) to "bulk liquefied hydrogen system" (or system) which is the defined term as used within the scope of the chapter as it occurs in: the Chapter title; 11.2; 11.2.4.1; 11.3; Table 11.3.2.1; 11.3.2.2 and Table 11.3.2.2. Note that this change is not to be made in Annex G.

Substantiation: The term liquefied hydrogen is preferred over the term liquefied hydrogen gas which is sometimes confusing to those unfamiliar with this material. Deletion of the term "gas" when liquid is used as the term to be regulated (LH2) will serve to simplify the code. A change has been made in 3.3.14 for bulk liquefied hydrogen system and the related annex note to delete the term "gas."
The deletion of 3.3.57 and its annex note eliminates an unnecessary and redundant definition.

In Section 11.3.2.1 the requirement applies to the location of LH2 systems, not storage. The term MAQ is a defined term and improperly used being used in this instance. Its use in the table is appropriate, but it is not universally applicable to each column in the table. Replacing the term MAQ with Quantity addressed each of the conditions described by the table.

The changes in Chapter 11 (title) and related use of the term in Sections 11.2, 11.2.4.1, etc. will coordinate the use of the term "bulk liquefied hydrogen system" throughout the Chapter.

Committee Meeting Action: Accept
An assembly of equipment that consists of, but is not limited to, storage containers, pressure regulators, pressure relief devices, vaporizers, liquid pumps, compressors, manifolds, and piping, with a storage capacity of more than 39.7 gal (150 L) of liquefied hydrogen, including unconnected reserves on hand at the site, and that terminates at the source valve.

The system includes stationary or portable containers, including unconnected reserves, pressure regulators, pressure relief devices, manifolds, interconnecting piping, and controls as required.

Substantiation: Table 11.3.2.2 addresses a system which for all practical purposes consists of interconnected components. On the other hand for small quantities inside buildings the primary control is the “control area concept.” For example:

- The use of Maximum Allowable Quantity per Control Area (MAQ), and the control area concept has been established to limit the quantity of hazardous materials, including hydrogen, within buildings or areas without the imposition of special controls.
  - The aggregate quantity of LH2 in a single control area without specialized controls is limited to 45 gallons (170 L).
  - Increases in quantity through the use of gas cabinets, gas rooms or sprinklers are not allowed (Table 6.3.1.1). Including “unconnected reserves on hand at the site” is an unenforceable statement. On hand where? Having unconnected LH2 sitting in reserve somewhere on site is not practical. To be in reserve the material would either have to be in a standby tank, or it would have to be in a mobile vehicle of some type. If it was in a standby tank the piping between the primary system and the standby system would likely share some part of a common system. The aggregate quantity of material in such a system would require that the total be used. There would be no change in the requirements for a system of this nature as the aggregate quantity would be used to define the system. If there were multiple systems at any one site where the systems were not interconnected each system would be evaluated based on its own distance to exposures.

The joint task group between NFPA 2 and 55 has been studying the provisions for GH2 and LH2 for the past several years. The group has been considering revisions to Table 11.3.2.2 to eliminate the quantity columns in favor of a single column based on pipe ID and system pressure in a manner similar to that taken for GH2. Progress on work related to LH2 slowed in 2010 due to budget constraints.

Study by Sandia National Laboratories and the joint task group attendant to NFPA 2 and 55 have determined that the size of a connected load, whether GH2 or LH2 is not a critical factor in determining the impact of gas released in an unignited cloud leak or fire event. When a “connected” load is involved the duration of an event can be prolonged with larger systems; however, unconnected reserves should not have an impact in determining siting, engineering controls, administrative controls or construction features to be employed. Deletion of the “unconnected reserves” component of this definition will have little to no impact in determining the extent of a bulk system. Removing the term “unconnected reserves” serves to focus the definition on the active and connected system which is the object of interest.

The term “unconnected reserves” pertinent to LH2 systems also appears in the annex note for Section 3.3.57. If the definition to 3.3.14 is revised, the annex note to 3.3.57 should be revised to correlate in concept with the change in definition.

Committee Meeting Action: Accept in Part
Revise the proposed text to read as follows:

3.3.14* Bulk Liquefied Hydrogen Gas System. An assembly of equipment that consists of, but is not limited to, storage containers, pressure regulators, pressure relief devices, vaporizers, liquid pumps, compressors, manifolds, and piping, with a storage capacity of more than 39.7 gal (150 L) of liquefied hydrogen, including unconnected reserves on hand at the site, and that terminates at the source valve.

A.3.3.57 Liquefied Hydrogen System. The system includes stationary or portable containers, including unconnected reserves, pressure regulators, pressure relief devices, manifolds, interconnecting piping, and controls as required.
**Committee Statement:** The committee accepted the revision to 3.3.14, but deleted A.3.3.57 to be consistent with the action taken on 55-22 (Log #55).

**55-24 Log #57**

(3.3.15 Bulk Oxygen System)

**Submitter:** Larry L. Fluer, Fluer, Inc. / Rep. Compressed Gas Association

**Recommendation:** Revise text to read as follows:

3.3.15* Bulk Oxygen System. An assembly of equipment, such as oxygen storage containers, pressure regulators, pressure relief devices, vaporizers, manifolds, and interconnecting piping, that has a storage capacity of more than 20,000 ft³ (scf) (566 m³) of oxygen, including unconnected reserves on hand at the site, and that terminates at the source valve.

**Substantiation:** Including “unconnected reserves on hand at the site” is an unenforceable statement. On hand where? When a “connected” load is involved the duration of a leak or upset event can be prolonged; however, unconnected reserves do not have an impact in determining siting, engineering controls, administrative controls or construction features to be employed. Deletion of the “unconnected reserves” component of this definition will have little to no impact on determining the extent of a bulk system. If the provision is not removed the storage of multiple cylinder packs, such as six packs, at supplier locations could be declared to be bulk gas systems. It is not intended that the provisions for bulk gas systems apply to small portable systems of the type described. Removing the term “unconnected reserves” serves to focus the definition on the active and connected system which is the object of interest.

**Committee Meeting Action:** Accept

**55-25 Log #58**

(3.3.39 Explosion Control)

**Submitter:** Larry L. Fluer, Fluer, Inc. / Rep. Compressed Gas Association

**Recommendation:** Revise text to read as follows:

3.3.39* Explosion Control. A means of either preventing an explosion through the use of explosion suppression, fuel reduction, or oxidant reduction systems or a means to prevent the structural collapse of a building in the event of an explosion through the use of deflagration venting, barricades, or related construction methods.

**Substantiation:** The definition has been revised to acknowledge changes made by the NFPA 2 technical committee. NFPA 2 will extract from NFPA 55 as the source document.

**This is not original material; its reference/source is as follows:**

NFPA 2 Section 3.3.57.2 (ROC Draft)

**Committee Meeting Action:** Accept

**55-26 Log #70**

(3.3.43.14.1 Class 1 Unstable Reactive Gas (New))

**Submitter:** Larry L. Fluer, Fluer, Inc. / Rep. Compressed Gas Association

**Recommendation:** Add a new definition as 3.3.43.1.1 and renumber the balance of the definitions in this section.

3.3.43.14.1 Class 1 Unstable Reactive Gas. Materials that in themselves are normally stable, but that can become unstable at elevated temperatures and pressures.

**Substantiation:** Class 1 unstable reactive gases are included in the MAQ table (Table 6.3.1.1) and as such a definition is needed. The definition used is correlated with NFPA 400 except that the annex text has not been extracted.

**Committee Meeting Action:** Accept
55-27  Log #27  Final Action: Reject
(3.3.56 Large Insulated Liquid Carbon Dioxide System (New))

Submitter: John J. Anicello, Airgas Inc.
Recommendation: Add new text as follows:
3.3.56 Large Insulated Liquid Carbon Dioxide System. An assembly of one or more insulated carbon dioxide containers with a capacity greater than 1000 pounds and associated equipment such as pressure regulators, pressure relief devices and interconnecting piping terminating at the source valve. (New definition)
Substantiation: There is no definition for large insulated liquid carbon dioxide system. This will allow the application of CGA G-6.1 by reference to regulate them.
Committee Meeting Action: Reject
Committee Statement: The substantiation is incomplete as it is written at this time. The committee advises the proponent to return at the public comment phase with more technically complete material, as would be addressed in 13.4.

55-28  Log #59  Final Action: Accept in Principle
(3.3.78 Standard Cubic Foot (scf) of Gas)

Submitter: Larry L. Fluer, Fluer, Inc. / Rep. Compressed Gas Association
Recommendation: Revise text to read as follows:
3.3.78 Standard Cubic Foot (scf) of Gas. A cubic foot of gas measured at an absolute pressure of 14.7 psi (101 kPa) and a temperature of 70°F (21°C).
Substantiation: Editorial. The current definition is not a sentence. The indefinite article “A” is used before words beginning with a consonant sound or with vowels which are not pure vowels.
Committee Meeting Action: Accept in Principle
Revise the proposed text to read as follows:
3.3.78 Standard Cubic Foot (scf) of Gas. An amount of gas that occupies one cubic foot of gas when measured at an absolute pressure of 14.7 psi (101 kPa) and a temperature of 70°F (21°C).
Committee Statement: The text was revised to better clarify the definition.
55-29 Log #34 Final Action: Accept in Part
(3.3.81 Bulk Gas System)

Submitter: Glenn Mahnken, FM Global
Recommendation: a) change the following titles
3.3.11* Bulk Gas Supply System
3.3.12* Bulk Hydrogen Compressed Gas Supply System.
3.3.13* Bulk Inert Gas Supply System
3.3.14* Bulk Liquefied Hydrogen Gas Supply System
3.3.15* Bulk Oxygen Supply System
3.3.48* Gaseous Hydrogen Supply System.
3.3.57* Liquid Hydrogen Supply System
b) Relocate 3.3.11, 3.3.12, 3.3.13, 3.3.14, 3.3.48 and 3.3.57 to sub paragraphs of 3.3.81.

Substantiation: a) The above existing definitions and applications in the code effectively limit the extent of each of the defined “systems” to the supply side of a compressed gas installation. Adding “supply” into the definition title will clarify this limitation for Code users.
b) Consolidate “system” definitions under the system heading (3.3.81) for better clarity.

Committee Meeting Action: Accept in Part
Relocate 3.3.11, 3.3.12, 3.3.13, 3.3.14, and 3.3.48 to be subparagraphs of 3.3.81.
Committee Statement: The committee believes that a gas system should not be limited exclusively to qualify as supply and changing the titles would have that effect. The committee agrees with consolidating the material under one location.

55-30 Log #35 Final Action: Reject
(3.3.81.X Compressed Gas Process System (New) )

Submitter: Glenn Mahnken, FM Global
Recommendation: Add a new definition:
3.3.81.X Compressed Gas Process System. An assembly of user equipment and piping, that consists of, but is not limited to, piping, valves, regulators, pressure relief devices, manifolds, that begins at the source valve.

Substantiation: The “source valve” is defined and used in the Code as a reference point to differentiate between the supplier side and the consumer or user side of a compressed gas installation (see A. 3.3.77). The piping and equipment upstream of the source valve is currently defined in the Code by all the "system" definitions (see my proposal for 3.3.81). However there is no corresponding designation for the equipment on the downstream side. Adding such a definition will help clarify the application of Code requirements that are intended for upstream, downstream or both sides of the source valve.

Committee Meeting Action: Reject
Committee Statement: This term does not appear in the code and is unnecessary.
55-31 Log #36 Final Action: Reject
(3.3.81.1 Compressed Gas System and 3.3.81.3 Cryogenic Fluid System)

Submitter: Glenn Mahnken, FM Global
Recommendation: Revise text to read as follows:

3.3.81.1* Compressed Gas System.* An assembly of equipment designed to contain, distribute, or transport compressed gases, including the supply side and the end use process (i.e. upstream and downstream of the source valve).

3.3.81.3* Cryogenic Fluid System.* An assembly of equipment designed to contain, distribute, or transport cryogenic fluids, including the supply side and the end use process (i.e. upstream and downstream of the source valve).

Substantiation: My understanding (referring to 7.1.1 and sub paragraphs, as well as 7.3.1.2.1) is that these definitions are intended to apply to piping and equipment on both sides of the source valve. However, the end user side is not specifically included in the definition. Hence the above clarification is proposed to avoid any ambiguity.

Committee Meeting Action: Reject
Committee Statement: The committee believes that clarifying the material in 7.1.1 in the definitions chapter would only create more confusion and rejected the proposal on that premise.

55-32 Log #60 Final Action: Accept
(3.3.88 Valve Protection Device)

Submitter: Larry L. Fluer, Fluer, Inc. / Rep. Compressed Gas Association
Recommendation: Delete the following text:

3.3.88 Valve Protection Device. A device attached to the neck ring or body of a cylinder for the purpose of protecting the cylinder valve from being struck or from being damaged by the impact resulting from a fall or an object striking the cylinder [1, 2009]

Substantiation: The term is not used within the document.
Committee Meeting Action: Accept
55-33 Log #2
Final Action: Accept in Principle in Part

(4.5.2)

Submitter: Jon Nisja, Northcentral Regional Fire Code Development Committee
Recommendation: Revise text to read as follows:

4.5.2 Hazardous Materials Inventory Statement. Where required by the AHJ, permit applications shall include a hazardous materials inventory statement (HMIS). [1:60.1.6.2]

4.5.2.1 Contents. The HMIS shall include a document indicating the following information:

1. Hazard class.
2. Common or trade name.
3. Chemical name, major constituents, and concentrations if a mixture. If a waste, the waste category.
5. Whether the material is pure or a mixture, and whether the material is a solid, liquid, or gas.
6. Maximum aggregate quantity stored at any one time.
7. Storage conditions related to the storage type, temperature, and pressure.

Substantiation: The contents of the Hazardous Materials Management Plan is indicated in the previous sections. This will provide the same guidance for the information required for adequately addressing the data needed in the Hazardous Materials Inventory Statement.

Committee Meeting Action: Accept in Principle in Part

Revise the suggested text to read and add a new definition as follows:

4.5.2 Hazardous Materials Inventory Statement. Where required by the AHJ, permit applications shall include a hazardous materials inventory statement (HMIS) in accordance with the fire code. [1:60.1.6.2]

3.3.X Fire Code. The fire prevention code adopted by the jurisdiction.

Committee Statement: The proponent was seeking to extract annex information from NFPA 1, Fire Code, to be included as part of the code. The committee rejected that portion for that reason. The committee modified the suggested text and created a new definition for Fire Code to correlate with the approach used with the term building code. By referring to the fire code, additional requirements for an HMIS can be determined.

55-34 Log #6
Final Action: Reject

(4.9.1, 4.10.3, 6.11.2.2, 7.6.3.2, 10.2.5.2, 11.3.1.3, and 14.2.2.3)

Submitter: Thomas L. Allison, Savannah River Nuclear Solutions
Recommendation: Delete 6.11.2.2, 7.6.3.2, 10.2.5.2, 11.3.1.3 and 14.2.2.3.

Delete 4.9.1 and 4.10.3.

Substantiation: The various sections in the Chapters are redundant to and sometimes in conflict with the sections in Chapter 4. Either delete the specific requirements in the chapters or delete the general requirement to prohibit smoking and smoking and post a sign.

Committee Meeting Action: Reject

Committee Statement: The committee disagrees with deleting the hazard-specific sections because in most cases those sections also have a prohibition on the use of open flames. The committee recognizes a need for clarity (See the committee action taken by 55-36 (Log #7)).
4.9.1(1) Within 25 ft (7.6 m) of outdoor storage or dispensing areas for flammable compressed or liquified gases.
4.9.1(3) [New] In rooms or areas where flammable materials are stored or dispensed.

There is no justification for smoking being prohibited near nonflammable, non-hazardous gas storage or dispensing areas. The revised text makes this clearer.

Committee Meeting Action: Reject
Committee Statement: Hazardous materials regulations have a long-standing establishment in the model codes to prevent exposure fires in all hazardous material areas, not just those with flammable gases.

4.10.3 No smoking signs. Signs prohibiting smoking shall be provided where smoking is prohibited by 4.9.1 or required by 6.11.2.2 for an entire site or building. or in the following headings (1) ...(2)...(3)...

Section 4.9.1 is broader than being specific to gases and is more related to source control. 6.11.2.2 is designed for specific gases. The expressed intent is not to delete extract material as much as clarifying the intent behind the language.
Hazardous materials shall be classified according to hazard categories as follows:

1. Physical hazards, which shall include the following:
   a. Flammable gas
   b. Flammable cryogenic fluid
   c. Inert gas
   d. Inert cryogenic fluid
   e. Oxidizing gas
   f. Oxidizing cryogenic fluid
   g. Pyrophoric gas
   h. Unstable reactive (detonable) gas, Class 3 or Class 4
   i. Unstable reactive (nondetonable) gas, Class 3
   j. Unstable reactive gas, Class 1 or Class 2

A.5.1.1 Not all hazardous materials are placed into the high hazard category and some of these materials have been recognized as being of low ordinary hazard, depending on their nature in a fire. Inert compressed gases and cryogenic fluids are one example, there are others. Compressed gases and cryogenic fluids represent the gas phase of an array of hazardous materials. As the genre of hazardous materials is expanded there are other materials in hazard categories or hazard classes that may in fact be high hazard materials by definition, but which in some cases do not have a MAQ and, therefore, are not required to comply with the requirements for high hazard occupancies. For example, Class IIIB combustible liquids, Class 1 unstable reactive materials (including gases), Class 1 water-reactive solids and liquids, Class 1-3 water-reactive gases, Class 1 oxidizing solids and liquids, and Class IV and V organic peroxides.

Substantiation: Although the inert gases appear in the MAQ tables they should not be treated as physical hazards within the context of the total regulatory approach. They are not unlike Class IIIB liquids or Class 1 water reactive solids and liquids which the codes have chosen to treat differently. The annex note to the definition of compressed gas found in 3.3.43.1 may be of value in understanding. Section 5.1.2 could be applied to gases in these categories. The problem with including them in the list of physical or health hazards is that controls otherwise not intended to apply can be triggered.

An annex note has been added to further explain why not every category of hazard is included in the listing of physical hazards.

Committee Meeting Action: Accept
Add a new paragraph to 6.3.1:

Only the flammable gas component of a gas mixture containing flammable and inert gas components shall be counted in the allowed quantity for flammable gases in each control area. The inert portion of the gas mixture shall not be counted toward the allowable quantity in the control area.

**Problem:**

The current code requires the total volume of a cylinder classified as a flammable gas to be counted in the control area inventory. If this cylinder contains 200 cubic feet of a gas that is 100% concentration of the flammable gas, all of that gas is included in the flammable gas inventory toward the maximum allowable quantity in the control area inventory. If this same cylinder contains 200 cubic feet of a gas mixture that is classified by CGA P-23 as a flammable gas and that gas mixture is 4% concentration of the flammable gas and 96% inert gas, all of this gas is required to be included in the flammable gas inventory toward the maximum allowable quantity in the control area inventory under the current code even though only 4% or 8 cubic feet of the gas is flammable.

The current method to inventory flammable gases does not reflect the actual hazard of the gases in gas cylinders with a mixture of flammable and inert gases.

**Substantiation:**

For a mixture of a flammable and an inert gas the total amount of flammable gas that is present in the gas cylinder should be counted toward the total allowed quantity of flammable gas in the control area, but the quantity of inert gas should not be counted in the flammable gas inventory. For example, if a gas cylinder containing 200 cubic feet of a gas mixture with only 4% of the total gas mixture is classified as flammable, the total allowed quantity in the control area shall be 8 cubic feet; not 200 cubic feet.

The actual inventoried quantity of flammable gas in a control area should accurately reflect the hazard that is present. The hazard of 200 cubic feet of flammable gas is significantly more hazardous than 200 cubic feet of 4% flammable gas with 96% inert gas. In the event of an unplanned release of the flammable and inert gas mixture, only the flammable component of the gas mixture would be available to burn and create a hazard in a control area. The gas cylinder would still be labeled and handled as a flammable gas cylinder, but the true hazard of the cylinder to safety of the building, the building occupants, and the emergency responders would be reflected by this change.

**Committee Meeting Action:** Reject

**Committee Statement:** Mixtures are classified based on the hazards of the mixtures as a whole per 5.1.3, making the proposed addition unnecessary.
Larry L. Fluer, Fluer, Inc. / Rep. Compressed Gas Association

Table 6.3.1.1 has been revised to coordinate gases amounts with the MAQ tables now found in NFPA 1, 400 and 5000. NFPA 55 has been used as the source document for these tables; however, the common format has not been used in NFPA 55 as the base document. Revising the format in NFPA 55 to the “common format” resolves a major problem with the maintenance of the MAQ tables as they are utilized throughout the NFPA regulatory scheme.

Compressed gases can be found in either the liquefied (or partially liquid) or gaseous state. Nonliquefied gases are those that do not liquify at ordinary ambient temperatures regardless of the pressure applied. Nonliquefied gases are elements or compounds that have relatively low boiling points, typically –130°F (–90°C) and lower. These gases do become liquids if cooled to temperatures below their boiling points. When these gases become liquefied at these very low temperatures, they are referred to as cryogenic liquids (or fluids).

Liquefied gases are those that generally become liquids in containers at ambient temperatures and at pressures from 25 psig to 1500 psig (172 kPa to 10 340 kPa). Liquefied gases are elements or compounds that have boiling points relatively near atmospheric temperatures. These range from –130°F to 68°F (–90°C to 20°C).

The MAQ for storage and use closed for Class 2 unstable reactive liquefied gases is shown in units of measure of gallons in NFPA 1, and 5000. It has been shown in terms of units of weight in NFPA 55.

Footnotes e, f, j, k, m, n, q, r, and s have been deleted as they are not used by the table.

Footnote “g” has been revised to recognize “gas rooms” which are used as a means to increase the MAQ as indicated in existing NFPA 55 Table 6.3.1.1.

Footnote “t” has been added to correlate with Table 6.3.1.1 of NFPA 55 which reduces the MAQ to “zero” in unsprinklered areas unless the material is located in gas cabinets, gas rooms or exhausted enclosures. The terms “unsprinklered or sprinklered areas” as used in NFPA 55 have been revised to “unsprinklered or sprinklered buildings” within the context of NFPA 5000.

Footnote “u” has been added to correlate with the restrictions imposed under the table within the context of NFPA 55. Footnotes as they appear in NFPA 1 have been shown in the submittal for reference only. They have been stricken here for information. When removed the footnotes in the table must be renumbered to correspond.

Committee Meeting Action: Accept in Principle

Accept the proposed table revisions and add a line in the table footnotes to read as follows:

a See 60.1.26.2 for exceptions to tabular amounts. For use of control areas, see 60.2.3 of NFPA 1. Table values in parentheses or brackets correspond to the unit name in parentheses or brackets at the top of the column. The aggregate quantity in use and storage is not permitted to exceed the quantity listed for storage. In addition, quantities in specific occupancies are not permitted to exceed the limits in 60.1.26.2 in the building code.

NA. Not applicable within the context of NFPA 55. Refer to the applicable building or fire code for additional information on these materials.

Committee Statement: The committee agrees with the proposed changes and added the note to clarify the meaning behind ‘NA’ in the table. Coordination with NFPA 1, Fire Code, NFPA 5000, Building Construction and Safety Code, and other model fire and building codes will enhance usability. The committee clarified under footnote a that the reference is to 60.2.3 of NFPA 1.
<table>
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<th>MATERIAL</th>
<th>CLASS</th>
<th>High Hazard Protection Level</th>
<th>STORAGE</th>
<th>USE-CLOSED SYSTEMS</th>
<th>USE-OPEN SYSTEMS</th>
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<td>NA</td>
<td>45 b h</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>inert</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Flammable, gas</td>
<td>Gaseous</td>
<td>2</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Liquefied</td>
<td>2</td>
<td>NA</td>
<td>NA</td>
<td>(150) b h</td>
</tr>
<tr>
<td></td>
<td>Liquefied Petroleum (LP)</td>
<td>2</td>
<td>NA</td>
<td>NA</td>
<td>(300)c o p</td>
</tr>
<tr>
<td>Inert gas</td>
<td>Gaseous</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Liquefied</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Oxidizing gas</td>
<td>Gaseous</td>
<td>3</td>
<td>NA</td>
<td>NA</td>
<td>1,500b c d</td>
</tr>
<tr>
<td></td>
<td>Liquefied</td>
<td>3</td>
<td>NA</td>
<td>NA</td>
<td>(150) b h</td>
</tr>
<tr>
<td>Pyrophoric Gas</td>
<td>Gaseous</td>
<td>2</td>
<td>NA</td>
<td>NA</td>
<td>50 b c d</td>
</tr>
<tr>
<td></td>
<td>Liquefied</td>
<td>2</td>
<td>NA</td>
<td>NA</td>
<td>(4) b c d</td>
</tr>
<tr>
<td>Unstable (reactive) Gas</td>
<td>Gaseous 4 or 3 detonable</td>
<td>1</td>
<td>NA</td>
<td>NA</td>
<td>10 b</td>
</tr>
<tr>
<td></td>
<td>3 non-detonable</td>
<td>2</td>
<td>NA</td>
<td>NA</td>
<td>50 b h</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>3</td>
<td>NA</td>
<td>NA</td>
<td>750 b h</td>
</tr>
<tr>
<td>Unstable (reactive) Gas</td>
<td>Liquefied 4 or 3 detonable</td>
<td>1</td>
<td>NA</td>
<td>NA</td>
<td>(1) b</td>
</tr>
<tr>
<td></td>
<td>3 non-detonable</td>
<td>2</td>
<td>NA</td>
<td>NA</td>
<td>(2) b h</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>3</td>
<td>NA</td>
<td>NA</td>
<td>(150) k h</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NL</td>
</tr>
<tr>
<td>Corrosive gas</td>
<td>Gaseous</td>
<td>4</td>
<td>NA</td>
<td>NA</td>
<td>810 b h</td>
</tr>
<tr>
<td></td>
<td>Liquefied</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>(150) b h</td>
</tr>
<tr>
<td>Highly toxic gas</td>
<td>Gaseous</td>
<td>4</td>
<td>NA</td>
<td>NA</td>
<td>20 b c d</td>
</tr>
<tr>
<td>Toxic gas</td>
<td>Liquefied</td>
<td>NA</td>
<td>NA</td>
<td>810$^{h,i}$</td>
<td>NA</td>
</tr>
</tbody>
</table>

*Liquefied NA (4) h, s NA NA NA (4) h, s NA NA*  

| Gaseous | NA | NA | 810$^{h}$ | NA | NA | 810$^{h}$ | NA | NA |

*See 60.1.26.2 for exceptions to tabular amounts. For use of control areas, see 60.2.3. Table values in parentheses or brackets correspond to the unit name in parentheses or brackets at the top of the column. The aggregate quantity in use and storage is not permitted to exceed the quantity listed for storage. In addition, quantities in specific occupancies are not permitted to exceed the limits in 60.1.26.2 in the building code.*

*Measured at NTP or 70 °F (21°C) and 14.7 psi (101.3 kPa).*

*Inside a building, the maximum capacity of a combustible liquid storage system that is connected to a fuel-oil piping system is permitted to be 660 gal (2,500L), provided that such system conforms to NFPA 31, Standard for the Installation of Oil-Burning Equipment. See NFPA 58, Liquefied Petroleum Gas Code for requirements for liquefied petroleum gases (LPG). LPG is not within the scope of NFPA 55.*

*The quantity of fuel in aircraft in hangars is required to be in accordance with NFPA 409, Standard on Aircraft Hangars.*

*Quantities are permitted to be increased 100 percent where stored or used in approved cabinets, gas cabinets, exhausted enclosures, gas rooms, explosives magazines, or safety cans, as appropriate for the material stored, in accordance with NFPA 1. Where Footnote h also applies, the increase for both footnotes is permitted to be applied accumulatively.*

*The quantity of fuel in aircraft in hangars is required to be in accordance with NFPA 409, Standard on Aircraft Hangars.*

*Maximum quantities are permitted to be increased 100 percent in buildings equipped throughout with an automatic sprinkler system in accordance with NFPA 495, Explosive Materials Code, Chapter 13.*

*Maximum quantities of black powder, smokeless propellant, and small arms primers stored or displayed in mercantile occupancies or stored in one- or two-family dwellings are required to be separated by a minimum of 300 ft (92 m).*

*In mercantile occupancies, storage of LP-Gas is limited to a maximum of 200 lb (91 kg) in nominal 1 lb (0.45 kg) LP-Gas Containers.*

*In storage, low, and ordinary hazard occupancies, the storage of Class IA flammable liquids, the combination storage of Class IB and Class IC flammable liquids is required to be permitted with the MAQ, if such storage complies with the requirements of NFPA 495, Explosive Materials Code, Chapter 13.*

*In lieu of the maximum allowable quantity limit per control area, the maximum aggregate quantity per building of special explosive devices in industrial, mercantile, and storage occupancies is required to be limited to 50 lb.*
limited to a maximum quantity of 660 gal (2,500 L) where stored in accordance with all the requirements in NFPA 30 for general-purpose warehouses.

4. Containing not more than the maximum allowable quantity per control area of Class I-A, Class I-B, or Class I-C flammable liquids.

5. A single cylinder containing 150 lb or less of anhydrous ammonia in a single control area in a nonsprinklered building is considered to be the maximum allowable quantity. Two cylinders, each containing 150 lb or less, in a single control area is considered to be the maximum allowable quantity, provided that the building is equipped throughout with an automatic sprinkler system in accordance with NFPA-13.

6. Allowed only where stored or used in gas rooms or in approved, exhausted gas cabinets or exhausted enclosures, as specified in this Code.

7. None allowed in unsprinklered buildings unless stored or used in gas rooms or in approved gas cabinets or exhausted enclosures, as specified in this Code.

8. With pressure-relief devices for stationary or portable containers vented directly outdoors or to an exhaust hood. [5000: Table 34.1.3.1]
55-40 Log #3 Final Action: Accept in Principle
(Table 6.3.1.1 and 6.5)
Submitter: William E. Hancock, Performance Design Technologies
Recommendation: Quantity of gases in the two tables are given in cubic feet and cubic meters. It should be clarified that these quantities are Standard Cubic Feet (and the equivalent in SI units). Table 10.3.2.1 shows an acceptable method of clarification.
Substantiation: See above.
Committee Meeting Action: Accept in Principle
Committee Statement: The committee agrees with the intended clarification being proposed. See committee action under 55-2 (Log #CP3).

55-41 Log #32 Final Action: Accept in Principle
(Table 6.5)
Submitter: John J. Anicello, Airgas Inc.
Recommendation: Add text to read as follows:

<table>
<thead>
<tr>
<th>Gas Hazard</th>
<th>Class</th>
<th>Quantity of Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen (Gaseous) bulk system</td>
<td>NA</td>
<td>15,000 ft³</td>
</tr>
</tbody>
</table>

Substantiation: Hydrogen bulk gas systems equal to or greater than 15000 SCF should be located in a detached building when indoors in accordance with the requirements of Chapter 10.
Committee Meeting Action: Accept in Principle
Revise the suggested text to read as follows:

<table>
<thead>
<tr>
<th>Gas Hazard</th>
<th>Class</th>
<th>Quantity of Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stationary Bulk Hydrogen Compressed Gas Systems</td>
<td>NA</td>
<td>15,000 ft³</td>
</tr>
</tbody>
</table>
Committee Statement: The committee reworded the language for clarification and corrected the scf conversion to metric.

55-42 Log #130 Final Action: Accept in Principle
(Table 6.5)
Submitter: Larry L. Fluer, Fluer, Inc. / Rep. Compressed Gas Association
Recommendation:

****Insert Table 6.5 Here****
Substantiation: Section 9.3(2) requires bulk oxygen systems to be located in a detached building. Similar requirements are found for GH2 in Table 10.3.2.1. The requirements of Chapter 9 and 10 need to be coordinated with Chapter 6.
Committee Meeting Action: Accept in Principle
Accept the proposed Table 6.5, but delete Row 1 on Bulk Oxygen Systems from the proposed table changes as follows:

****Insert-L130-CA-Include-Here****
Committee Statement: The requirements for bulk oxygen have been addressed by the committee action on 55-102 (Log #29).
<table>
<thead>
<tr>
<th>Gas Hazard</th>
<th>Class</th>
<th>Quantity of Material</th>
<th>ft³</th>
<th>m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk oxygen systems</td>
<td>NA</td>
<td>20,000</td>
<td>570</td>
<td></td>
</tr>
<tr>
<td>Bulk hydrogen compressed gas systems</td>
<td>NA</td>
<td>15,000</td>
<td>425</td>
<td></td>
</tr>
<tr>
<td>Unstable reactive (detonable)</td>
<td>4 or 3</td>
<td>Quantity thresholds for gases requiring special provisions*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unstable reactive (nondetonable)</td>
<td>3</td>
<td>2,000</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>Unstable reactive (nondetonable)</td>
<td>2</td>
<td>10,000</td>
<td>283</td>
<td></td>
</tr>
<tr>
<td>Pyrophoric gas</td>
<td>NA</td>
<td>2,000</td>
<td>57</td>
<td></td>
</tr>
</tbody>
</table>

NA: Not applicable.
*See Table 6.3.1.1.
Table 6.5  Detached Buildings Required Where Quantity of Material Exceeds Amount Shown

<table>
<thead>
<tr>
<th>Gas Hazard</th>
<th>Class</th>
<th>Quantity of Material ft³</th>
<th>m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk hydrogen compressed gas systems</td>
<td>NA</td>
<td>15,000</td>
<td>425</td>
</tr>
<tr>
<td>Unstable reactive (detonable)</td>
<td>4 or 3</td>
<td>2,000</td>
<td>57</td>
</tr>
<tr>
<td>Unstable reactive (nondetonable)</td>
<td>3</td>
<td>10,000</td>
<td>283</td>
</tr>
<tr>
<td>Unstable reactive (nondetonable)</td>
<td>2</td>
<td>2,000</td>
<td>57</td>
</tr>
<tr>
<td>Pyrophoric gas</td>
<td>NA</td>
<td>2,000</td>
<td>57</td>
</tr>
</tbody>
</table>

NA: Not applicable.
*See Table 6.3.1.1.
6.5.1 For such storage or use areas to be regulated as outdoor storage or use, compliance with 6.5.3 and 6.5.4 shall be required:

(1) The building or structure shall be constructed of non-combustible materials.
(2) Supports and shall not obstruct more than one side or more than 25 percent of the open perimeter of the storage or use area.
(3) The building or structure shall be limited to a maximum area of 1500 ft² with increases in area allowed by the building code based on occupancy and type of construction.

6.5.4 Structure Separation Distances:

(4) 6.5.4.1 The distance from the structure constructed as weather protection and the structural supports to buildings, lot lines, public ways or means of egress to a public way shall not be less than the distance required for an outside hazardous material storage or use area without weather protection based on the hazard classification of the materials contained.
(5) 6.5.4.2 Where the weather protection structure is constructed of noncombustible materials; reductions in the separation distance shall be permitted based on the use of fire barrier walls where permitted for specific materials in accordance with the requirements of Chapters 7 through 11.

Substantiation: The provisions for weather protection are inappropriately placed as subparagraphs to Section 6.5 for detached buildings. Buildings or structures used for weather protection may or may not be independent detached structures. For example, the typical cylinder dock may abut a building used for the production or storage of compressed gas. It is part of the building which is sheltered by overhead cover, but considered as outdoor storage in order to provide relief from requirements such as mechanical ventilation, explosion control and sprinkler systems in some cases. In order to “earn” the exemption, the area must be maintained substantially open to the surrounds.

The building codes allow for this dispensation providing the weather protected area is limited in size and of structures. For example, the typical cylinder dock may abut a building used for the production or storage of compressed gas. It is part of the building which is sheltered by overhead cover, but considered as outdoor storage in order to provide relief from requirements such as mechanical ventilation, explosion control and sprinkler systems in some cases. In order to “earn” the exemption, the area must be maintained substantially open to the surrounds. The building codes allow for this dispensation providing the weather protected area is limited in size and of non-combustible construction. The I-Codes have traditionally limited the area occupied as weather protection to 1500 sf as a means to grant dispensation from other requirements of the building code affecting sprinkler systems (in some cases), mechanical ventilation systems and explosion control. Allowances are made for area increase based on comparable areas of any building including the use of sprinkler systems (when otherwise not required) and street frontage based on fire separation distance. Approval of this proposal will correlate the concept of construction with the requirements listed in the IBC/IFC with the exception of the clarifications made. To determine the allowable area increases the construction type and occupancy of the sheltered area must first be determined.

Weather protection cannot be obstructed by enclosing it with perimeter walls that substantially block the free movement of air, and accessibility. On the other hand limited obstructions within a given set of prescriptive controls are acceptable. For example, a cylinder dock on the exterior of the building is allowed to abut the exterior building wall providing the three remaining walls are open to the exterior. The provisions also allow for the obstruction of multiple walls, providing that the total area of the perimeter walls that are obstructed does not exceed 25% of the total open perimeter area. To determine this mathematically the designer would calculate the aggregate perimeter area of all open sides of the building or structure used for weather protection and then demonstrate that obstructed areas (covered by abutting buildings or partial walls) do not exceed 25% of the aggregate area.

Section 6.5.1 has been deleted as it is redundant to Section 6.6.2 (old Section 6.5.2.2). It had been improperly placed as a subsection to 6.5 which is a requirement for detached buildings. Buildings and structures constructed as weather protected areas constructed in accordance with 6.5.1 and 6.5.2 through 6.5.4.

Weather protected areas that are not constructed in accordance with 6.6.2.5. shall be regulated as an indoor storage or use are regulated as outdoor storage or use. Where the weather protection structure is constructed of noncombustible materials, the storage or use area shall be permitted to be used for sheltering outdoor storage or use areas, without requiring such areas to be classified as indoor storage or use area.

Supports and shall not obstruct more than one side or more than 25 percent of the open perimeter area. To determine this mathematically the designer would calculate the aggregate perimeter area of all open sides of the building or structure used for weather protection and then demonstrate that obstructed areas (covered by abutting buildings or partial walls) do not exceed 25% of the aggregate area.

For such storage or use areas to be regulated as outdoor storage or use, compliance with conditions in 6.5.3 and 6.5.4 shall be required:

6.5.2 6.6 Classification of Weather Protection as an indoor Versus Outdoor Area.

6.6.1 6.6.2.1 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 or use.

6.6.2 6.5.2.2 For such storage or use areas, weather protected areas constructed in accordance with 6.6.3, to be regulated as outdoor storage or use, compliance with conditions in 6.5.3 and 6.5.4 shall be required:

6.6.2.1 6.5.2.3 Where storage or use areas are provided with weather protection that does not comply with these conditions; weather protected areas that are not constructed in accordance with 6.6.3 the storage or use area shall be regulated as an indoor storage or use area.
protection can be detached buildings or they can be attached to a building. The issue is not whether they are attached or detached, the issue is whether the sheltered area is considered to be indoors or outdoors.

Committee Meeting Action: Accept

Revise text to read as follows:

6.5.2 For such storage or use areas to be regulated as outdoor storage or use, compliance with 6.5.3 and 6.5.4 shall be required:

6.6.3 Buildings or structures used for weather protection shall be in accordance with the following:

(1) The building or structure shall be constructed of non-combustible materials.
(2) Supports shall not obstruct more than one side or more than 25 percent of the open perimeter of the storage or use area.
(3) The building or structure shall be limited to a maximum area of 1500 ft² with increases in area allowed by the building code based on occupancy and type of construction.

6.5.4 Structure Separation Distances

(4) 6.6.2.5.1 The distance from the structure constructed as weather protection and the structural supports to buildings, lot lines, public ways or means of egress to a public way shall not be less than the distance required for an outside hazardous material storage or use area without weather protection based on the hazard classification of the materials contained.

(5) Where the weather protection structure is constructed of noncombustible materials, Reductions in the separation distance shall be permitted based on the use of fire barrier walls where permitted for specific materials in accordance with the requirements of Chapters 7 through 11.

Committee Statement: The committee agreed with the proposed changes and revised the proposed language for editorial and clarification purposes.

Final Action: Accept

Log #74
(6.6.1.2)

Submitter: Larry L. Fluer, Fluer, Inc. / Rep. Compressed Gas Association

Recommendation: Revise text to read as follows:

6.6.2 The requirements of 6.6.1.1 shall not apply where emergency power is provided in accordance with 6.6.2 and NFPA 70, National Electrical Code.

Substantiation: Section 6.6.2 provides requirements in addition to those prescribed by NFPA 70. Adding 6.6.2 as a cross reference in 6.6.1.2 is an editorial function.

Committee Meeting Action: Accept
55-45 Log #75
(6.8 and A.8.8)

Final Action: Accept

Submitter: Larry L. Fluer, Fluer, Inc. / Rep. Compressed Gas Association

Recommendation: Revise text to read as follows:

6.8 Explosion Control.

Explosion control shall be provided as required by Table 6.8 in accordance with NFPA 68, Standard on Explosion Protection by Deflagrating Venting or, NFPA 69, Standard on Explosion Protection Systems, where amounts of compressed gases in storage or use exceed the quantity thresholds requiring special provisions. NFPA 68, Standard on Explosion Protection by Deflagrating Venting, provides more information on this subject.

Substantiation: NFPA 68 has been converted from a recommended practice to a Standard, and as such it is appropriate to refer to this document in the body of the code. Table 6.8 provides for the use of venting as an appropriate means to address the requirements for explosion control. Moving the requirements from an informational annex to the body of the code coordinates the concept in NFPA 55 with that used in NFPA 2 for hydrogen. It is appropriate for all flammable gases when explosion control is required through the use of deflagration venting.

Committee Meeting Action: Accept

55-46 Log #23
(6.9.2.1)

Final Action: Accept in Principle

Submitter: Tom Christman, Caryville, TN

Recommendation: Revise text to read as follows:

6.9.2.1 When sprinkler protection is provided, 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 NFPA 13, Standard for the Installation of Sprinkler Systems, for Ordinary Hazard Group 2, with a minimum design area of 3000 ft² or more.

Substantiation: The code provides no justification on why the design area needs to be increased to a minimum of 3000 sq ft. There is no increased fire risk from any of the inert gases which may be present in an area. Flammable gases are covered by Section 6.9.2.2 To stipulate a mandated minimum design area without noting the specific hazard or reason with annex material seems to be arbitrary. The designer of the system should be allowed to protect the hazard as noted with the classification of the system as Ordinary Hazard, Group 2. The Code should not restrict a designer to a minimum design area without substantial justification. If this Code has predetermined that the storage or use of any compressed gas is an Ordinary Hazard, Group 2, the designer should have the latitude to follow the Density/Area Curves as noted in NFPA 13 for the applicable hazard.

Committee Meeting Action: Accept in Principle

Revise the proposed text to read as follows:

6.9.2.1 When sprinkler protection is provided, 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 NFPA 13, Standard for the Installation of Sprinkler Systems, for Ordinary Hazard Group 2, with a minimum design area of 3000 ft² (278.7 m²).

Committee Statement: The committee agrees with the proposed change, but changed the word "provided" to "required" for clarity.
When sprinkler protection is provided, 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 NFPA 13, Standard for the Installation of Sprinkler Systems, for Extra Hazard Group 1 with a minimum design area of 2500 ft\(^2\) (232.25 m\(^2\)).

The use of flammable gases for maintenance or temporary activities such as hot work is permitted without classification of the sprinkler system as Extra Hazard, Group 1.

The code provides no justification on why the design area needs to be increased to a minimum of 3000 sq ft. To stipulate a mandated minimum design area without noting the specific hazard or reason with annex material seems to be arbitrary. The designer of the system should be allowed to protect the hazard as noted with the classification of the system as Extra Hazard, Group 1. The Code should not restrict a designer to a minimum design area without substantial justification. If this Code has predetermined that the storage or use of a flammable compressed gas is an Extra Hazard, Group 1 risk, the designer should have the latitude to follow the Density/Area Curves as noted in NFPA 13 for the applicable hazard.

A new section is added to allow the use of compressed flammable gases within a sprinklered area without having to classify the system as Extra Hazard, Group 1. Most facilities would generally NOT be classified as an Extra Hazard but most facilities from time to time require hotwork to be performed to maintain the building. As the classification of the sprinkler system cannot be changed from the original design, the code needs to provide the flexibility to conduct required work without having to install the sprinkler system as Extra Hazard.

Committee Meeting Action: Accept in Principle in Part

Revise the proposed text to read as follows:

6.9.2.2 When sprinkler protection is provided, 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 NFPA 13, Standard for the Installation of Sprinkler Systems, for Extra Hazard Group 1 with a minimum design area of 2500 ft\(^2\) (232.25 m\(^2\)).

Committee Statement: The committee revised the word "provided" to "required" for clarity. 6.9.2.2.1 was deleted because the material is already addressed in 6.2.3 and 6.3.1.6.2.

Electrical powered equipment shall not be installed inside of gas cabinets containing flammable gas cylinders.

Gas cabinets are not sold as listed or tested by a nationally recognized testing laboratory. I have seen gas cabinets that have been modified to install electrical equipment inside of the cabinet for flow control equipment or other types of gas flow or pressure monitoring equipment. There are no current code requirements that address the hazard of electrical equipment located inside of a gas cabinet with flammable gas cylinders inside of the cabinet. In the event of a leak or gas equipment failure, the electrical equipment presents an ignition source for the flammable gas and could cause a fire or an explosion. The change is needed to make sure that cabinets are not modified by the installation of electrical equipment by the user.

Committee Meeting Action: Reject

Committee Statement: The proposal is prohibiting the installation of all electric equipment where electrical equipment may be needed to be installed in accordance with the NEC.
6.16.4 Quantity Limits. Gas cabinets shall contain not more than three containers, cylinders, or tanks the MAQ limit given in Table 6.3.1.1 for Gas Cabinet, Gas Room, or Exhausted Enclosure; sprinklered or unsprinklered as appropriate; for the material being stored.

Substantiation: The limit of three containers, cylinders, or tanks is inappropriate since it is not related to quantity.

Committee Meeting Action: Reject

Committee Statement: There is no reasonably simple way for an inspector to determine compliance with regards to the quantity of gas in an area versus content. The committee is concerned about the number of potentially active connections in a single enclosure.

7.1.3 Large Insulated Liquid Carbon Dioxide System. Large insulated liquid carbon dioxide systems shall be in accordance with the provisions of CGA G-6.1—2005, Standard for Insulated Carbon Dioxide Systems at Customer Sites.

7.1.4 Large Insulated Liquid Nitrous Oxide System. Liquid insulated nitrous oxide systems shall be installed in accordance with the provisions of G-8.1—2007, Standard for Nitrous Oxide Systems at Customer Sites.

Substantiation: Insulated carbon dioxide and nitrous oxide systems are not cryogenic fluids, and therefore chapter 8 provisions do not apply in the current code leaving them inadequately regulated under chapter 7 provisions. CGA has developed standards for the installations of these containers and by referencing their use will bring a harmonized minimum standard around the country.

Committee Meeting Action: Reject

Committee Statement: The substantiation is incomplete as it is written at this time. The committee advises the proponent to return at the public comment phase with more technically complete material, as would be addressed in 13.4.

7.1.4.1.5 Containers, Design, and Construction. Compressed gas containers, cylinders, and tanks used for metal hydride storage systems shall be designed and constructed in accordance with 7.1.5.1.

Substantiation: Clarification of requirements is warranted as it avoids misapplication of this section of the code. One could argue that 7.1.4 is only for metal hydride storage systems and that the added language is redundant and only editorial, however, the use of the term has been inserted into other subsections and insertion of the language serves to bring consistency to the approach.

Committee Meeting Action: Accept
Defective containers, cylinders, and tanks shall be returned to the supplier. Suppliers shall repair the containers, cylinders, and tanks, remove them from service, or dispose of them in an approved manner. Suppliers shall ensure that defective containers, cylinders and tanks that have been repaired are evaluated by qualified personnel 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.

Substantiation: Repairs to pressure vessels is conducted by authorized requalifiers or testers under the requirements of the Department of Transportation. Suppliers and third party authorized cylinder requalifiers can perform the work providing they have been approved by DOT or similar agency (TC) for performing the required tests and/or repairs. In the event that the supplier is not the authorized requalifier the supplier has a responsibility to ensure that any work performed to correct deficiencies has been performed as requested. Persons qualified to ensure that the required repairs and testing has been performed include those that are familiar with the repair and requalification process.

Committee Meeting Action: Accept in Principle

Revise the proposed text to read as follows:

7.1.5.2.1 Defective containers, cylinders, and tanks shall be returned to the supplier.
7.1.5.2.2 Suppliers shall repair the containers, cylinders, and tanks, remove them from service, or dispose of them in an approved manner.
7.1.5.2.3 Suppliers shall ensure that defective containers, cylinders 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.

Committee Statement: The committee changed the word “personnel” to “individual” to be consistent with the definition Qualified Individual.

Containers, Cylinders, and Tanks Containing Residual Gas. Compressed gas containers, cylinders, 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.

Cylinder requalifiers are in effect an extension of the supply and distribution chain where containers are received, segregated, examined, serviced and processed. These containers may contain compressed gases when received, and the practices exercised by the suppliers including nesting, transport, security, etc. apply as the cylinders move through the process.

Section 7.1.5.4 and others provide direction to the handling of cylinders, containers and tanks that are being serviced. The inclusion of the term in this provision works in concert with correlating changes to expand the requirements and exemptions granted to the gas manufacturers or distributors to include the category of requalifiers as those involved with cylinder servicing (other than the gas suppliers).

For additional information see 49 CFR 107.805.

A companion definition for “authorized cylinder requalifier” has been submitted as a separate proposal.

Committee Meeting Action: Accept
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. The design limits shall be available to the AHJ upon request.

7.1.6.3.1 The design limits 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

Substantiation: The reference in 7.1.6.3 to 7.1.4.1.12 is to the NEC. The appropriate reference for inspection is to 7.1.6.2. The last sentence of 7.1.6.3 is a requirement for the designer and as such is not part of inspection. The last sentence has been proposed to be added as subparagraph 7.1.6.3.1 and the following paragraph renumbered.

Committee Meeting Action: Accept in Principle

Revise the suggested text to read as follows:

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. The design limits shall be available to the AHJ upon request.

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

Committee Statement: The committee added clarifying language to 7.1.6.3.1.
Storage, use, and handling areas shall be secured against unauthorized entry. 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.

The goal of this requirement is to prevent unauthorized personnel or those unfamiliar with gas storage systems from tampering with the equipment as well as to prevent the inadvertent or unauthorized removal or use of compressed gases from storage areas. Where the compressed gases are located in an area open to the general public, a common practice is to fence and lock the storage or use area, with access restricted to supplier and user personnel. When the storage or use is located within the user's secure area and is not accessible by the general public, it is not always necessary to fence or otherwise secure the individual gas storage or use areas. Personnel access patterns may still mandate that the system be fenced, as determined by the supplier and the user.

Substantiation: As explained by the annex note, the primary purpose of security is to prevent tampering and unauthorized use of compressed gases by the general public. Many facilities are either fully fenced or otherwise provided with access control whereby only the users of these materials are permitted access. The intent of the code was not to require that any storage or use be under lock and key or that the security provided be such that storage or use by facility employees was hampered by security controls. It is reasonable to expect that facilities that are not accessible by the general public have administrative procedures in place that directs the proper storage and use areas as well as specifying how these materials will be allowed to be employed. New Section 7.1.8.2.1 does not mandate the use of administrative controls, but allows administrative controls to be used as a means to limit access. In areas not accessible by the general public the user has a choice as to whether to provide physical barriers as a means of protection or to otherwise restrict access through the use of policies and procedures. This flexibility is required by the code to address practical application of these requirements.

Committee Meeting Action: Accept

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.

Substantiation: Cylinder requalifiers are in effect an extension of the supply and distribution chain where containers are received, segregated, examined, serviced and processed. Nesting is a recognized way to handle securing of cylinders in plants and facilities handling large numbers of containers. Including authorized cylinder requalifier’s facilities in the use of nesting is in keeping with the practices currently employed in facilities of this nature.

A companion definition for “authorized cylinder requalifier” has been submitted as a separate proposal.

Committee Meeting Action: Accept
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.

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 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.

Substantiation: Section 7.1.9.1 was written as a general requirement for all compressed gases. There are instances where compressed gas cylinders may be used in a form not anticipated by the code when this section was developed. Tube trailers, cylinder packs and similar arrangements conventionally are not equipped with protective caps, collars, or similar devices. On the other hand such equipment generally is equipped with safeguards to protect the container valves from impact.

Adding the new requirements that recognize the requirements for manifold protection can resolve the problem with tube trailer systems. A new requirement has been established in 7.1.9.1.1 to address systems other than DOT (over the road) type systems which may include equipment commonly known as 6 packs, 12 packs and similar items which are comprised of cylinders equipped with a manifold that are attached to a wheeled frame. Physical protection is typically provided by the framework used as a supporting structure. In addition, stationary storage/use systems are not equipped with valve protection of the type suggested by 7.1.9.1. Systems of this nature are usually protected through the use of Section 4.11 or 7.1.8.3. The “other approved means” is an important consideration to recognize that every possible circumstance cannot be addressed. Physical protection can be provided by means other than those specifically described in 4.11 or 7.1.8.3. Sufficient guidance is provided to inform the user of the need and of the exceptions to be applied.

Committee Meeting Action: Accept
Compressed gas containers, cylinders, tanks, and systems in storage or use shall be separated from materials and conditions that present exposure hazards to or from each other.

Compressed gas containers, cylinders, tanks, and systems in storage or use shall be separated in accordance with 7.1.10.

Subparagraph 7.1.10.1.2 shall not apply to gases contained within closed piping systems, compressed gas containers, cylinders, tanks, and systems in storage or use when separated in accordance with 7.1.10.

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

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

The distances shown in Table 7.1.10.2 shall be permitted to be reduced without limit where compressed gas cylinders, tanks, and containers 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.

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.

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

Spatial separation shall not be required between cylinders deemed to be incompatible that are connected to manifolds for the purposes of filling and manufacturing procedures, assuming the prescribed controls for the manufacture of gas mixtures are in place.

Substantiation: As currently written Section 7.1.10.1.2 is redundant to 7.1.10.1.1. Section 7.1.10.1.3 is in effect an exception for piping systems and should be moved to become a subparagraph to 7.1.10.2 as it is misplaced. The balance of the statement in 7.1.10.1.3 other than that portion addressing piping systems is identical to 7.1.10.2 and it is redundant to 7.1.10.1.1.

Creating a separate subsection to address piping systems clarifies the fact that the separation of individual piping systems is not required. From a code perspective all use of compressed gas is a condition of “closed use” including systems where the gas may be used in a welding torch. It is quite common for gas welding equipment to have oxygen and fuel gas incorporated into a hose (an extension of the piping system) where oxygen is transported through one side of the hose with fuel gas transported on the other.

In large facilities or in multistoried buildings it is quite common to have various gases transported in piping systems in pipe racks that contain natural gas, compressed air, oxygen, hydrogen, nitrogen/argon or other gases. The concept is not new, rather it is being relocated to the appropriate place in the code.

Committee Meeting Action: Accept
7.1.10.4 Clearance from indoor combustible storage and construction. Compressed gas cylinders shall not be stored indoors within 20 ft of combustible storage or combustible construction unless the storage area is provided with adequate automatic sprinkler protection.

7.1.10.5* Clearance from indoor flammable liquids hazards. Compressed gas cylinders shall not be stored indoors in areas exposed to flammable liquids storage or to operations where flammable liquid spills and resulting fires may expose the cylinders.

* A 7.1.10.3.5 Curbing and emergency drainage may be used to prevent exposure to flammable liquids spills if cylinders are located at least 20 ft from the curbing.

Substantiation: These exposures to indoor cylinder storage are not clearly addressed by the current codes. Indoor fires involving combustible storage, construction and flammable liquids can grow rapidly. Indoor locations may also hinder manual fire-fighting from cooling the cylinders, resulting in excessive heating of the cylinders. Sprinklers and space separation will help to reduce the exposures to the cylinders.

Committee Meeting Action: Reject

Committee Statement: The proponent asked to reject 7.1.10.4 by not accepting it in his motion as it prohibited the storage of compressed gas in buildings of other than noncombustible construction without the use of sprinklers. Such a requirement would prohibit the storage of inert gases or compressed air in unsprinklered buildings if spacial separation of 20 ft or more was not provided between the cylinders and combustible elements of the building. The committee feels that 7.1.10.5 is not enforceable. 7.1 creates a general requirement that would apply to cylinders of any size, excluding containers and tanks.

55-60 Log #84

Compressed gas containers, cylinders, 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.

Compressed gas containers, cylinders and tanks that have not been designed for use under elevated temperature conditions shall not be exposed to direct sunlight out-of-doors 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.

Substantiation: The filling density for compressed gases is related to temperature and pressure. Filling densities and pressures are generally determined at 130°F. The 125°F (52°C) limitation provides a margin of safety to users of gaseous materials. When ambient temperatures exceed 125°F, and containers are exposed to direct sunlight, it is possible to exceed the 130°F threshold temperature limit internally causing containers to become over-pressurized and leak, pressure relief valves to release, or in the case of liquefied gas to expand to a point where the container may be subject to extreme hydraulic overpressure. In areas where ambient temperatures are expected to exceed 125°F containers stored or used out of doors should be under weather protection, moved inside to a cooler environment or otherwise provided with shade to avoid direct contact with the rays of the sun.

Committee Meeting Action: Accept
55-61 Log #85

(7.1.10.10.1 and A.7.1.10.10.1 (New))

Final Action: Accept

Submitter: Larry L. Fluer, Fluer, Inc. / Rep. Compressed Gas Association

Recommendation: Add new text to read as follows:

7.1.10.10: **Exposure to Electrical Circuits**. Compressed gas containers, cylinders, and tanks, shall not be placed where they could be 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, National Electric Code (NEC).

A.7.1.10.10.1 Electrical devices can include pressure transducers, signal transmitters, shut off controls and similar devices. Some of these devices may be non-incendive and suitable for use in hazardous areas. Flammability of gases is not the only concern with respect to electrical circuits as piping serving systems in uses can act as conductors of electrical energy exposing unrelated portions of the system to electrical hazards if improperly installed.

**Substantiation:** To allow the mounting of electrical devices on piping cylinders, containers or tanks provided they are installed in accordance with the NEC.

Committee Meeting Action: Accept
Accessible manual valves or automatic remotely activated fail-safe emergency shutoff valves shall be provided to shut off the flow of gas in case of emergency, and clearly marked.

Emergency shutoff valves on a bulk source or piping systems serving the bulk supply shall be identified by means of a sign.

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.

Accessible manual or automatic emergency shutoff valves shall be provided to shut off the cryogenic fluid supply in case of emergency.

Emergency shutoff valves on a bulk source or piping systems serving the bulk supply shall be identified by means of a sign.

Emergency shutoff valves shall be located at the point of use, at the source of supply and at the point where the system piping enters the building.

The approach to providing emergency shutoff valves should be consistently applied as general requirements of Chapters 7 and 8. The terms “Emergency Shutoff Valve, Manual Emergency Shutoff Valve and Automatic Emergency Shutoff Valve” are defined terms. Automatic Emergency Shutoff Valves are required, by definition, to be of a fail-safe design. These valve can be activated by either automatic or manual means.

Signage is required for those shutoff systems serving the bulk supply to provide for ready identification. Having a shutoff at each point of use is conventional and the addition of signage is not always appropriate. For example, if the shutoff valve is a cylinder valve the shutoff may be obvious.

A similar code change was accepted into the ROC draft of NFPA 2. Accepting this change will correlate NFPA 2 and 55 in concept except that NFPA 2 uses the terms [GH2 or LH2] in lieu of gas or cryogenic fluid where appropriate.


Substantiation: The current wording has been interpreted to mean that the materials requiring excess flow control be classified as having all three of the properties indicated. Clarification is warranted so that the user understands that gases in any of the hazard classes designated is required to comply with the requirements for excess flow control.

Committee Meeting Action: Accept
Technical Committee on Industrial and Medical Gases,
Revise 7.3.1.12.1 as follows:

7.3.1.12.1* Where compressed gases or liquids having a hazard ranking of the following in accordance with NFPA 704, Standard System for the Identification of the Hazards of Materials for Emergency Response, are carried in pressurized piping above a gauge pressure of 15 psi (103 kPa), an approved means of either leak detection and emergency shutoff, or excess flow control shall be provided:

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

Substantiation: The revisions clarify that leak detection with automatic shutoff is not needed in lieu of excess flow protection.

Committee Meeting Action: Accept

Larry L. Fluer, Fluer, Inc. / Rep. Compressed Gas Association
Revise text to read as follows:

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

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

An approved means of leak detection and emergency shutoff is one way of meeting the requirements for excess flow control. Bulk cryogenic fluids are not subject to the requirements for excess flow control based on a health hazard ranking due to cold temperature when installed in accordance with the requirements of Chapters 8 or 9. Bulk cryogenic fluids that are vaporized and distributed as a compressed gas downstream of the source valve are subject to the requirements for excess flow control if the gas has either a health hazard ranking of Class 3 or 4 based on corrosivity or toxicity, a flammability hazard ranking of Class 4, or a reactivity ranking of Class 3 or 4.

Chapter 7 covers compressed gases, not cryogenic fluids. The use of the word “liquids” may cause the user to believe that cryogenic fluids, which are assigned health hazard rankings of 3, because of the low temperature require excess flow protection on the bulk source when a bulk cryogenic fluid system supplies gas (for example, a liquid nitrogen tank supplying gaseous nitrogen). On the other hand a cryogenic fluid that may have a health hazard rating of Class 3 or 4 based on corrosivity or toxicity a flammability ranking of Class 4 or a reactivity ranking of Class 3 or 4 would be required to be equipped with excess flow control. Excess flow control for cryogenic fluid systems where the gas is vaporized is typically located downstream of the source valve which is normally in close proximity to where the cryogen is vaporized and converted from the liquid phase to the gaseous phase. Clarifications have been added with modifications to the annex note that provide guidance to the user in this regard.

Committee Meeting Action: Accept
55-66  Log #89  Final Action: Accept
(7.3.1.12.1.2 and A.7.3.1.12.1.2, and Figures A.3.3.12(d) and (e) (New) )

Submitter: Larry L. Fluer, Fluer, Inc. / Rep. Compressed Gas Association
Recommendation:   1. Revise Section 7.3.1.12.1.2 as follows:

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.

A.7.3.1.12.1.2 When distributed systems are employed the excess flow control system located at the bulk source may be sized to operate at a release rate greater than any single point of use or branch connection. Additional points of excess flow control may be required throughout the system in order to provide shut down in the event of a failure in any single system branch. Such systems will generally be designed to operate when flow exceeds the capacity of the point(s) of use served.

2. In Figures A.3.3.12(d) and (e) relocate the excess flow valve (EFV) to a point downstream of the Source Valve (SV).

Substantiation: The design of the excess flow control system is the responsibility of the user. The rate of gas consumption and required operating pressures are variable and dependent on user demands on the system. The intent of the excess flow control system is to limit release in the event of a rupture or breach of the piping system.

The drawings in Figure A.3.3.12(d) and (e) should be revised to locate the excess flow valve downstream of the source valve.

Committee Meeting Action: Accept

55-67  Log #38  Final Action: Reject
(7.3.1.12.1.3 (New) )

Submitter: Glenn Mahnken, FM Global
Recommendation:   Add new text to read as follows:

7.3.1.12.1.3 Where leak detection is used as a means of excess flow control, the leak detection means shall be provided at both the bulk source and end use areas.

Substantiation: Clarifies that leak detection is needed on both sides of the source valve.

Committee Meeting Action: Reject
Committee Statement: Excess flow control and leak detection plus automatic shut off are separate concepts in the code.
The controls required by 7.3.1.12.1 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
4. *Systems equipped with emergency shutdown controls used to transfer a batch load to or from a delivery vehicle to a storage system or from a delivery vehicle or storage system to process operations.

A batch load is typically the entire quantity or a substantial quantity of the material in the vessel used to initiate the transfer. The rapid transfer of a large quantity of material from delivery vehicles into storage tanks or transfer systems where the product is transferred into a process would trip conventional excess flow control systems. Examples of these transfer operations typically involve the delivery of bulk product via a transport vehicle where the material is transferred by pump or pressure from the delivery vessel to the storage vessel. An example of such a transfer for a process operation might be the transfer of an entire load of hydrogen as a batch from either a storage tank or a delivery vehicle for a hydrogenation reaction.

Substantiation: None given.
Committee Meeting Action: Reject
Committee Statement: The proposal, as written, is incomplete. The committee rejected this material at the proponent's request.

The controls required by 7.3.1.12.1 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
4. *Systems equipped with emergency shutdown controls used to transfer a batch load to or from a delivery vehicle to a storage system or from a delivery vehicle or storage system to process operations.

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.

Substantiation: Table 7.6.2 was developed for flammable gases other than bulk, i.e., non-bulk. The addition of the term “non-bulk” in the charging language is needed as section titles or table titles are not regulatory by nature.
Committee Meeting Action: Accept
Report on Proposals – June 2012

Submitter: Larry L. Fluer, Fluer, Inc.
Recommendation: 1. Revise Section 7.6.2.1 as follows:

7.6.2.1 Bulk hydrogen gas installations shall be in accordance with Table 10.3.2.2.1(a) and Table 10.3.2.2.1(b).
Chapter 10.

2. Delete Section 7.6.2.5.1 in its entirety (See NFPA Errata #1).

7.6.2.5.1 Bulk hydrogen gas installations shall be separated from building openings in accordance with Table 10.3.2.2.1(a) and Table 10.3.2.2.1(b).

3. Relocate Section 10.4.6 to Section 7.6.3 and renumber the following sections.

7.6.3.10.4.6 Indoor Non-Bulk Hydrogen Compressed Gas System Location.

7.6.3.1.10.4.6.1 Hydrogen systems of less than 3500 scf (99 m³) and greater than the MAQ, where located inside buildings, shall be located in the building so that the system will be as follows:

(1) In a ventilated area in accordance with the provisions of Section 6.15
(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
   (a) The distance shall be permitted to be reduced to 10 ft (3.1 m) where the room or area is protected by a listed detection system per Article 500.7(K) of NFPA 70, National Electrical Code, 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) Isolation valves used to isolate the fuel supply shall be of a fail-safe design.
(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

7.6.3.2.10.4.6.2 Systems Installed in One Room.

7.6.3.2.1.10.4.6.2.1 More than one system of 3500 scf (99 m³) 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.

7.6.3.2.2.10.4.6.2.2 The separation distance between multiple systems of 3500 scf (99 m³) 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 in accordance with the requirements of Section 6.9.

Substantiation: Chapter 10 is applicable to bulk gas systems. Proposals have been introduced to increase the quantity threshold used to define bulk hydrogen compressed gas systems from 400 cubic feet to 5000 cubic feet which will align the threshold level with Section 7.6.2.2 for other flammable gases. Section 7.6.2.1 has been revised to refer the user to Chapter 10 for requirements for bulk gas systems. Section 7.6.2.5.1 has been deleted as bulk hydrogen is proposed to be regulated by Chapter 10.

A separate proposal has been submitted to revise Chapter 10 to regulate bulk gas systems. The proposed revision of Chapter 10 to have it apply only to bulk GH2 systems necessitates requirements for indoor non-bulk systems currently found in Section 10.4.6 to be relocated to Chapter 7.

The actions taken by the IMG TG on this proposal should be consistent with respect to the proposals affecting the reorganization of Chapter 10.

This is not original material; its reference/source is as follows:

NFPA 2 - NFPA 55 Joint Task Group 6
Committee Meeting Action: Accept in Principle
Accept the proposed changes, but replace the proposed changes under item 3 with the content from correlating proposal number 4 from the action on 55-127 (Log #31).

Committee Statement: In item number 2, the proponent's reference to Errata # 1 is not correct. However, the problem raised has been dealt with through the committee action on 55-105 (Log #139). The modifications to item 3 have been augmented through the use of correlating proposal number 4 through the action on 55-127 (Log #31).
Revise 7.6.2.2 as follows:

7.6.2.2 Bulk gas systems for flammable gases other than hydrogen shall be in accordance with Table 10.3.2.2.1(a) and/or Table 10.3.2.2.1(b) and 10.3.2.2.4 where the quantity of flammable compressed gas exceeds 5000 ft³ (scf) (141.6 m³).

Substantiation: The provision in question being adding addresses barrier confinement and the same principle applies to all gaseous bulk flammables.

Committee Meeting Action: Accept
7.6.3.3 Mechanical Spark. Friction heat or impact spark shall be controlled. Hand tools used in areas that cannot be purged free of flammable concentrations shall be spark resistant.

Substantiation: Ignition Hazard of Steel Tools

- Although there are many ventilation/purging provisions within NFPA 55, a flammable environment can develop as could be expected with ventilation or equipment malfunction. Flammable gas such as hydrogen gas is colorless, odorless, tasteless and therefore not detectable by the human senses. In the event of ventilation or equipment failure, flammable concentration can quickly accumulate that is not detectable by the human senses.

- Non-sparking hand tools are used to guard against mechanical sparks such as impact and friction sparks, which are both a potential ignition source in flammable environments. Hand tools used on flammable gas cylinders or systems are used in a torque application, i.e. tools will make contact in a rubbing action. Friction sparks are generated from rubbing or surface contact between steel and other materials; they can generate friction sparks and therefore create an ignition hazard in a flammable environment. This occurs when metal parts of the steel tool rub against another hard surface. Impact sparks, however, are created by a steel object being struck or dropped on another hard surface.

Studies & data referencing Mechanical Sparks and their Hazards:

- In a document entitled, Frictional Sparking, Martin Sheldon stated that “It is well known that the sharpening of steel tools on a grindstone is accompanied by showers of sparks.” Sheldon went on to say “frictional heating and spark occurs when two solid bodies come into contact with each other, because of microscopic surface irregularities, they do not touch over the whole of their surfaces but only at a relative few spots. At the actual contact spots adhesion occurs between the two bodies and if they are moved relative to each other the work necessary to overcome this adhesion is converted into heat, raising the temperature of the bodies…..As the contact spots are forced apart fragments of the materials may be broken off and projected into the surroundings…These small particles of material have arisen from the areas where work was expended. If these particles are heated sufficiently the glowing particles will appear as frictional sparks.”

- A test by R.E. Bruderer, Ignition Properties of Mechanically Sparks and Hot Surfaces in Dust/Air Mixtures, reported that “systematic tests with steel friction sparks resulted in the ignition of the easily ignitable flammable gases (hydrogen) and combustible dusts.”

- M.J. Burgess and R.V. Wheeler also reported immediate ignitions of hydrogen-air obtained by rubbing mild steel on mild steel at 2 meter per second in Safety Mines Research Bd. Paper 46. H.M.S.O.

- NFPA 30, Flammable and Combustible Liquids, Chapter 6, section 6.5.1 lists frictional heat or sparks as sources of ignition of flammable vapors and precaution shall be taken to control ignition sources.

- OSHA Flammable and Combustible Liquids regulation, 29 CFR Parts 1910.106(b)(6) states that precaution shall be taken to eliminate or control sources of ignitions including frictional heat and mechanical sparks to prevent the ignition of flammable vapors.

- In Frictional Sparking, Martin Sheldon reported steel friction sparks are incandescent particles at temperatures around 1500°C/2732°F

- NFPA 921, Guide for Fire and Explosion Investigations 2008 Edition, Chapter 5 Basic Fire Science Table 5.76.1.1 Reported Burning and Sparking Temperature of Selected Ignition Sources under Mechanical Sparks lists a Steel tool spark temperature at 2550°F.

- Minimum ignition temperatures(MIT) for flammable gases are reportedly less than 2550°F, for example, MIT for hydrogen is 968°F, 824°F for gasoline, 440°F for kerosene, 959°F for ethane, 380°F for ethyl ether, 689°F for ethyl alcohol, 896°F for toluene. Spark temperature of steel hand tools far exceeds the minimum ignition temperature of flammable gases.

- A test conducted by W. Bartknecht, Ignition Capability of Hot Surfaces and Mechanically Generated Sparks in Flammable Gas and Dust/Air Mixtures showed that if steel is rubbed against steel for a longer duration, (0.5-2.0 seconds) then friction sparks are generated which are much more ignition efficient. At ignition temperature 400°C (752°F), the electrical equivalent energy by steel friction sparks range from 10mJ to 100mJ. Reported minimum ignition energy (MIE) for most flammable gases is less than 10milijoules(mJ), for example, MIE for hydrogen is 0.017mJ, 0.3mJ for methane, 0.25mJ for ethane, 0.017mJ for gasoline, 0.2mJ for ethyl ether, 2.5mJ for toluene. Power density of friction sparks from steel rubbed against steel also far exceeds the minimum ignition energy of flammable gases.

- When working with flammable gases, a potential hazard arises because of the possibility that sparks produced by
Recognizing the potential for steel tools to be an ignition source in flammable environments, the Occupational Safety & Health Administration (OSHA) provides guidance in booklet 3080 Hand and Power Tools, 2002 revised, “Iron and steel hand tools may produce sparks that can be an ignition source around flammable substances. Where this hazard exists, spark-resistant tools should be used.”

- Handbook of Compressed Gases by Compress Gas Association, 4th edition, page 28, states that “Nonsparking tools must be used when working with or on flammable compressed gas cylinder/systems.”

- Manufacturers of flammable gases regularly require the use of “non-sparking” tools under Handling and Storage section in the MSDS’s for their products. A few examples: Praxair, Linde Gas, Airgas, Canexus, and Calgaz

### Example of accidents caused by sparks from steel tools:
- This sample of OSHA documented accidents illustrates that accidents do happen when proper safety measures are not taken to guard against friction sparks from steel tools.
- Listed as accident#62 on dust incident data compiled by the Chemical Safety Board (CSB), an explosion resulted as a spark created by a worker with an Allen wrench who was turning a screw to adjust a machine. The spark ignited some propellant dust and a vacuum system carried the fire another room where a barrel of dust exploded.
- OSHA inspection# 124728437, employee #1 and a coworker, both maintenance mechanics, were working in a 30 in. by 36 in. manhole at a Space Age Fuel gas station in Gresham, OR. Employee #1 was trying to change a fuel pump, while the coworker watched from outside the manhole. Employee #1 was using an Allen wrench to loosen the bolts on the fuel pump lead when he apparently created a spark that ignited the gas fumes in the manhole, causing an explosion. Employee #1 suffered burns to his face, hands, arms, and legs. He was transported to hospital for treatment.
- OSHA inspection# 126764497, employee #1 was performing maintenance work on equipment used to make ignition caps for automotive air bags. He ran into some problems and called maintenance, but instead of waiting for them to arrive, he dismantled and attempted to reassemble the parts. In the process, he put in a part upside down. The part had four screws, and while two of them were still able to be installed, the other two no longer matched with their holes. Unaware that the part was upside down, Employee #1 tried to force one of the screws in at an angle. The friction resulting from this effort ignited the cap’s residual explosive material. Flames flashed up the sleeve of Employee #1’s smock and he sustained third-degree burns to his arm.
- OSHA inspection# 309946457, employee #1 was working in the hydrogenation area when he removed the lid from Converter Number 1 and placed it on the ground next to the approximately 25-in.-diameter opening to the converter. Employee #1 then removed the gasket from around the lid and used a wire-brush grinder to remove the silicone that had sealed the gasket to the lid. Converter Number 1 contained a mixture of vegetable oil and hydrogen. While Employee #1 was grinding the lid, sparks mixed with the hydrogen and exploded. Employee #1 was thrown approximately 7 ft into the air and onto some overhead pipes. Employee #1’s right arm was severed and he was killed.
- OSHA inspection# 300965795, employee #1 was in the process of cleaning loose material from drill piping with a metal hammer. While striking the pipe with a hammer, an explosion occurred. Employee #1 was killed.
- OSHA inspection# 2272953, employees were assigned the job of tending a 100 gallon (water-jacket) reactor kettle of methyl methacrylate in the mixing room. Employee #1 was standing between Kettle #1 and Kettle #2, preparing to check the viscosity of the liquid product, employee#2 was standing 5 feet south of employee#1, asking him how the batch was progressing. Employee#1 used a metal wrench (Visegrips) to pry open the cover of kettle #1. The wrench handle struck the angle iron support for the agitator motor, producing a spark. Employee#2 noticed the spark, which was immediately followed by a massive “Fireball”. Employee#1 and #2 were engulfed in the fireball. Employee#2 came to the area of kettle #1 to assist the other employees and also received injuries. All three employees received first and second degree burns on their face, arms and abdomen. No bonding or grounding was used for the transfer of flammable liquids; nor were non-sparking tools provided.

NFPA 55 provides safeguards for the storage, use, and handling of flammable gases. When considering controlling ignition sources, mechanical sparks from steel tools should not be overlooked as an ignition source. Unless it can easily be determined that the flammable concentration is not within the flammability limits, it is a safer practice to use spark resistant hand tools in areas that cannot be purged free of flammable concentrations. Without this specification, ferrous tools are likely to be used which can be an ignition source. However, if upon further consideration, the Committee still does not see the need for restricting ferrous tools in flammable atmospheres, we ask the Committee to at least include the proposed text in Annex text to raise the awareness of ignition hazard associated with ferrous tools in direct contact with flammable materials.

This is not original material; its reference/source is as follows:
Ignition Capabilities of Hot Surfaces and Mechanically Generated Sparks in Flammable Gas and Dust/Air Mixture, W. Bartknecht. Ignition Properties of Mechanical Sparks and Hot Surfaces in Dust/Air/Mixtures, R.E. Bruderer. M.J.
As written, the statement is unenforceable. Any area covered by this code can be purged of flammable concentration.

In addition, hand tools are not defined. There are already many ways to address the issue, including procedural controls that are already in existence. The use of spark-resistant hand tools in a flammable environment can create a false sense of security and should not be considered a mitigation means. The committee does not support work in flammable gas environments.

55-73 Log #131 Final Action: Accept
(7.8.3 and Table 7.8.3)

Submitter: Larry L. Fluer, Fluer, Inc. / Rep. Compressed Gas Association

Recommendation: Revise text to read as follows:

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

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.

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

7.8.3.2.2 The 13 fire barrier shall be at least 5 ft (1.5 m) from the storage or use area perimeter.

7.8.3.3 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 of buildings shall be separated from building openings by 25 ft.

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

****Insert Table 7.8.3 Here****

Substantiation: Table 7.8.3 was created in a companion format to that used by Table 7.6.2. When Table 7.6.2 was revised in the last code cycle Table 7.8.3 was not reformatted. In the last code cycle revisions were made in Table 7.6.2 to eliminate embedding a requirement for required distance to building openings which were placed into text in Section 7.6.2.5 (note that this section was the subject of errata #1).

In this proposal Table 7.8.3 has been revised to a format similar to that used in Table 7.6.2 except that unlike Table 7.6.2 distances are also indicated in metric units of measure.

A companion definition has been issued under a separate proposal to define “fire barrier” which is used throughout this section and other sections of the code.

Committee Meeting Action: Accept
### 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></td>
<td>ft³</td>
<td>m³</td>
<td>ft</td>
<td>m</td>
</tr>
<tr>
<td>250</td>
<td>7.1</td>
<td>5</td>
<td>1.5</td>
<td>25</td>
</tr>
<tr>
<td>&gt;250 to 2500</td>
<td>&gt; 7.1 to 71.0</td>
<td>10</td>
<td>3.0</td>
<td>50</td>
</tr>
<tr>
<td>≥ 2500 to 7500</td>
<td>≥ 71.0 to 212.4</td>
<td>20</td>
<td>6.0</td>
<td>100</td>
</tr>
</tbody>
</table>
55-74 Log #93  Final Action: Accept
(7.9.1, 7.9.2.2, and 7.9.2.3)

Submitter: Larry L. Fluer, Fluer, Inc. / Rep. Compressed Gas Association
Recommendation: Revise text to read as follows:

7.9.1 General. The storage or use of toxic and or highly toxic 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 7.9.

7.9.2.2 Distance to Exposures. The outdoor storage or use of toxic and 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.

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

Substantiation: The use of the term “and” as a conjunction between toxic and highly toxic implies that both conditions exist. The term “or” designates an either/or condition. Sections 7.9.2.2; 7.9.3; 7.9.3.1; 7.9.3.3; 7.9.6 and others correctly reflect the fact that the use of either classification is intended.

Committee Meeting Action: Accept

55-75 Log #5  Final Action: Accept
(7.9.3.2.2)

Submitter: A. Shane Fast, The Chlorine Institute
Recommendation: Revise text to read as follows:

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 container, cylinder, or tank valves.

Substantiation: The proposed wording clarifies that actuators mounted directly on the container valve meet the intent of this paragraph. As written, it could be implied that the valve must be downstream of the tank valve and it is the opinion of The Chlorine Institute that closing the container valve is as good as or better than having a secondary valve.

Committee Meeting Action: Accept

55-76 Log #28  Final Action: Reject
(8.1.3 (New))

Submitter: John J. Anicello, Airgas Inc.
Recommendation: Add text to read as follows:

8.1.3 Stationary insulated containers containing cryogenic fluids shall be installed and maintained in accordance with the provisions required in this chapter for bulk cryogenic fluid systems.

Substantiation: There are non-portable containers being installed under the threshold level for a bulk system based on the definition and is occurring without proper controls due to a lack of adequate regulation.

Committee Meeting Action: Reject
Committee Statement: The committee believes that this issue goes beyond a simple change and needs further study. The committee encourages further discussion and development.
8.2.1.2.3.3 Vacuum level monitoring shall not be required for microbulk systems.

While microbulk cryogenic fluid systems are similar to bulk gas systems they do have some unique characteristics that need to be addressed in the code. These vessels do not typically have connections for vacuum monitoring.

Committee Meeting Action: Reject
Committee Statement: The committee believes that this issue goes beyond a simple change and needs further study as it has broad ramifications on other codes and standards. The committee encourages further discussion and development on the proper method handling this issue.

55-78 Log #95 Final Action: Accept
(8.2.3)

Submitter: Larry L. Fluer, Fluer, Inc. / Rep. Compressed Gas Association
Recommendation: Delete the following text:
8.2.3 Concrete Containers -
8.2.3.1 Concrete containers shall be built in accordance with the building code.
8.2.3.2 Barrier materials and membranes used in connection with concrete, but not functioning structurally, shall be materials prescribed by nationally recognized standards.

Substantiation: Concrete containers are not typically found in the modern tanks and storage systems available today. The provisions attendant to Section 8.2.3 are so general that they provide little if any guidance to a designer that chooses to create such a storage system for the materials regulated by NFPA 55. Removal of these provisions does not stop a designer from constructing such a system under the requirements of Section 1.5. Systems constructed under the provisions of 1.5 would require the designer to demonstrate that the design is at least equivalent if not superior to systems otherwise required.

There are no known requirements in the model building codes for the construction of tanks or containers for cryogenic fluids although there are requirements specific to liquefied natural gas which is regulated by NFPA 59A. If the provisions for concrete containers are to be retained in NFPA 55 specific provisions at least equivalent in scope to those specified in NFPA 59A Section 7.5 need to be developed. Referring to NFPA 59A may not be appropriate given the considerable difference in temperature between LNG and other cryogens such as hydrogen or helium. If the IMG TC feels that a section should be retained, then an option would be to designate the section as “Reserved” until such time as an interest group developed meaningful requirements.

Existing facilities deemed to be compliant when the systems were constructed are protected under the requirements of Section 1.4 and removal of the provisions affecting new construction would have no bearing on existing installations.

Leaving these general requirements in place without direction to the user creates a problem for code users, designers and AHJs alike. If they are to be retained, the requirements should be technically viable, otherwise they should be deleted.

Committee Meeting Action: Accept
ASME pressure-relief valves shall be sealed made to be tamper resistant in order to prevent adjusting the set pressure by other than authorized personnel.

Pressure relief valves typically are spring-loaded valves where the relief pressure is set by adjustment of a spring. Valves should be made to be tamper resistant sealed to prevent adjustment by other than authorized personnel typically found at a retest facility. An ASME pressure relief valve is designed to comply with the requirements of the ASME Boiler and Pressure Vessel Code and typically is equipped with a wire and lead seal to prevent resist tampering.

Substantiation: Use of the words “tamper resistant” are preferable to the term “sealed.” Sealed can have a connotation of being plugged which is not the intent. Modification has been made to the annex not accordingly.

Committee Meeting Action: Accept in Principle

Revise text to read as follows:

ASME pressure-relief valves shall be sealed made to be tamper resistant in order to prevent adjusting the set pressure by other than authorized personnel.

Pressure relief valves typically are spring-loaded valves where the relief pressure is set by adjustment of a spring. Valves should be made to be tamper resistant sealed to prevent adjustment by other than authorized personnel typically found at a retest facility. An ASME pressure relief valve is designed to comply with the requirements of the ASME Boiler and Pressure Vessel Code and typically is equipped with a wire and lead seal to prevent resist tampering.

Committee Statement: The committee revised the annex note to clarify that the lead seal and wiring meets the requirement.

Shutoff valves shall be of a locking type 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.

Substantiation: The intent is to have the valves located between pressure relief devices and containers locked open except during maintenance as required by ASME rules. Having the capability to lock the valve does not give the user or the AHJ direction in what is required – which is to lock the valves open except when maintenance is being performed.

Committee Meeting Action: Accept
55-81  Log #19  Final Action: Reject
(8.5)

Submitter: Robert M. Sutter, B&R Compliance Associates

Recommendation: Delete text to read as follows:
8.5.1.1 Bulk Cryogenic Fluid systems..."
8.5.1.3 Bulk Cryogenic Fluid systems..."
8.5.1.5 Bulk cryogenic fluid systems..."
8.5.1.6 Bulk cryogenic fluid systems..."

Substantiation: These requirements should apply to bulk and microbulk cryogenic fluid systems. Therefore the specific reference to bulk can be deleted.

Committee Meeting Action: Reject

Committee Statement: The committee believes that this issue goes beyond a simple change and needs further study. The suggested reason for striking the term bulk is to try and account for a size of system that may not have been considered in the code. Doing so would likely create more confusion than it corrects. The committee encourages further discussion and development.
Micro Bulk Cryogenic Liquid Systems shall have the following protections:

1. If located indoors, be installed within a room used only for this purpose.

2. If located outdoors, Oxygen Systems sited to comply with minimum distance requirements in Chapter 9 Bulk Oxygen Systems.


4. Location in an enclosure constructed per NFPA 99, sections 5.1.3.3.2(1) through 5.1.3.3.2(5), 5.1.3.3.2(8), and 5.1.3.3.2(9).

5. Location in an enclosure ventilated per NFPA 99, Section 5.1.3.3.3.

6. Design such that the items noted in NFPA 99, Section 5.1.3.4.13.2 and items located in trailer unloading area are readily visible to delivery personal during filling operations.

7. Protection against overpressurization of the pressure vessel during filling operations.

8. Does not have a bottom fill valve.

9. Installation per NFPA 99, sections 5.1.10.1 through 5.1.10.5.7.

10. Installation by personnel qualified to meet CGA M-1, *Guide for Medical Gas Installations at Consumer Sites* or ASSE 6015 Professional Qualifications Standards for Bulk Medical Gas Systems Installers.


Micro Bulk Cryogenic Liquid System with a primary and secondary supply shall have their headers located in the same enclosure.

Micro Bulk Cryogenic Liquid System with a reserve header shall be permitted to be located in the same enclosure as the primary and secondary headers or in another enclosure compliant with NFPA 99, Section 5.1.3.4.12.1.

Micro Bulk Cryogenic Liquid System shall consist of the following:

1. Two equal headers each having sufficient capacity for an average day's supply, with either being capable of either role, consisting of one primary supply and one secondary supply and with the headers connected to the final line pressure regulator assembly in such a manner that either header may supply the system and a reserve header, per NFPA 99, Section 5.1.3.4.9 having sufficient number of gas cylinder connections for an average day's supply, but not fewer than three, and connected downstream of the primary/secondary headers and upstream of the final line pressure regulators.

2. One Micro Bulk Cryogenic Liquid main header having sufficient capacity for an average day's supply, one secondary supply, the secondary supply consist of either a Micro Bulk Cryogenic Liquid, Liquid Containers, or High Pressure Cylinders, having sufficient capacity for an average day's supply, and a reserve header, per NFPA 99, Section 5.1.3.4.9 having sufficient number of gas cylinder connections for an average day's supply, but not fewer than three, and connected downstream of the primary/secondary headers and upstream of the final line pressure regulators.

3. One Micro Bulk Cryogenic Liquid main header having sufficient capacity for an average day's supply, one reserve header consists of either a Micro Bulk Cryogenic Liquid supply or High Pressure Cylinders per NFPA 99, Section 5.1.3.4.9, connections for an average day's supply, and connected downstream of the primary/secondary headers and upstream of the final line pressure regulators.

The Micro Bulk Cryogenic System shall include the following:

1. When the primary or main header is supplying the system, the secondary and reserve header is prevented from supplying the system.

2. When the primary or main header is depleted, the roles of primary or main, secondary (when installed), and reserve, will alternate and provide an operating cascade (primary-secondary-reserve) automatically begins to supply the system.

3. Capacity determined after consideration of the customer usage requirements, delivery schedules, proximity of the facility to alternate supplies, and the emergency plan.

4. Where there are two or more Micro Bulk Cryogenic Liquid vessels of equal capacity, they are permitted to alternate in the roles of primary and secondary.

5. A reserve supply sized for greater than an average day's supply, with the appropriate size of vessel of number of cylinders being determined after consideration of delivery schedules, proximity of the facility to alternate supplies, and
the facility's emergency plan.

(7) At least two main vessel relief valves and rupture discs installed downstream of a three-way (three-port) valve.

(8) A check valve located in the primary supply piping upstream of the intersection with a secondary supply or reserve supply.

(9) A contents gauge on each of the main vessel(s).

(10) A pressure relief installed downstream of the connection of the reserve header and upstream of the final line pressure regulating assembly and set at 50 percent above the normal inlet pressure.

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

(12) The manifolds for two equal headers shall include a manual or automatic means to place either header into the role as primary header and the other in the role of secondary header (when so provided).

(13) The manifolds for main supply with a secondary supply (when so provided) headers shall include a manual or automatic means to place the secondary header into the role as primary header during the filling of the main supply.

(14) The manifolds shall include a means to automatically activate the reserve header if for any reason the primary and secondary (when so provided) headers cannot supply the system.

(15) Permanent anchors holding the components to the pad or flooring in accordance with the design requirements.

The Micro Bulk Cryogenic System in this category shall actuate a local signal and shall activate an indicator at all master alarms under the following conditions: indicator at all master alarms under the following conditions:

- When or at a predetermined set point before the main or primary supply reaches an average day's supply, indicating low contents.
- If the secondary supply is a cryogenic vessel, when or at a predetermined set point before the secondary supply reaches an average day's supply, indicating low contents.
- If the reserve supply is a cryogenic vessel, when or at a predetermined set point before the reserve supply, reaches an average day's supply, indicating low contents.
- Where there is more than one main supply vessel, or at a predetermined set point before the secondary supply begins to supply the system, indicating changeover.
- When or at a predetermined set point before the reserve supply begins to supply the system, indicating reserve is in use.
- If the reserve is a cryogenic vessel, when or at a predetermined set point before the reserve internal pressure falls too low for the reserve to operate properly, indicating reserve failure.

Substantiation: MicroBulk Sources are being installed in the U.S. without guidance given by either the NFPA 55 or by the NFPA 99.

NFPA 55 and NFPA 99 do not address the unique requirements for MicroBulks Systems. The microbulk seems to be a hybrid of a Bulk System and Dewar manifold system. The guidelines in both the NFPA 99 and NFPA 55 do not take into consideration microbulk systems.

This is not original material; its reference/source is as follows: NFPA 55 and NFPA 99.

Committee Meeting Action: Reject

Committee Statement: The issue of microbulk needs further development with regards to the approach to solve the perceived problem that they are not being addressed by the code. 55-82 (Log #142) and the issue of microbulk requires further study before the committee can make a determination of the appropriate path forward.
Submitter: Robert M. Sutter, B&R Compliance Associates

Recommendation: Revised text to read as follows:

8.5.1 Bulk cryogenic fluid systems in medical gas applications at health care facilities shall be in accordance with Chapter 8, 1.1.2(3), and the material specific requirements of Chapter 9 as applicable the following:

8.5.1.1 For oxygen systems
(1) Section 8.2 through 8.2.1.2.3.2,
(2) Section 8.2.4 through 8.2.5.6.1,
(3) Section 8.2.5.7 through 8.4.4.1.2.1,
(4) Section 8.4.6,
(5) Section 8.5.1.1 through 8.7.2.1.4,
(6) Section 8.7.2.2 through 8.12,
(7) Section 8.13.2 through 8.14.10.2,
(8) Section 8.14.11.2 through 8.14.11.4.4.1,
(9) and Chapter 9,
8.5.1.1 for nitrogen systems
(1) Section 8.2 through 8.2.1.2.3.2,
(2) Section 8.2.4 through 8.2.5.6.1,
(3) Section 8.2.5.7 through 8.4.4.1.2.1,
(4) Section 8.4.6,
(5) Section 8.5.1.1 items (3) and(4) through 8.5.1.3,
(6) Section 8.5.1.5 through 8.6.5,
(7) Section 8.7.2.2 through 8.7.3,
(8) Section 8.8 through 8.12,
(9) Section 8.13.1.3 through 8.13.1.4,
(10) Section 8.13.2 through 8.14.10.2,
(11) Section 8.14.11.2.3 through 8.14.11.3.2.3,
(12) and section 8.14.11.3.4, through 8.14.11.4.4.2.

Substantiation: The NFPA 55 standard was not written to address the unique aspects of a medical gas system. Many of the requirements for bulk medical gas systems that are now found in NFPA 55 are not needed and at times contradictory. For example 8.4.5 requires the piping to be labeled in accordance with ASNI A13.1. The installer would be required to use Blue/White labels on the oxygen pipe. This is the colors for a material of inherently low hazard gas or gaseous admixture. For nitrogen NF systems the 99 standard now requires compliance with the NFPA 55 standard which in turn requires compliance with CGA P-18. In the scope of CGA P-18 it says, “This standard does not apply to medical bulk inert gas systems”. Until the unique requirements of medical gas systems can be properly addressed in NFPA 55

Committee Meeting Action: Reject

Committee Statement: The proposal did not provide adequate rationale for the suggested changes and was lacking in substance with regards to the reasons behind applying certain criteria and not others. For example, fire barriers, courtyards, vehicle loading and unloading areas, etc. were not included in the list of required design options.
Revise text to read as follows:

Bulk and microbulk cryogenic fluid systems in medical gas applications at health care facilities shall be in accordance with Chapter 8, 1.1.2(3), and the material specific requirements of Chapter 9 as applicable.

The uses of microbulk systems are becoming more popular in health care facility applications and the wording of the current requirements has caused some AHJ's to prohibit their use. Adding this and several other proposals would clarify and allow the use of microbulk systems.

Microbulk is a term that is not currently defined in NFPA 55. The issue of microbulk needs further development with regards to the approach to solve the perceived problem that they are not being addressed by the code. 55-82 (Log #142) and related proposals on the issue of microbulk requires further study before the committee can make a determination of the appropriate path forward. The committee encourages proponents with an interest on this issue to seek common ground and return with coordinated proposals, if possible.

Add new text to read as follows:

Microbulk fluid systems shall include a fill mechanism consisting of the following components:

(1) A nonremovable product specific fill connection in compliance with CGA V-1, Standard For Compressed Gas Cylinder Valve Outlet And Inlet Connections.

(2) Meet the requirements of 8.5.1.7 sections (2) through (8).

Microbulk systems do not typically have fill connections that meet the requirements in CGA V-6. They do have fill connections that meet the requirements in CGA V-1.

Add new section after 8.5.1.7 and renumber.

The issue of microbulk needs further development with regards to the approach to solve the perceived problem that they are not being addressed by the code. 55-82 (Log #142) and related proposals on the issue of microbulk requires further study before the committee can make a determination of the appropriate path forward. The committee encourages proponents with an interest on this issue to seek common ground and return with coordinated proposals, if possible. If additional reference standards are to be utilized, then copies of those need to be provided to the committee for review.
55-86 Log #4
(8.5.1.1(3))

Final Action: Reject

Submitter: Robert Sutter, B&R Compliance Assoc.

Recommendation: Revise text to read as follows:

Systems shall be installed by personnel qualified in accordance with CGA M-1, Guide for Medical Gas Installations at Consumer Sites or ASSE 6015 Professional Qualification Standard for Bulk Cryogenic System Installers.

Substantiation: The ASSE 6000 series standards are a series of qualification standards for personnel associated with medical gas systems. The 6015 standard was written specifically for installers of bulk medical gas systems at health care facilities. The proposed language does not make qualification to the ASSE 6015 standard a specific requirement but it provides an alternate method of demonstrating qualifications to install medical cryogenic systems.

This is not original material; its reference/source is as follows:

Committee Meeting Action: Reject
Committee Statement: The current ASSE standard being cited contains references that are outdated with regard to modern publications. NFPA 55 does not preclude the use of the equivalency statement for alternative methods in Section 1.5.

55-87 Log #15
(8.5.1.2)

Final Action: Reject

Submitter: Robert M. Sutter, B&R Compliance Associates

Recommendation: Revise text to read as follows:

The following components of the bulk cryogenic fluid system shall be accessible and visible to delivery personnel during filling operations:

1. Fill connection
2. Top and bottom fill valves used for vessel filling
3. Hose purge valve
4. Vent valve
5. Full trycock (if installed)
6. Liquid level gauge
7. Tank pressure gauge

Substantiation: Changing the term from bulk system to cryogenic fluid allows this section to apply to bulk and microbulk cryogenic fluid systems.

The typical microbulk container does not have a bottom fill valve. Making the change still requires the valves used for filling to be accessible and visible.

Typical microbulk tanks do not have full trycock valves installed. On vessels were the valve is installed it needs to be readily accessible and visible.

Committee Meeting Action: Reject
Committee Statement: The committee perceives this to be related to the issues surrounding microbulk. The issue of microbulk needs further development with regards to the approach to solve the perceived problem that they are not being addressed by the code. 55-82 (Log #142) and related proposals on the issue of microbulk requires further study before the committee can make a determination of the appropriate path forward. The committee encourages proponents with an interest on this issue to seek common ground and return with coordinated proposals, if possible. If additional reference standards are to be utilized, then copies of those need to be provided to the committee for review.
For oxygen systems a delivery vehicle pad shall be provided in accordance with 9.3.2.3. The way the requirement is currently written some inspectors will require nitrogen systems to have delivery vehicle pads. I have already seen locations where they have required no smoking signs for nitrogen systems.

Delete the existing 8.5.1.4 and revise the suggested text to create new text as follows:

8.5.1.4 A delivery vehicle pad shall be provided in accordance with 9.3.2.3.

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

A8.14.11.3.4 The inert cryogens, nitrogen and argon, do not require the installation of a noncombustible spill pad as they do not typically condense oxygen from the air in sufficient quantities to pose a hazard during transfer.

A8.14.11.3.4.1 A noncombustible spill pad shall be provided for delivery areas where bulk liquid helium is transferred from delivery vehicles.

A8.14.11.3.4.1 The noncombustible spill pad is provided for liquid helium transfer operations as cryogen is at a temperature that is sufficiently low enough to liquefy oxygen, presenting a hazard when in contact with combustible surfaces.

Committee Statement: The committee identified a broader need to create a general provision applicable to cryogenic fluids beyond oxygen, as raised by the proponent. The intent of the proponent to include oxygen has been maintained by the action taken here.

Bulk cryogenic fluid reserve supply systems consisting of either a second cryogenic fluid source or a compressed gas source shall include the following:

(1) A second cryogenic fluid vessel or When the reserve source is a compressed gas source the reserve shall be equipped with:

(a) a cylinder header manifold having not less than three gas cylinder connections or as otherwise required for an average of one day’s gas supply, but not fewer than three, and

(b) a pressure switch monitoring the pressure in the cylinder header manifold (where provided)

(2) When the reserve source is a second cryogenic fluid vessel, the reserve tank shall be equipped with:

(a) An actuating switch or sensor to monitoring the internal tank pressure of the reserve cryogenic fluid vessel (where provided), and

(b) A contents gauge to monitoring the liquid level in the reserve cryogenic fluid vessel (where provided)

(3) When the reserve source is either a cryogenic fluid or compressed gas source A check valve shall be provided to prevent backflow into the reserve system.

(5) A pressure switch monitoring the pressure in the cylinder header (where provided)

Substantiation: The change is intended to be an editorial change for clarification only. The current wording presents some confusion as to when the specific requirements are applied. Reformattting the provisions and minimizing the use of jargon terms (header) will assist code users in better understanding the provisions.

Committee Meeting Action: Accept
Report on Proposals – June 2012

55-90     Log #13
Final Action: Accept in Principle

55-90     Log #13
(8.5.1.6(1))

Submitter: Robert M. Sutter, B&R Compliance Associates
Recommendation: Delete text as follows:
A second cryogenic fluid vessel or a cylinder header having gas cylinder connection for an average day’s supply but
not fewer than three.
Substantiation: There is no need for reserve system to have a second cryogenic fluid vessel or a cylinder header.
Committee Meeting Action: Accept in Principle
Committee Statement: See the action taken by the committee under 55-89 (Log #98), which resolves the issue.

55-91     Log #94
Final Action: Accept

55-91     Log #94
(8.5.1.7)

Submitter: Larry L. Fluer, Fluer, Inc. / Rep. Compressed Gas Association
Recommendation: Revise text to read as follows:
8.5.1.7 Bulk cryogenic fluid systems shall include a fill mechanism consisting of the following components:
(1) A non-removable product-specific fill connection in compliance with CGA V-6, Standard Cryogenic Liquid Transfer
Connection
(2) A means to cap and secure the fill connection inlet
(3) A strainer with a minimum 100 mesh screen with a body and screen both of Monel® or brass construction
(4) A check valve to prevent product backflow from the fill inlet
(5) A fill hose purge valve
(6) Supports that hold the fill piping off the ground
(7) A secure connection between the bulk tank and the fill piping
(8) Supports as necessary to hold the fill line in position during all operations associated with the filling procedure

Substantiation: The provision was placed into NFPA 99 by a CGA proposal identified as ROP Item 99-174 Log 225.
The requirements for a screen were initially published in the 2005 Edition of NFPA 99. The substantiating statement in
support of the proposal was as follows:
“A strainer in the fill line will stop material that could damage the seats in the fill valves from entering the system.”
The requirement was incorporated into NFPA 55 in the Fall 2008 code revision cycle as a product of a joint task group
formed between the NFPA 55 and NFPA 99 technical committees charged with coordinating the two documents
regarding medical gas systems. The public comment was ROC Item 55-2 Log #1 and submitted to the IMG TC from the
Experience shows that the strainer adds the unnecessary potential for mechanical failure of the screen which may
result in particulate contamination in the tank. A recent incident occurred where the screen (strainer internals)
separated from the strainer housing during a delivery and was found downstream in the fill line piping, lodged in the fill
cluster.

****Insert Figure Here****
Committee Meeting Action: Accept
55-92 Log #99 Final Action: Accept
(8.6.2, 8.6.2.1, and A.8.6.2)

Recommendation: Revise text to read as follows:

8.6.2* Security of Areas. Areas used for the storage of containers and systems shall be secured against unauthorized entry.

A.8.6.2 The purpose of this requirement is to prevent unauthorized personnel or those unfamiliar with cryogenic storage systems from tampering with the equipment. Where the bulk storage system is located in an area open to the general public, a common practice is to fence the system and lock it, with access restricted to supplier personnel and sometimes user personnel. When the bulk storage system is located within the user’s secure area and is not open to the general public, it is not always necessary to fence the bulk storage system. Personnel access patterns may still mandate that the system be fenced, as determined by the supplier and the user.

8.6.2.1* Administrative controls shall be allowed to be used to control access to individual storage areas located in secure facilities not accessible by the general public.

Substantiation: Provide more specific guidance on fencing of bulk storage systems. As explained by the annex note, the primary purpose of security is to prevent tampering and unauthorized use of cryogenic fluids by the general public. Many facilities are either fully fenced or otherwise provided with access control whereby only the users of these materials are permitted access. The intent of the code was not to require that any storage or use be under lock and key or that the security provided be such that storage or use by facility employees was hampered by security controls. It is reasonable to expect that facilities that are not accessible by the general public have administrative procedures in place that directs the proper storage and use areas as well as specifying how these materials will be allowed to be employed.

New Section 7.1.8.2.1 does not mandate the use of administrative controls, but allows administrative controls to be used as a means to limit access. In areas not accessible by the general public the user has a choice as to whether to provide physical barriers as a means of protection or to otherwise restrict access through the use of policies and procedures. This flexibility is required by the code to address practical application of these requirements.

Committee Meeting Action: Accept

55-93 Log #132 Final Action: Accept
(Table 8.7.2)

Recommendation:

****Insert Table 8.7.2 Here****

Substantiation: The inclusion of “other building exits” is not needed in row (2) and its inclusion presents a conflict in requirements with row (9). Perhaps the wording should have been “Wall openings other than building exits;” but at this point deletion of the term clarifies the issue and row (9) stands alone.

Committee Meeting Action: Accept
<table>
<thead>
<tr>
<th>Exposure</th>
<th>Minimum Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Buildings, regardless of construction type</td>
<td>1</td>
</tr>
<tr>
<td>(2) Wall openings and other building exits</td>
<td>1</td>
</tr>
<tr>
<td>(3) Air intakes</td>
<td>10</td>
</tr>
<tr>
<td>(4) Property lines</td>
<td>5</td>
</tr>
<tr>
<td>(5) Places of public assembly (assembly occupancies)</td>
<td>50</td>
</tr>
<tr>
<td>(6) Nonambulatory patient areas</td>
<td>50</td>
</tr>
<tr>
<td>(7) Combustible materials, (e.g., paper, leaves, weeds, dry grass, debris)</td>
<td>15</td>
</tr>
<tr>
<td>(8) Incompatible hazardous materials</td>
<td>20</td>
</tr>
<tr>
<td>(9) Building exits</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>3.1</td>
</tr>
<tr>
<td></td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td>6.1</td>
</tr>
<tr>
<td></td>
<td>3.1</td>
</tr>
</tbody>
</table>
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).

The connecting angles between fire barrier walls are 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.

See Figure A.8.13.2.7.2.1 which addresses bulk cryogenic systems located in a courtyard. This figure also applies to the case where any or all of the three walls are constructed as fire barrier walls.

The committee agreed with the proposal and editorially changed the word "is" to "are" in 8.7.2.1.4.1.
Containers that have been removed from service shall be handled in an approved manner.

[8.9.1.1 and 8.9.1.2 to remain as printed]

Containers that have previously been used for flammable cryogenic fluids which have been removed from service shall be purged with an inert gas to remove residual flammable gas and stored with all valves closed and the outlets plugged.

Substantiation: Section 8.9.1 is a generic requirement. When flammable cryogenic fluids have been stored in the containers the existing language needs to be prescriptive so that direction is given to the user and AHJ as to how containers of this nature should be handled.

Committee Meeting Action: Accept in Principle

Revise the proposed text to read as follows:

8.9.1 Containers. Containers that have been removed from service shall be handled in an approved manner.

[8.9.1.1 and 8.9.1.2 to remain as printed]

8.9.1.3 Containers that have previously been used for flammable cryogenic fluids which have been removed from service shall be purged with an inert gas to remove residual flammable gas and stored with all valves closed and the valve outlets plugged.

Committee Statement: The committee agreed with the proposal and added the word "valve" for clarity so that specifically the valve outlet is plugged and not anything else.
Cryogenic fluid storage systems shall be inspected periodically and maintained by a qualified representative of the equipment owner unless otherwise required by the material-specific requirements of Chapters 9 and 11. The interval between periodic inspections other than those specified by material specific requirements shall be based on nationally recognized good practices or standards.

A.8.14.1.3.1 CGA P-18, Standard for Bulk Inert Gas Systems at Consumer Sites recommends periodic inspection intervals for inert gas systems.

Substantiation: Companion proposals have been made to address inspection requirements for oxygen and hydrogen systems. The substantiating statement relative to oxygen systems is as follows: Industry practice is to inspect oxygen systems on an annual basis. The chapter 8 requirement for inspection has been changed to reflect the longer intervals for inspecting inert gas systems, but oxygen systems require more frequent inspections. NFPA 50 required annual inspections of oxygen systems in section 4.2.1, and it carried forward into chapter 8 of NFPA 55.

Committee Meeting Action: Accept in Principle
Revise the proposed text to read as follows:
8.14.1.3.1 Cryogenic fluid storage systems shall be inspected annually and maintained by a qualified representative of the equipment owner as required by the material-specific requirements of Chapters 9 and 11.
8.14.1.3.1.1* The interval between inspections other than those specified by material specific requirements shall be based on nationally recognized good practices or standards.
A.8.14.1.3.1.1 CGA P-18, Standard for Bulk Inert Gas Systems at Consumer Sites recommends periodic inspection intervals for inert gas systems.

Committee Statement: The committee revised the proposal to remove vague and unenforceable language and to adhere to the Manual of Style.
Overfilling

Over pressurization, controls shall be provided to prevent overfilling of stationary containers during filling operations.

Substantiation: When the requirement was in NFPA 99 2005 it was for over pressurization not over filling. The only vessels that I am aware of that have over filling protection are Chart Industries MicroBulk containers. (Full trycock valves do not prevent over filling they only let you know that you are about to over fill the vessel.)

Committee Meeting Action: Accept in Principle
Committee Statement: See the committee action under 55-100 (Log #CP5), which resolves the issue brought forward by this proposal.
Where a bulk oxygen system is intended for use in medical gas applications, the applicable provisions of NFPA 99, Standard for Health Care Facilities, shall be required to be in accordance with 8.5 in addition to the provisions stated herein.

Substantiation: Based on the work of a joint task group between NFPA 55 and 99 technical committees appropriate requirements for medical gas cryogenic supply systems have been taken from NFPA 99 and placed in section 8.5. When NFPA 99 is complete the provisions can be reflected in NFPA 55 as extract text. As required by Section 9.1 Chapters 1 through 9 are applicable to all medical bulk oxygen systems. Although one could argue that Section 9.1 addresses the requirements of Section 8.5, adding a reference to Section 8.5 in 9.1.1.2 directs the user to specific supply system requirements replacing a general reference to NFPA 99.

Committee Meeting Action: Accept

(2) In a detached building of fire-resistive or noncombustible/limited-combustible construction, ventilated to prevent the accumulation of oxygen vapors, and equipped with protection level controls in accordance with the requirements of the building code, used exclusively for that purpose.

The committee deleted the mixed-use concept and replaced it with clarifying language.
9.3.2.3 The area of noncombustible surfacing provided under liquid mobile supply equipment shall have a width not less than the full width of the delivery vehicle and a length not less than 8 ft (2.5 m) in the direction of the vehicle axis.

Substantiation: Editorial.
Committee Meeting Action: Accept

55-104 Log #106 Final Action: Accept in Principle

(9.5 (New) )

Submitter: Larry L. Fluer, Fluer, Inc. / Rep. Compressed Gas Association

Recommendation: Add new text to read as follows:

9.5 Inspection.
9.5.1 Cryogenic oxygen storage systems shall be inspected annually and maintained by a qualified representative of the equipment owner.
9.5.1 A record of the inspection shall be prepared and provided to the user or the AHJ upon request.

Substantiation: Industry practice is to inspect oxygen systems on an annual basis. The requirements of 8.14.1.3.1 for inspection have been changed to reflect the intervals for inspecting inert gas systems, but oxygen systems require more frequent inspections. NFPA 50 (1999 Edition) required annual inspections of oxygen systems in section 4.2.1, and it carried forward into chapter 8 of NFPA 55 as a general requirement. This proposal relocates the provision from Chapter 8 to a material specific requirement in accordance with the requirements of Chapter 9.

Committee Meeting Action: Accept in Principle
Revise the proposed new text to read as follows:

9.5 Inspection.
9.5.1 Bulk cryogenic oxygen storage systems shall be inspected annually and maintained by a qualified representative of the equipment owner.
9.5.1 A record of the inspection shall be prepared and provided to the user or the AHJ upon request.

Committee Statement: The committee agreed with the proposal, but added the word “bulk” to be consistent with Chapter 9.
A joint task group, known as Task Group 6, has been appointed by the Chairs of the NFPA 2, Hydrogen Technologies Code and the IMG TC. Revisions to separation distance tables in NFPA 55 were the focus of this group in the last code revision cycle. Feedback from industry and code users alike sought a simplification of requirements relative to the application of the tabular distances and the work of the task group continued.

One of the major stumbling blocks for readers of the existing tables was one where an assumption was made that distances should increase as system pressure increased. The use of pressure to pipe ID changes as pressure increases resulting in a decrease in the pipe ID and the corresponding leak rate which is generally based on 3% of the internal area of the largest section of pipe in the system under the pressure indicated.

Other complaints heard were that the table was too complex with too many pieces of data. Others found the use of complex exponential equations difficult when pipe IDs other than those common IDs listed in the table were encountered. Other comments were received that the metric units of measure were inconsistent and questions arose as to why there were two tables. To make things a bit more confusing a printing error resulted in quantity being placed into the table heading (corrected by Errata #1).

The task group addressed these issues with several changes in the manner in which the data is presented without changing either the criteria used or the end results (other than due to the display of data or mathematical rounding).

- The table (10.3.2.2.1(a)) was simplified by grouping the exposures into three separate groups with Groups 1 and 2 being people sensitive groups and Group 3 being of a material or property nature. As the chapter was reorganized the table was renumbered to 10.3.2.1(a).
- Table 10.3.2.1(a) has maintained the four common pressure ranges and it has been combined with Table 10.3.2.2.1(b) so that SI units are provided in the same table.
- Distances have been calculated first in inch-pound units of measure and rounded to the nearest foot (instead of five feet), and SI units have been determined using standard conversion formulas and rounding to the nearest meter using conventional rounding.
- The footnotes to Table 10.3.2.2.1 have been removed and placed into an annex note as they were informative.
- The pipe ID has been listed for the Typical Maximum Pipe Size (Table 10.3.2.1(a)).
- Table 10.3.2.1(b) is new. It replaces Table A.10.3.2.2.1.1(E) and the use of exponential formulas shown in A.10.3.2.2.1.1(B) in the 2010 Edition.
- Table 10.3.2.2.1(b) lists the pipe diameters in a range generally from 0.2 to 2 inches in increments of 1/10th of an inch. The resultant separation distance for each exposure group has been calculated and displayed in the table. The formulas have been simplified and are shown at the top of each column for each exposure group. For example, for Group 1 exposures in the 15 to 250 psig pressure range distance “D” is determined by multiplying the internal pipe ID in mm by 0.231 and rounding to the nearest foot or corresponding nearest meter. Interpolation between values can be used as indicated in table footnotes. The table is functional for pipe or tube as all values are based on ID.
- The exposures in each group are those established in Table 10.3.2.1(a).
- Comments received regarding an expected progression of distance with increasing pressures remain unresolved for Table 10.3.2.1(a). By referring to Table 10.3.2.1(b) it becomes clear that this is the case as the distances are normalized across any single row based on a single pipe ID. For example for a 0.7 inch ID pipe the distances across the pressure ranges in the table range as follows:

\[
\begin{align*}
>15 \text{ to } =250 \text{ psi} & \approx 4 \text{ ft} \\
>250 \text{ to } =3000 \text{ psi} & \approx 13 \text{ ft} \\
>3000 \text{ to } =7500 \text{ psi} & \approx 20 \text{ ft} \\
>7500 \text{ to } =15000 \text{ psi} & \approx 26 \text{ ft}
\end{align*}
\]

- Table 10.3.2.1(a) displays the “typical” sizes based on pressure. On the other hand Table 10.3.2.2(b) allows a rapid assessment of pipe sizes in the field without the use of what might be viewed as cumbersome calculations. Once
Chapter 10 Bulk Gaseous Hydrogen Compressed Gas Systems

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

10.1.1 This chapter shall not apply to individual systems using containers each having a total hydrogen content of less than 400 scf (11 m³)–5000 ft³ (scf) (141.6 m³), if each system is separated by a distance not less than 5 ft (1.5 m), or to systems located in control areas when the aggregate quantity contained is less than the Maximum Allowable Quantity per Control Area (MAQ).

10.1.2 Where individual systems, each having a total hydrogen content of less than 400 scf (11 m³), are located less than 5 ft (1.5 m) from each other, this code shall apply.

10.2 General Design of Gaseous Hydrogen Systems.

10.2.1 10.2.5 Marking.
10.2.1.1 Hazard identification signs shall be provided in accordance with Section 6.11.
10.2.1.2 In addition, the area in which a hydrogen system is located shall be permanently placarded as follows:

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

10.2.2 10.2.1* Piping Systems. Piping, tubing, valves, and fittings shall be designed and installed in accordance with 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 the ICC International Fuel Gas Code (IFGC), Section 705.

10.2.3 Piping, Tubing, and Fittings.
10.2.3.1 In addition to the requirements of 7.3.1.4, brazing materials used for joints in piping and tubing systems shall have a melting point above 1000°F (538°C).

10.2.3.2 Underground piping systems shall be in accordance with 7.1.17.

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

10.2.3.3.1 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.

10.2.3.3.2 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.

10.2.4 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 accessories 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 minimize 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.

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

**10.2.5 Marking.**

**10.2.5.1** Hazard identification signs shall be provided in accordance with Section 6.11.

**10.2.5.2** In addition, the area in which a hydrogen system is located shall be permanently placarded as follows:

**WARNING:** HYDROGEN — FLAMMABLE GAS
NO SMOKING — NO OPEN FLAMES

**10.2.6 Bonding and Grounding.** The bulk hydrogen compressed gas system shall be electrically bonded and grounded.

**10.2.6.1 10.8.1** Mobile hydrogen supply units shall be electrically bonded to the storage system before hydrogen is discharged from the supply unit.

**10.2.6.2 10.8.2** 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.

**10.2.6.3 10.8.3** Where GH2 compression equipment is operated unattended, it shall be equipped with a high discharge and a low suction pressure automatic shutdown control.

**10.2.6.4 10.8.4** Control circuits that automatically shut down shall remain down until manually activated or reset after a safe shutdown is performed.

**10.2.6.4.1 10.8.4.1** Valves.

**10.2.6.4.1.1 10.8.4.1.1** Valves shall be installed such that each compressor can be isolated for maintenance.

**10.2.6.4.1.2 10.8.4.1.2** 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.

**10.2.6.5 10.8.4.2** Foundations.

**10.2.6.5.1 10.8.4.2.1** Foundations used for supporting equipment shall be designed and constructed to prevent frost heaving.

**10.2.6.6 10.8.4.3** 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 bulk gas installation.
10.2.6.6 10.8.4.4 Relief Valves.

10.2.6.6.1 10.8.4.4.1 Each compressor shall be provided with a vent or relief device that will prevent overpressurizing of the pump under normal or upset conditions.

10.2.6.6.2 10.8.4.4.2 Pressure relief devices used to serve pumps or compression equipment shall be connected to a vent pipe system in accordance with 10.2.2.

10.2.6.7 10.8.4.5 Pressure Monitoring. The pressure on the compressor discharge shall be monitored by a control system.

10.2.6.8 10.8.4.6 Protection. Transfer piping and compressors shall be protected from vehicular damage.

10.2.7 10.5 Operation and Maintenance.

10.2.7.1 10.5.2 Operating Instructions.

10.2.7.1.1 10.5.2.1 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.

10.2.7.1.2 10.5.2.2 Instructions shall be maintained at the operating site at a location acceptable to the authority having jurisdiction.

10.2.7.2 10.5.3 Maintenance. Maintenance shall be performed annually by a qualified representative of the equipment owner. 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. Scheduled maintenance and retest activities shall be formally documented, and records shall be maintained a minimum of 3 years.

10.5.4 Clearance to Combustibles. Clearance to combustibles shall be in accordance with the requirements of 7.1.10.3.

10.2.8 10.7 Cargo Transport Unloading.

10.2.8.1 10.4.1.3 Vehicular protection shall be provided in accordance with 7.1.8.3.

10.2.8.2 10.7.1 Unloading connections on delivery equipment shall not be positioned closer to any of the exposures cited in Table 10.3.2.2.1(a) and/or Table 10.3.2.2.1(b) than the distances given for the bulk hydrogen compressed gas storage system.

10.2.8.3 10.7.2 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 rolling of the vehicle.

10.2.8.4 10.7.3 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.

10.2.8.5 10.7.4 Mobile hydrogen supply units shall be electrically bonded to the bulk hydrogen compressed gas storage system before hydrogen is discharged from the supply unit.

10.2.8.6 10.7.5 Transfer System Depressurization.

10.2.8.6.1 10.7.5.1 The transfer systems shall be capable of depressurizing to facilitate disconnection.

10.2.8.6.2 10.7.5.2 Bleed connections shall be connected to a hydrogen venting system in accordance with 10.2.3 10.2.2.

10.2.8.7 10.7.6 Where required, check valves on delivery systems shall be in accordance with 7.3.1.3.2.
10.2.8.8  10.7.7  Prohibitions on smoking or the use of open flame shall be in accordance with 7.6.3.2.

10.2.8.9  10.7.8  An emergency shutoff valve shall be provided in accordance with 7.3.1.11.

10.3  Location of Outdoor Bulk Gaseous Hydrogen Compressed Gas Systems.

10.3.1  General Requirements.

10.3.1.1  Bulk hydrogen compressed gas systems located above ground either at grade or above grade shall be in accordance with Section 10.3.

10.3.1.2  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.

10.3.1.3  10.4.1.2  Electrical wiring and equipment shall be in accordance with Table 10.3.1.3 10.4.1.2.

---

**Table 10.3.1.3-10.4.1.2  Electrical Area Classification**

<table>
<thead>
<tr>
<th>Location</th>
<th>Classification</th>
<th>Extent of Classified Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage equipment excluding the piping system downstream of the source valve</td>
<td>Class I, Division 2</td>
<td>Between 0 ft (0 m) and 15 ft (4.6 m)</td>
</tr>
</tbody>
</table>

---

10.3.2  Specific Requirements.

10.3.2.1  The location of hydrogen systems shall be in accordance with Table 10.3.2.1.

---

**Table 10.3.2.1  Location of Gaseous Hydrogen Systems**

<table>
<thead>
<tr>
<th>Location</th>
<th>Quantity of Hydrogen</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≤MAQ</td>
<td>&gt;MAQ to &lt;3500 scf (&lt;99 m³)</td>
<td>≥3500 to &lt;15,000 scf (≥99 m³ to &lt;425 m³)</td>
</tr>
<tr>
<td>Outdoors</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>In a detached building</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>In a gas room, in accordance with Section 6.4</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Not in a gas room</td>
<td>A</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

A: Allowed. NA: Not allowed.

10.3.2.2  Minimum Distance. Location

10.3.2.1* 10.3.2.2.1*  Minimum Distance. The minimum distance from a bulk hydrogen compressed gas system located outdoors to specified exposures shall be in accordance with Tables 10.3.2.1(a) or 10.3.2.1(b) 10.3.2.2.1(a) or Table 10.3.2.2.1(b). (See also Annex G.)

A.10.3.2.1  The exposures integral to Tables 10.3.2.1(a) and (b) have been arranged into groups based on similar risks. The following thresholds are applicable to the exposures identified in each group.
Group 1 Exposures. The distances specified are those required to reduce the radiant heat flux level to 500 Btu/hr \cdot ft^{2} (1,577 W/m^{2}) at the property line or the distance to a point in the unignited hydrogen jet where the hydrogen content is reduced to a 4 percent mole fraction (volume fraction) of hydrogen whichever is greater. In all cases the distance required to achieve a 4 percent mole fraction was the greater distance and used to establish the requirements.

Group 2 Exposures. The distances specified are those required to reduce the radiant heat flux level to 1,500 Btu/hr \cdot ft^{2} (4,732 W/m^{2}) for persons exposed a maximum of 3 minutes.

Group 3 Exposures. The distances specified are those required to reduce the radiant heat flux level to 6,340 Btu/hr \cdot ft^{2} (20,000 W/m^{2}) or the visible flame length for combustible materials, or a radiant heat flux level of 8,000 Btu/hr \cdot ft^{2} (25,237 W/m^{2}) or the visible flame length for non-combustible equipment. In both cases the visible flame length was used to establish the requirements.

### 10.3.2.2.1.1 (B)* Alternative Internal Diameters.

The separation distance for piping systems with internal diameters greater other than those specified in Table 10.3.2.1(a) and Table 10.3.2.2.1(b) for the pressure range selected shall be permitted with tabular distances determined based on the use of the equations in Table 10.3.2.1(b) and 10.3.2.2.1.1(B).

#### Table 10.3.2.2.1.1(B) - Separation Distance Based on Alternative Pipe or Tube Internal Diameters

<table>
<thead>
<tr>
<th>Notes*</th>
<th>&gt;15 to ≤250 psi (≥103.4 to ≤1724 kPa)</th>
<th>&gt;250 to ≤3000 psi (≥1724 to ≤20,684 kPa)</th>
<th>&gt;3000 to ≤7500 psi (≥20,684 to ≤51,711 kPa)</th>
<th>&gt;7500 to ≤15,000 psi (≥51,711 to ≤103,421 kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>(D_{a} = 0.2317d^{0.00935})</td>
<td>(D_{a} = 0.7390d^{0.00966})</td>
<td>(D_{a} = 1.1062d^{0.00959})</td>
<td>(D_{a} = 1.4507d^{0.00968})</td>
</tr>
<tr>
<td>(b)</td>
<td>(D_{b} = 0.091137d^{1.1303} + e)</td>
<td>(D_{b} = 0.365099d^{1.1152} + e)</td>
<td>(D_{b} = 0.60173d^{1.1003} + e)</td>
<td>(D_{b} = 0.84053d^{1.1023} + e)</td>
</tr>
<tr>
<td>(c)</td>
<td>(D_{c} = 0.075952d^{1.1022} + e)</td>
<td>(D_{c} = 0.2889d^{1.1003} + e)</td>
<td>(D_{c} = 0.45889d^{1.0887} + e)</td>
<td>(D_{c} = 0.6324d^{1.0859} + e)</td>
</tr>
<tr>
<td>(d)</td>
<td>(D_{d} = 0.096350d^{0.99028})</td>
<td>(D_{d} = 0.3072d^{0.9962})</td>
<td>(D_{d} = 0.45967d^{0.99071})</td>
<td>(D_{d} = 0.60297d^{0.99956})</td>
</tr>
<tr>
<td>(e)</td>
<td>(D_{e} = 0.096350d^{0.99028})</td>
<td>(D_{e} = 0.3072d^{0.9962})</td>
<td>(D_{e} = 0.45967d^{0.99071})</td>
<td>(D_{e} = 0.60297d^{0.99956})</td>
</tr>
</tbody>
</table>

Notes:

1. Use this table assumes a leak diameter of 3 percent of the pipe flow area or internal diameter where \(d\) = inside diameter (ID) of pipe or tube expressed in millimeters (mm), and \(D_{a}, D_{b}, D_{c}, D_{d}, D_{e}\) = separation distance in meters (m).

2. All pressures are gage pressures.

3. Notes are from Table 10.3.2.2.1(a) and Table 10.3.2.2.1(b) as follows:

   a. Unignited jet concentration decay distance to 4 percent mole fraction (volume fraction) hydrogen
   b. \(D_{rad}\) = radiation heat flux level of 500 Btu/hr \cdot ft^{2} (1577 W/m^{2})
   c. \(D_{rad}\) = for heat flux level of 1500 Btu/hr \cdot ft^{2} (4732 W/m^{2}) exposure to employees for a maximum of 3 minutes
   d. The greater of \(D_{rad}\) for combustible heat flux level of 6340 Btu/hr \cdot ft^{2} (20,000 W/m^{2}) or the visible flame length
   e. The greater of \(D_{rad}\) for noncombustible equipment heat flux level of 8000 Btu/hr \cdot ft^{2} (25,237 W/m^{2}) or the visible flame length
A.10.3.2.2.1(B) The following is a sample calculation for separation distances using ¼ in. ID tubing at gauge pressure of 250–3000 psi:

1. Determine internal diameter (ID) where ID = OD - (2 × wall thickness); wall thickness = 0.049 in. (known); outside diameter (OD) = 0.250 in.: 
   \[ ID = 0.250 - (2 \times 0.049) = 0.152 \text{ in.} = 3.86 \text{ mm} \]

To use the equations in Table 10.3.2.2.1.1(B) the ID values (the value of \( d \) in the equation) to be used must be expressed in millimeters.

2. Next, determine separation distance(s). The separation distances \( D_a, D_b, \ldots \) are calculated in meters to two significant places after the decimal. To convert meters to feet, multiply meters by 3.281 and round off to the nearest 5 ft.

For example, assuming the 250–3000 psi pressure range (second column), calculations for separation distance for the Table 10.3.2.2.1.1(B) footnotes (a) through (e) are as follows.

Where:
\[ D_{a,b,c,d,e} = \text{calculated separation distance for } D_a, D_b, \ldots \]
\[ e = 2.71828 \ldots, \text{ the base of natural logarithms} \]

Then:

(a) \[ D_a = 0.74d^{0.000962} \]
   \[ D_a = 0.74(3.86^{0.000962}) \]
   \[ D_a = 0.74(3.858) = 2.85 \text{ m} \approx 9.4 \text{ ft} \]

(b) \[ D_b = 0.37d^{1.1152} + e^{-0.040721d}(0.19d^{1.2531} - 0.37d^{1.1152}) \]
   \[ D_b = 0.37(3.86^{1.1152}) + e^{-0.040721}(0.19)(3.86^{1.2531}) - (0.37)(3.86^{1.1152}) \]
   \[ D_b = 1.67 + 0.66(1.03 - 1.67) \]
   \[ D_b = 1.67 - 0.42 \]
   \[ D_b = 1.25 \text{ m} = 4.1 \text{ ft} \approx 5 \text{ ft} \]

(c) \[ D_c = 0.29d^{1.092} + e^{-0.10392d}(0.19d^{1.1795} - 0.29d^{1.092}) \]
   \[ D_c = 0.29(3.86^{1.092}) + e^{-0.10392}(0.19)(3.86^{1.1795}) - (0.29)(3.86^{1.092}) \]
   \[ D_c = 0.29(4.37) + e^{-0.10392}(0.19)(4.92) - (0.29)(4.37) \]
   \[ D_c = 1.27 + 0.67(0.94 - 1.27) \]
   \[ D_c = 1.27 - 0.22 \]
   \[ D_c = 1.05 \text{ m} = 3.45 \text{ ft} \approx 5 \text{ ft} \]

(d) \[ D_d = 0.31d^{0.00062} \]
   \[ D_d = 0.31(3.86^{0.00062}) \]
   \[ D_d = 0.31(3.84) = 1.19 \text{ m} \approx 3.9 \text{ ft} \approx 5 \text{ ft} \]

(e) \[ D_e = 0.31d^{0.00062} \]
   \[ D_e = 0.31(3.86^{0.00062}) \]
   \[ D_e = 0.31(3.84) = 1.19 \text{ m} = 3.9 \text{ ft} \approx 5 \text{ ft} \]

The subscripts to \( D, a, b, c, d, \) and \( e \), relate to notes (a) through (e), respectively, in Table 10.3.2.2.1.1(B). To convert the distance in meters to feet, multiply by 3.2808. The resultant distance in feet is then rounded off to the nearest 5-foot dimension. For example, a distance of 5.2 ft would be rounded down to 5 ft. A distance of 7.6
ft would be rounded up to 10 ft.

[Delete Tables 10.3.2.2.1(a) and 10.3.2.2.1(b) in their entirety and replace with the following tables]
<table>
<thead>
<tr>
<th>Pressure</th>
<th>Internal Pipe Diameter (ID)</th>
<th>Exposures Group 1</th>
<th>Exposures Group 2</th>
<th>Exposures Group 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Internal Pipe Diameter (ID)</td>
<td>(a) Lot lines</td>
<td>(a) Exposed persons other than those servicing the system</td>
<td>(a) Buildings of non-combustible non-fire rated construction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(b) Air intakes (HVAC, compressors, other)</td>
<td>(b) parked cars</td>
<td>(b) Buildings of combustible construction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(c) Operable openings in buildings and structures</td>
<td></td>
<td>(c) Flammable gas storage systems above or below ground</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(d) ignition sources such as open flames and welding</td>
<td></td>
<td>(d) Hazardous Materials Storage Systems above or below ground</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(a) Exposed persons other than those servicing the system</td>
<td></td>
<td>(e) Heavy timber, coal or other slow-burning combustible solids</td>
</tr>
<tr>
<td>&gt; 15 to ≤ 250 psig</td>
<td>d = 52.5 mm</td>
<td>m</td>
<td>ft</td>
<td>m</td>
</tr>
<tr>
<td>&gt; 103.4 to ≤ 1724 kPa</td>
<td>d = 18.97 mm</td>
<td>m</td>
<td>ft</td>
<td>m</td>
</tr>
<tr>
<td>&gt; 250 to ≤ 3000 psig</td>
<td>d = 7.31 mm</td>
<td>m</td>
<td>ft</td>
<td>m</td>
</tr>
<tr>
<td>&gt; 1724 to ≤ 20,684 kPa</td>
<td>d = 7.16 mm</td>
<td>m</td>
<td>ft</td>
<td>m</td>
</tr>
<tr>
<td>&gt; 20,684 to ≤ 51,711 kPa</td>
<td>m</td>
<td>ft</td>
<td>m</td>
<td>ft</td>
</tr>
<tr>
<td>&gt; 51,711 to ≤ 103,421 kPa</td>
<td>m</td>
<td>ft</td>
<td>m</td>
<td>ft</td>
</tr>
<tr>
<td>Pressure</td>
<td>Internal Pipe Diameter (ID)</td>
<td>d (mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------</td>
<td>----------------------------</td>
<td>--------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 15 to ≤ 250 psig</td>
<td>d = 52.5 mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 103.4 to ≤ 1724 kPa</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 250 to ≤ 3000 psig</td>
<td>d = 18.97 mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 1724 to ≤ 20,684 kPa</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 3000 to ≤ 7500 psig</td>
<td>d = 7.31 mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 20,684 to ≤ 51,711 kPa</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 7500 to ≤ 15000 psig</td>
<td>d = 7.16 mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 51,711 to ≤ 103,421 kPa</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(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) Utilities overhead including electric power, building services or hazardous materials piping systems
Table 10.3.2.1(b) Minimum Distance (D) from Outdoor Bulk Hydrogen Compressed Gas Systems to Exposures – By Maximum Pipe Size

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

<table>
<thead>
<tr>
<th>Internal Pipe Diameter (ID)</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>(in)</td>
<td>D = 0.231d</td>
<td>D = 0.12584d - 0.47126</td>
<td>D = 0.096d</td>
<td>D = 0.738d</td>
<td>D = 0.43616d - 0.91791</td>
<td>D = 0.307d</td>
</tr>
<tr>
<td>d (mm)</td>
<td>m</td>
<td>ft</td>
<td>m</td>
<td>ft</td>
<td>m</td>
<td>ft</td>
</tr>
<tr>
<td>0.2</td>
<td>1</td>
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<td>0.3</td>
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<td>2</td>
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</tr>
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<td>4</td>
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<td>7</td>
</tr>
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<td>7</td>
<td>23</td>
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<td>11</td>
<td>3</td>
<td>10</td>
</tr>
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<td>25</td>
<td>4</td>
<td>12</td>
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<td>10</td>
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<td>13</td>
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<td>11</td>
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<td>16</td>
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<td>2.1</td>
<td>12</td>
<td>40</td>
<td>6</td>
<td>20</td>
<td>5</td>
<td>17</td>
</tr>
</tbody>
</table>
Pressure

<table>
<thead>
<tr>
<th>Internal Pipe Diameter (ID)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposures&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Exposures&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Group 1</td>
<td>Group 2</td>
<td>Group 3</td>
</tr>
<tr>
<td>ID (in)</td>
<td>d (mm)</td>
<td>D = 1.105d</td>
</tr>
<tr>
<td>m</td>
<td>ft</td>
<td>m</td>
</tr>
<tr>
<td>0.2</td>
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<td>6</td>
</tr>
<tr>
<td>0.3</td>
<td>7.6</td>
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</tr>
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<td>11</td>
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<tr>
<td>0.5</td>
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<tr>
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<tr>
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<td>53</td>
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<tr>
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<td>56</td>
</tr>
</tbody>
</table>

<sup>a</sup> Linear interpolation of internal pipe diameters and distances between table entries is allowed.

<sup>b</sup> For a list of exposures in each exposure group see Column 1 of Table 10.3.2.1(a).
10.3.2.2.1.4 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 exceed the values shown in Table 10.3.2.1.2.1(a) when in accordance with and Table 10.3.2.1.2.1(b) for the pressure range indicated except as allowed by 10.3.2.2.1.1(B) or 10.3.2.2.1.1(C).

10.3.2.2.1.1(E) 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 400 scf (11.3 m³). The piping system size used in the application of Tables 10.3.2.1.2.1(a) and or 10.3.2.1.2.1(b) shall be determined based on that portion of the system with the greatest maximum internal diameter.

A.10.3.2.2.1-10.3.2.2.1.1(E) Systems that employ compressors downstream of a bulk supply typically operate at higher pressures than that of the bulk supply. As a result, the diameter of the piping system can vary with the pressure. The use of a higher pressure rating or variation of internal diameters is not warranted unless there is a storage component with a hydrogen content that exceeds 400 scf (11.3 m³) located downstream of the primary storage source and upstream of the source valve. The volume of gas contained within the piping system is not included in determining the quantity in storage.

For example, a 3000 psig (20,684 kPa) storage system that supplies a 6000 psig (41,369 kPa) compressor that directly feeds a process with less than 400 scf (11.3 m³) of intervening storage at a pressure of 6000 psig (41,369 kPa) or less is considered a 3000 psig (20,684 kPa) system. Conversely, a system with the primary storage of 3000 psig (20,684 kPa) might supply a compressor that in turn delivers hydrogen to intermediate storage with a quantity of greater than 400 scf (11.3 m³). (Note: Pressures given are gauge pressures.) The piping serving the intermediate storage system from a point of discharge on the compressor can have an internal diameter of less than that serving the primary storage system upstream of the compressor. Accordingly, each portion of the system must be analyzed with respect to the tabular distances. See the typical P&IDs shown in Figure A.3.3.12(a) through Figure A.3.3.12(f) for additional information in this regard.

The use of Table 10.3.2.1.2.1.1(B) is based on the maximum internal diameter of the piping system over the range of pressures specified. In practice, it is common to maintain a consistent size of piping throughout the system; however, there might be cases where the ID of the piping system varies. In such cases, the piping with the largest internal diameter in the system is used to establish the system pipe size for the purposes of using the table, regardless of the length of the piping. It is not uncommon for portions of the system equipped with pressure gauges, pressure transducers, or other instrumentation to be served by small-diameter piping systems. However, the maximum internal diameter of the piping system will control the establishment of distance for the exposures indicated.

Pipe sizes are typically expressed in nominal terms as illustrated in Table A.10.3.2.2.1.1(E) below. This is compared with tubing in which the outside diameter (OD) is expressed in exact terms. Designers commonly use pipe schedule to specify the wall thickness for a given material based on the design conditions. Typical pipe sizes found in commerce include those shown in Table A.10.3.2.2.1.1(E).
<table>
<thead>
<tr>
<th>Nominal Pipe Size (in.)</th>
<th>O.D. (in.)</th>
<th>Pipe Schedules — Wall Thickness (in.)</th>
<th>40</th>
<th>80</th>
<th>XH</th>
<th>XXH</th>
</tr>
</thead>
<tbody>
<tr>
<td>¼</td>
<td>0.540</td>
<td></td>
<td>0.088</td>
<td>0.119</td>
<td>0.119</td>
<td>—</td>
</tr>
<tr>
<td>3/8</td>
<td>0.675</td>
<td></td>
<td>0.094</td>
<td>0.126</td>
<td>0.126</td>
<td>—</td>
</tr>
<tr>
<td>⅛</td>
<td>0.840</td>
<td></td>
<td>0.109</td>
<td>0.147</td>
<td>0.147</td>
<td>0.294</td>
</tr>
<tr>
<td>⅛</td>
<td>1.050</td>
<td></td>
<td>0.113</td>
<td>0.154</td>
<td>0.154</td>
<td>0.308</td>
</tr>
<tr>
<td>⅛</td>
<td>1.315</td>
<td></td>
<td>0.133</td>
<td>0.179</td>
<td>0.179</td>
<td>0.358</td>
</tr>
<tr>
<td>1/4</td>
<td>1.660</td>
<td></td>
<td>0.140</td>
<td>0.194</td>
<td>0.194</td>
<td>0.382</td>
</tr>
<tr>
<td>1/2</td>
<td>1.900</td>
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<td>0.145</td>
<td>0.200</td>
<td>0.200</td>
<td>0.400</td>
</tr>
<tr>
<td>1/2</td>
<td>2.375</td>
<td></td>
<td>0.154</td>
<td>0.218</td>
<td>0.218</td>
<td>0.436</td>
</tr>
<tr>
<td>2/3</td>
<td>2.875</td>
<td></td>
<td>0.203</td>
<td>0.276</td>
<td>0.276</td>
<td>0.552</td>
</tr>
<tr>
<td>3/4</td>
<td>3.500</td>
<td></td>
<td>0.216</td>
<td>0.300</td>
<td>0.300</td>
<td>0.600</td>
</tr>
<tr>
<td>1/2</td>
<td>4.000</td>
<td></td>
<td>0.226</td>
<td>0.318</td>
<td>0.318</td>
<td>0.636</td>
</tr>
<tr>
<td>1</td>
<td>4.500</td>
<td></td>
<td>0.237</td>
<td>0.337</td>
<td>0.337</td>
<td>0.674</td>
</tr>
</tbody>
</table>

XH = extra heavy; XXH = extra extra heavy.

Note: Standard pipe schedule or pipe size as listed by ANSI/ASME B36.10M, Welded and Seamless Wrought Steel Pipe, and API Spec 5L, Specification for Line Pipe.

To determine internal diameter (ID) of a selected pipe size, multiply by 2 the wall thickness for the selected schedule and subtract the result from the outside diameter (OD):

\[ ID = OD - (2 \times \text{wall thickness}) \]

For example, for 2 in. Schedule 40 pipe:

Wall thickness = 0.154 in.; OD = 2.375 in.

Then:

\[ ID = 2.375 - (2 \times 0.154) = 2.067 \text{ in.} \]

When tubing is used in lieu of pipe, the OD of the tubing is designated in inches (e.g., ¼, 3/8, ⅛, 1, 1¼, 1½, 2), and the tubing is manufactured to those specific dimensions. Tube wall thickness is determined based on the working pressure and materials of construction. The calculation of internal diameter is the same as that used for conventional pipe:

\[ ID = OD - (2 \times \text{wall thickness}) \]

For example, for ¼ in. OD tubing, if the wall thickness is 0.049 in. and the OD is 0.250 in., then:

\[ ID = 0.250 - (2 \times 0.049) = 0.152 \text{ in.} \]

### 10.3.2.2.1.1(A) Shutoff Valves on the Source of Supply

When shutoff valves are not connected directly to the source of supply, all interconnecting piping between the source connection and points downstream shall be...
10.3.2.2.1.1(C) The separation distance for piping systems with internal diameters less than those specified in Table 10.3.2.1(a) and Table 10.3.2.1(b) for the pressure range selected shall be allowed to be reduced with tabular distances determined based on the use of equations in Table 10.3.2.1.1(B).

10.3.2.2.1.1(D) Separation distances determined based on the use of piping systems with pipe ID greater than that indicated in Table 10.3.2.1(b) 10.3.2.2.1.1(B) shall be subject to review and approval by the AHJ.

A.10.3.2.2.2. The methodology used to determine the distances listed in Table 10.3.2.1(b) has been evaluated for piping up to and including internal diameters of approximately 3 inches (76 mm). The establishment of risk informed separation distances for piping systems with greater internal diameters are subject to a hazard analysis that demonstrates an equivalent level of risk under the provisions of Section 1.5.

10.3.2.3 * 10.3.2.2.1.1(F)* Determination of System Pressure. The system pressure shall be determined by the maximum operating pressure of the storage array with content greater than 400 scf (11.3 m³), irrespective of those portions of the system elevated to a higher pressure.

A.10.3.2.3 A.10.3.2.2.1.1(F) Portions of a system might operate at higher pressures than the bulk supply; however, those portions of the system do not require the use of a pressure rating higher than that of the bulk supply unless there is a storage component exceeding 400 scf (11.3 m³) downstream of the primary storage source and upstream of the source valve. The volume of gas contained within the piping system is not included when the quantity in storage is determined. For example, a 3000 psig (20,684 kPa) storage system that supplies a 6000 psig (41,369 kPa) compressor that directly feeds a process with less than 400 scf (11.3 m³) of intervening storage at a pressure of 6000 psig (41,369 kPa) or less is considered a 3000 psig (20,684 kPa) system.

10.3.2.4* 10.3.2.2.2* Reduction of Distance By Mitigation Means.

A.10.3.2.4 A.10.3.2.2.2 Distances to assumed lot lines established for the purpose of determining exterior wall and opening protection should not be confused with lot lines that are property lines in the true sense of the definition, and distances to assumed lot lines can be disregarded in the application of Tables 10.3.2.1.2.1(a) and 10.3.2.1.2.1(b). The lot lines specified in 10.3.2.2.2 are property lines used to separate one lot from another or to separate a property from a street or other public space.

A permit holder cannot exercise any right of control over the property of others, whether the ownership is public or private. In cases where the permit holder owns an adjacent lot or parcel, the separation from property lines assumes that the permit holder could transfer ownership of the adjacent property at some point, and therefore the requirements for property line separation should be observed.

10.3.2.4.1* 10.3.2.2.2 Passive Means. Except for distances to lot lines, operable building openings, air intakes, and overhead utilities, the distances to Group 1 and 2 exposures shown in Tables 10.3.2.1.2.1(a) and 10.3.2.1.2.1(b) shall not apply be permitted to be reduced by one-half and shall not apply to Group 3 exposures where fire barrier walls having a minimum fire resistance rating of 2 hours constructed in accordance with the following are located between the system and the exposure.

(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.
10.3.2.2.4—Where fire barrier walls of three sides are used, the walls shall be in accordance with 11.3.2.2.4.

(5) 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.

(6)* Table 10.3.2.2.1(a) note f. Where clearance is required between the bulk hydrogen compressed gas system and the barrier wall for the performance of service or maintenance related activities the a minimum horizontal clearance of 5 feet shall be provided between the structure and the system required for access for service related activities.

(7) 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.

(8) The minimum wall height shall be not less than 8 ft (2.1 m).

(9) The minimum wall length shall project not less than 5 ft (1.5 m) horizontally beyond the most remote point of the system or the exposure.

A.10.3.2.4.1-A.10.3.2.2.3 The code has historically recognized that, in certain instances, fire barrier walls can serve as a means to reduce the limits of unacceptable consequences due to the release of hydrogen from high-pressure equipment. Testing other than that related to establish fire resistance of the fire barrier walls has not been documented. Researchers at Sandia National Laboratories have been investigating the use of fire barrier walls as a means of mitigation in the establishment of distances related to the installation of bulk gaseous hydrogen systems, and a technical paper has been presented detailing the early findings.

As stated by Sandia National Laboratories researchers Houf, Schefer, and Evans in “Analysis of Barriers for Mitigation of Unintended Releases of Hydrogen,” the purpose of the Sandia study was to extend the available database on barrier walls as a hazard mitigation strategy and to provide technical data for risk-informed decisions in hydrogen codes and standards regarding barrier wall design and implementation. Additional research by Sandia’s Jeff LaChance in a paper titled “NFPA Mitigation Analysis” the focus of the research included testing to assess the effectiveness of various barrier designs in terms of the following:

(1)—Deflecting jet flames

(2)—Reducing the extent of the flammable cloud resulting from an unignited release

(3)—Reducing the magnitude of the radiative heat flux produced by a jet flame from an ignited release

(4)—Minimizing the amount of ignition overpressure produced from the barrier confinement

When the work is concluded, it is expected that the results will likely provide the basis for criteria for the proper configuration, design, and construction of such barriers in order that the walls do not create other hazards. The work to date has been limited; however, the results have been promising. Houf, Schefer, and Evans have determined that for the conditions investigated, 2000 psi (13.79 MPa) source pressure and a \( \frac{3}{4} \) in. (3.175 mm) diameter round leak, the barrier configurations studied were found to (1) reduce horizontal jet flame impingement hazard by deflecting the jet flame, (2) reduce radiation hazard distances for horizontal jet flames, and (3) reduce horizontal unignited jet flammability hazard distances. For the one wall vertical barrier and the three wall barrier configurations examined in the tests, the simulations of the peak overpressure hazard from ignition were found to be approximately 5.8 psi (40 kPa) on the release side of the barrier and approximately 0.73 psi to 0.44 psi (5 kPa to 3 kPa) on the downstream side of the barrier.
As stated by Sandia National Laboratories researchers Houf, Schefer, and Evans in “Evaluation of Barrier Walls for Mitigation of Unintended Releases of Hydrogen,” the purpose of the Sandia study was to extend the available database on barrier walls as a hazard mitigation strategy and to provide technical data for risk-informed decisions in hydrogen codes and standards regarding barrier wall design and implementation. Additional analysis by Sandia (LaChance, Phillips and Houf) in a paper titled “Risk Associated with the Use of Barriers in Hydrogen Refueling Stations” provided insights on the effectiveness of various barrier designs in terms of the following:

1. Deflecting jet flames
2. Reducing the extent of the flammable cloud resulting from an unignited release
3. Reducing the magnitude of the radiative heat flux produced by a jet flame from an ignited release
4. Minimizing the amount of ignition overpressure produced from the barrier confinement

Houf, Schefer, and Evans have determined that for the conditions investigated, 2000 psi (13.79 MPa) source pressure and a 1/8 in. (3.175 mm) diameter round leak, the barrier configurations studied were found to (1) reduce horizontal jet flame impingement hazard by deflecting the jet flame, (2) reduce radiation hazard distances for horizontal jet flames, and (3) reduce horizontal unignited jet flammability hazard distances. For the one-wall vertical barrier and the three-wall barrier configurations examined in the tests, the simulations of the peak overpressure hazard from ignition were found to be approximately 5.8 psi (40 kPa) on the release side of the barrier and approximately 0.73 psi to 0.44 psi (5 kPa to 3 kPa) on the downstream side of the barrier. Although an overpressure can be expected due to latent ignition of a flammable cloud the overpressure is expected to be limited to a localized area. Special designs for overpressure in addition to the structural loads imposed by the building code have not been required.

The function of the fire barrier wall is to protect the exposure from the system and not the converse. The code assumes that other factors will enter into locating any material or structure in proximity to the bulk hydrogen compressed gas system. For example, if a property or lot line is involved opposite the hydrogen installation the proximity of a building to be constructed on the lot line is regulated by the building code based on the type and occupancy of structure to be constructed.

Investigation is continuing into the parameters for the construction of fire barrier walls. In the interim, a risk-informed approach to the establishment of distance has been introduced into Chapter 10 of this code. The Industrial and Medical Gases Technical Committee recognizes that previous editions of the code have allowed the use of fire barrier walls as a mitigation method. Until such time as the investigation by Sandia National Laboratories or others has been completed, 10.3.2.2.3 provides for the use, in limited cases, of fire barrier walls to mitigate effects on the downstream side of the wall by allowing a reduction of one-half of the separation distance otherwise required through the use of the risk-informed tables.

The resultant distances should be measured from a point on the unexposed (or downstream side) of the fire-barrier wall to the exposure. For example, the 45 ft (14.0 m) distance to lot lines shown for a 3,000 psi gauge (20,684 kPa gauge) system using piping with a maximum internal diameter (ID) of 0.747 in. (18.97 mm) can be reduced to 22.5 ft (7.0 m) between the property line and the fire barrier wall.

The concept of limiting the use of barrier walls is an interim determination that augments the requirements now found in the risk-informed approach to the establishment of separation distances. The outcome of the scientific research underway will measure the effect of the mitigation provided by the walls and will bring a firmness to the fire barrier requirements. The importance of completing the research is that all the factors integral to the construction of fire barrier walls will have been established through the scientific process. The use of the scientific process is a fundamental precept established in the acceptance of the risk-informed approach.

10.3.2.2.3* The distances in (1), (2), (4), and (10) in Table 10.3.2.2.1(a) and Table 10.3.2.2.1(b) shall be
permitted to be reduced by one-half where fire barrier walls having a minimum fire resistance rating of 2 hours are located between the system and the exposure.

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

A.10.3.2.4.2 To determine the acceptability of technologies, processes, products, facilities, materials, and uses attending the design, operation or use of such systems, the AHJ is authorized to require the owner or agent to provide, without charge to the jurisdiction, a technical opinion and report. The model fire prevention codes provide the authority for the AHJ to seek technical assistance from independent third parties with expertise in the matter to be reviewed at the submitter’s expense. The AHJ is authorized to require design submittals to be prepared by, and bear the stamp of, a registered design professional or professional engineer.

Active means of control could include a means to detect leakage or fire coupled with automatic system shut down.

**Gas Detection.** To utilize gas detection as a means of control the gas sensor would be placed at a point between the bulk hydrogen compressed gas system and the exposure. Gas detection systems may be limited in their ability to detect the presence of hydrogen in the open. The are most effective if the sensor is located within an enclosed space such as an equipment enclosure. If used, gas detection systems should be either listed or approved.

**Flame Detection.** Flame detection systems may include combination UV/IR detection systems and be installed in accordance with the requirements of NFPA 72.

Ultraviolet flame detectors typically use a vacuum photodiode Geiger–Muller tube to detect the ultraviolet radiation that is produced by a flame. The photodiode allows a burst of current to flow for each ultraviolet photon that hits the active area of the tube. When the number of current bursts per unit time reaches a predetermined level, the detector initiates an alarm.

A single wavelength infrared flame detector uses one of several different photocell types to detect the infrared emissions in a single wavelength band that are produced by a flame. These detectors generally include provisions to minimize alarms from commonly occurring infrared sources such as incandescent lighting or sunlight. An ultraviolet/infrared (UV/IR) flame detector senses ultraviolet radiation with a vacuum photodiode tube and a selected wavelength of infrared radiation with a photocell and uses the combined signal to indicate a fire. These detectors need exposure to both types of radiation before an alarm signal can be initiated. A multiple wavelength infrared (IR/IR) flame detector senses radiation at two or more narrow bands of wavelengths in the infrared spectrum. These detectors electronically compare the emissions between the bands and initiate a signal where the relationship between the two bands indicates a fire. [72, A.5.8.2]

**10.3.2.5 Required Separation Distance For All Systems.** Separation distances are required for bulk hydrogen compressed gas systems independent of system pressure or internal diameter of piping systems in accordance with the following:

1. **10.3.2.3** Unloading connections on delivery equipment shall not be positioned closer to any of the exposures cited in 10.3.2.1.2-(a) or 10.3.2.1.2-(b) than the distances given for the storage system.

2. **Table 10.3.2.2.1(a) note-g** Equipment classified as meeting Class I, Division 2, Group B requirements of NFPA 70, *National Electrical Code* when the area is in accordance with NFPA 497, *Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas.*
(3) **Table 10.3.2.1(a) note h** Bulk hydrogen storage systems are allowed to integrate (co-locate) other nonliquefied flammable gas systems 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. The minimum separation distance indicated requires a minimum separation 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 feet.

(4) **10.3.1.2** 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.

**10.3.2.6 Hydrogen And Other Flammable Gas Blends.** Bulk hydrogen compressed gas storage systems are allowed to integrate (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 Design Requirements at Specific Locations.**

**10.4.1 Outdoor Locations.**

**10.4.1.1** Where overhead cover is provided, it shall be in accordance with the provisions of 6.5.2.

**10.4.1.2** Electrical wiring and equipment shall be in accordance with Table 10.4.1.2.

<table>
<thead>
<tr>
<th>Location</th>
<th>Classification</th>
<th>Extent of Classified Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage equipment excluding the piping system downstream of the source valve</td>
<td>Class I, Division 2</td>
<td>Between 0 ft (0 m) and 15 ft (4.6 m)</td>
</tr>
</tbody>
</table>

10.4.1.3 Vehicular protection shall be provided in accordance with 7.1.8.3.

**10.4 Underground Bulk Hydrogen Compressed Gas Systems**

**10.4.2 Underground Systems.** Bulk hydrogen compressed gas systems—Gaseous hydrogen systems installed underground where compressed gas containers are to be buried in contact with earth or fill shall be in accordance with 10.4.2.

**10.4.2.1 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.

**10.4.2.1.1 Compressed Gas Container Examination.**

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

**10.4.2.2 Compressed Gas Container Examination.**

**10.4.2.2.1** 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.
10.4.1.2.10.4.2.1.3 Composite Containers. (Reserved)

10.4.1.3 10.4.2.2 Corrosion Protection. Compressed gas containers and underground piping shall be protected from corrosion in accordance with 7.1.10.9 or 7.1.17 as applicable.

10.4.1.4 10.4.2.3 Outlet Connections.

10.4.1.4.1 10.4.2.3.1 Threaded compressed gas container outlet connections shall be designed with primary and secondary seals that shall be tested for functionality.

10.4.1.4.2 10.4.2.3.2 The seal design shall include a method of detecting a leak in the primary seal.

10.4.1.5 10.4.2.4 Piping Systems.

10.4.1.5.1 10.4.2.4.1 Joints in the piping system shall be butt welded and 100 percent inspected using nondestructive testing (NDT) methods in accordance with the requirements of ANSI/ASME B31.3, Process Piping, or other approved standards.

10.4.1.5.2 10.4.2.4.2 Valves, controls, safety devices, and instrumentation shall be above ground and accessible to authorized personnel.

10.4.1.6 10.4.2.5 Location. Compressed gas containers shall be located in accordance with 10.4.2.5.1 through 10.4.2.5.4.

10.4.1.6.1 10.4.2.5.1 Underground compressed gas containers shall not be located beneath buildings.

10.4.1.6.2 10.4.2.5.2 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.

10.4.2.5.3 Compressed Gas Container Separation Distances.

10.4.1.6.3 10.4.2.5.3.1 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).

10.4.1.6.4 10.4.2.5.3.2 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.

10.4.1.6.5 10.4.2.5.4 A minimum distance of 1 ft (0.3 m), shell to shell, shall be maintained between adjacent underground containers.

10.4.1.6.6 10.4.2.5.5 A minimum distance of 3 ft (0.9 m) shall be maintained between compressed gas containers and buried utilities.

10.4.1.7 10.4.2.6 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.

10.4.1.7.1 10.4.2.7.2 The concrete shall extend a minimum of 1 ft (0.3 m) horizontally beyond the footprint of the tank in all directions.

10.4.1.8 10.4.2.7 Depth, Cover, and Fill. 10.4.2.7.1 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.

10.4.1.9 10.4.2.8 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.

10.4.1.10 10.4.2.9 Venting of Underground Compressed Gas Containers. Vent pipes for underground compressed gas containers shall be in accordance with 10.2.1.

10.4.1.11 10.4.2.10 Overfill Protection and Prevention Systems. An approved means or method shall be
provided to prevent the overfilling of the storage containers.

**10.4.1.12 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.

**10.5-10.4.3 Installation in Vaults Above and Below Ground.** (Reserved)

**10.6 Indoor Bulk Hydrogen Compressed Gas Systems**

**10.6.1 General.**

**10.6.1.1 Location.** The location of bulk hydrogen compressed gas systems shall be in accordance with Table 10.6.1.1.10.3.2.1.

| Table 10.6.1.1 10.3.2.1 Location of Bulk Gaseous Hydrogen Compressed Gas Systems |
|-----------------|-----------------|-----------------|-----------------|
| Location        | Quantity of Hydrogen | ≤MAQ | >MAQ to <3500 scf (<99 m³) | ≥3500 5000 scf to <15,000 scf (≥14299 m³) | ≥15,000 scf (≥425 m³) |
| Outdoors        | A                | A                | A                | A                |
| In a detached building | A                | A                | A                | A                |
| In a gas room, in accordance with Section 6.4 | A                | A                | Detached building required |
| Not in a gas room | A                | NA               | NA               | NA               |

A: Allowed. NA: Not allowed.

**10.6.1.2 Indoor Bulk Hydrogen Compressed Gas Systems.**

**10.6.1.2.1 General.** Hydrogen systems of less than 3500 scf (99 m³) and greater than the MAQ, when located inside buildings, shall be located in the building so that the system will be as follows:

1. In a ventilated area in accordance with the provisions of Section 6.15
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
   (a) The distance shall be permitted to be reduced to 10 ft (3.1 m) where the room or area is protected by a listed detection system per Article 500.7(K) of NFPA 70, National Electrical Code, 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) Isolation valves used to isolate the fuel supply shall be of a fail-safe design.
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

**10.6.2 Systems Installed in One Room.**

**10.6.2.1 General.** More than one system of 3500 scf (99 m³) 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.

**10.6.2.2 General.** The separation distance between multiple systems of 3500 scf (99 m³) 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 in accordance with the requirements of Section 6.9.

10.6.1.2 10.6*  Fire Protection.

Fire protection shall be in accordance with the requirements of Section 6.9.

10.6.2 10.4.4  Detached Buildings.

10.6.2.1 10.4.4.1  Detached buildings shall be constructed of noncombustible or limited-combustible materials in accordance with the requirements of Section 6.5.

10.6.2.2 10.4.4.2  Ventilation shall be provided in accordance with the requirements of Section 6.15.

10.6.2.2.1 10.4.4.2.1  Outlet openings shall be located at the high point of the room in exterior walls or the roof.

10.6.2.2.2 10.4.4.2.2  Inlet and outlet openings shall each have a minimum total area of 1 ft²/1000 ft³ (1 m²/305 m³) of room volume.

10.6.2.2.3 10.4.4.2.3  Discharge from outlet openings shall be directed or conducted to the atmosphere.

10.6.2.3 10.4.4.3*  Explosion control shall be provided in accordance with the requirements of Section 6.8.

10.6.2.4 10.4.4.4  Electrical equipment shall be in accordance with Article 501 of NFPA 70, National Electrical Code, for Class I, Division 2 locations.

10.6.2.5 10.4.4.5  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 10.4.4.4.

10.6.3 10.4.5  Hydrogen Gas Rooms.

10.6.3.1 10.4.5.1  Floors, walls, and ceilings shall be constructed of noncombustible or limited-combustible materials in accordance with the requirements of the building code.

10.6.3.1.1 10.4.5.1.1  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.

10.6.3.1.2 10.4.5.1.2  Not less than 25 percent of the perimeter wall shall be an exterior wall.

10.6.3.1.3 10.4.5.1.3  Openings to other parts of the building shall not be permitted.

10.6.3.1.4 10.4.5.1.4  Windows and doors shall be in exterior walls only.

10.6.3.2 10.4.5.2  Ventilation shall be as provided in Section 6.15.

10.6.3.3 10.4.5.3  Explosion control shall be provided in accordance with the requirements of Section 6.8.

10.6.3.4 10.4.5.4  There shall be no sources of ignition from open flames, electrical equipment, or heating equipment.

10.6.3.5 10.4.5.5  Electrical equipment shall be in accordance with Article 501 of NFPA 70, National Electrical Code, for Class I, Division 2 locations.

10.6.3.6 10.4.5.6  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 10.6.3.6 10.4.5.5.

Also, in support of A.10.3.2.4.1 add the following informational references to Annex H under Section H.2.2.


pp. 4758-4775.
REASONS:

A joint task group, known as Task Group 6, has been appointed by the Chairs of the NFPA 2, Hydrogen Technologies Code and the IMG TC. Revisions to separation distance tables in NFPA 55 were the focus of this group in the last code revision cycle. Feedback from industry and code users alike sought a simplification of requirements relative to the application of the tabular distances and the work of the task group continued.

One of the major stumbling blocks for readers of the existing tables was one where an assumption was made that distances should increase as system pressure increased. The use of pressure to pipe ID changes as pressure increases resulting in a decrease in the pipe ID and the corresponding leak rate which is generally based on 3% of the internal area of the largest section of pipe in the system under the pressure indicated.

Other complaints heard were that the table was too complex with too many pieces of data. Others found the use of complex exponential equations difficult when pipe IDs other than those common IDs listed in the table were encountered. Other comments were received that the metric units of measure were inconsistent and questions arose as to why there were two tables. To make things a bit more confusing a printing error resulted in quantity being placed into the table heading (corrected by Errata #1).

The task group addressed these issues with several changes in the manner in which the data is presented without changing either the criteria used or the end results.

- The table was simplified by grouping the exposures into three separate groups with Groups 1 and 2 being people sensitive groups and Group 3 being of a material or property nature.
- Table 10.3.2.1(a) has maintained the four common pressure ranges and it has been combined with Table 10.3.2.2.1(b) so that SI units are provided in the same table.
- Distances have been calculated first in inch-pound units of measure and rounded to the nearest foot (instead of five feet), and SI units have been determined using standard conversion formulas and rounding to the nearest meter using conventional rounding.
- The footnotes to Table 10.3.2.2.1 have been removed and placed into an annex note as they were informative.
- The pipe ID has been listed for the Typical Maximum Pipe Size (Table 10.3.2.1(a)).
- Table 10.3.2.1(b) is new. It replaces Table A.10.3.2.2.1.1(E) and the use of exponential formulas shown in A.10.3.2.2.1.1(B) in the 2010 Edition.
- Table 10.3.2.2.1(b) lists the pipe diameters in a range generally from 0.2 to 2 inches in increments of 1/10th of an inch. The resultant separation distance for each exposure group has been calculated and displayed in the table. The formulas have been simplified and are shown at the top of each column for each exposure group. For example, for Group 1 exposures in the 15 to 250 psig pressure range distance “D” is determined by multiplying the internal pipe ID in mm by 0.231 and rounding to the nearest foot or corresponding nearest meter. Interpolation between values can be used as indicated in table footnotes. The table is functional for pipe or tube as all values are based on ID.
- The exposures in each group are those established in Table 10.3.2.1(a).
- Comments received regarding an expected progression of distance with increasing pressures remain unresolved for Table 10.3.2.1(a). By referring to Table 10.3.2.1(b) it becomes clear that
this is the case as the distances are normalized across any single row based on a single pipe ID. For example for a 0.7 inch ID pipe the distances across the pressure ranges in the table range as follows:

- >15 to \( \leq 250 \text{ psi} \) – 4 ft
- >250 to \( \leq 3000 \text{ psi} \) – 13 ft
- >3000 to \( \leq 7500 \text{ psi} \) – 20 ft
- >7500 to \( \leq 15000 \text{ psi} \) – 26 ft

- Table 10.3.2.1(a) displays the “typical” sizes based on pressure. On the other hand Table 10.3.2.2(b) allows a rapid assessment of pipe sizes in the field without the use of what might be viewed as cumbersome calculations. Once an ID is determined the distances are easily estimated and verified.

As work on Section 10.3 was conducted it became apparent that the organization of Chapter 10 could be improved. For example, Section 10.4 established requirements for outdoor locations when weather protection was used. Electrical classification for wiring was specified. The requirements of Chapter 6 appearing in 10.4 appeared to be redundant to the requirements of Chapter 6 triggered by 10.1. Having a general requirement for electrical buried in a section following the tables appeared to be out of order. The chapter was reorganized to follow a general outline that established the following major sections:

10.1 Applicability
10.2 General Requirements applicable to all bulk GH2 systems
10.3 Outdoor
10.3.1 Outdoor General Requirements
10.3.2 Specific requirements for outdoor systems
10.4 Underground Systems
10.5 Vaults above or below ground (remains reserved)
10.6 Indoor
10.6.1 Indoor General Requirements
10.6.2 Detached Buildings
10.6.3 Hydrogen Gas Rooms

Modifications have been made to correlate the use of the term “bulk hydrogen compressed gas system” throughout Chapter 10. The substantive modifications other than reformatting of the chapter are found in Section 10.3. Using the table below the user can follow the reorganization and the table becomes a road map to how the Chapter was reconstructed.

<table>
<thead>
<tr>
<th>Old Section No.</th>
<th>New Section No.</th>
<th>Reason for change</th>
</tr>
</thead>
</table>

55/L139/Include/A2012/ROP
<table>
<thead>
<tr>
<th>Old Section No.</th>
<th>New Section No.</th>
<th>Reason for change</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1</td>
<td>10.1</td>
<td>Clarification. Chapter 9 applies to bulk oxygen systems.</td>
</tr>
<tr>
<td>10.1.1</td>
<td>10.1.1</td>
<td>Modifies definition of bulk hydrogen compressed gas system. Separate proposal issued and correlated.</td>
</tr>
<tr>
<td>10.1.2</td>
<td>-</td>
<td>Section deleted. Bulk systems are regulated as individual systems under the requirements of Chapter 10.</td>
</tr>
<tr>
<td>10.2</td>
<td>10.2</td>
<td>Existing Section 10.2 was titled design of gaseous hydrogen systems. The general requirements for all bulk GH2 systems have been moved to Section 10.2.</td>
</tr>
<tr>
<td>10.2.1</td>
<td>10.2.2</td>
<td>Relocated to 10.2.2. New Section 10.2.1 is now marking which was relocated from 10.2.5.</td>
</tr>
<tr>
<td>10.2.2</td>
<td></td>
<td>Relocated to 10.2.3 with minor edits.</td>
</tr>
<tr>
<td>10.2.2.1</td>
<td></td>
<td>Relocated to 10.2.3.1.</td>
</tr>
<tr>
<td>10.2.2.2</td>
<td></td>
<td>Relocated to 10.2.3.1.1</td>
</tr>
<tr>
<td>10.2.3</td>
<td></td>
<td>Section heading only. Deleted.</td>
</tr>
<tr>
<td>10.2.3.1</td>
<td></td>
<td>Relocated to 10.2.1.2</td>
</tr>
<tr>
<td>10.2.3.2</td>
<td></td>
<td>Relocated to 10.2.1.3</td>
</tr>
<tr>
<td>10.2.4</td>
<td>10.2.4</td>
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</tr>
<tr>
<td>10.2.4.1</td>
<td>10.2.4.1</td>
<td>Minor edits</td>
</tr>
<tr>
<td>10.2.4.1.1</td>
<td>10.2.4.1.1</td>
<td>Minor edits</td>
</tr>
<tr>
<td>10.2.4.2</td>
<td>10.2.4.2</td>
<td>Minor edits</td>
</tr>
<tr>
<td>10.2.4.3</td>
<td>10.2.4.3</td>
<td>Minor edits</td>
</tr>
<tr>
<td>10.2.4.4</td>
<td></td>
<td>Relocated to 10.2.5.1</td>
</tr>
<tr>
<td>10.2.5</td>
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<td>Relocated to 10.2.1</td>
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<td>Relocated to 10.2.1.1</td>
</tr>
<tr>
<td>10.2.5.2</td>
<td></td>
<td>Relocated to 10.2.1.2</td>
</tr>
<tr>
<td>10.2.6</td>
<td></td>
<td>Relocated to 10.2.5</td>
</tr>
<tr>
<td>10.3</td>
<td>10.3</td>
<td>Title only. Minor edits.</td>
</tr>
<tr>
<td>10.3.1</td>
<td>10.3.1</td>
<td>The statement in 10.3.1.1 has been moved to 10.3.1 and terminology has been coordinated with the published definition for bulk hydrogen compressed gas system found in Chapter 3.</td>
</tr>
<tr>
<td>10.3.1.1</td>
<td>10.3.1</td>
<td>Relocated 10.3.1.1 to 10.3.1 with Editorial change.</td>
</tr>
<tr>
<td>10.3.1.2</td>
<td>10.3.2.5 (4)</td>
<td>The text has been moved without change to 10.3.2.5 item (4).</td>
</tr>
<tr>
<td>10.3.2</td>
<td>10.3.2</td>
<td>The existing heading has been deleted. The title to Section 10.3.2.2 has been revised and the section renumbered to 10.3.2.</td>
</tr>
<tr>
<td>10.3.2.1</td>
<td>10.6.1.1</td>
<td>Modified and relocated to 10.6.1.1 and applied to indoor situations only.</td>
</tr>
<tr>
<td>Old Section No.</td>
<td>New Section No.</td>
<td>Reason for change</td>
</tr>
<tr>
<td>----------------</td>
<td>----------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>10.3.2.2</td>
<td>10.3.2</td>
<td>The section number has been revised due to the deletion of 10.3.2.1.</td>
</tr>
<tr>
<td>10.3.2.2.1</td>
<td>10.3.2.1</td>
<td>Editorial.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tables 10.3.2.2.1(a) and (b) have been reformatted for simplification purposes and renumbered. The two tables (inch-pound and SI) have now been combined into a single table.</td>
</tr>
<tr>
<td>A.10.3.2.1</td>
<td>New.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Footnotes to the tables have been eliminated and either transferred to the Annex or included as text in specific requirements. NFPA’s Manual of Style asks that requirements not be included in footnotes to tables.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Table 10.3.2.2.1(a) and (b) footnotes “a” through “e” have been reformatted and clarified. They have been included as Annex notes as they are informational in nature.</td>
</tr>
<tr>
<td>10.3.2.2.1.1(B)</td>
<td>10.3.2.1.1</td>
<td>Editorial revision to charging paragraph.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The alternative diameter equations and examples have been deleted as the equations are now simplified and resident in proposed Table 10.3.2.1(b).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Table 10.3.2.1(b) has been footnoted to allow the use of interpolation and the equations included in the heading rows to the table are provided to assist the user with the use of the table.</td>
</tr>
<tr>
<td>A.10.3.2.2.1.1(B)</td>
<td>deleted</td>
<td>This Annex note had been deleted in its entirety as Table 10.3.2.1(b) now provides a simplified approach to calculation for the user.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Exponential equations have been eliminated and replaced with simplified formulas.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Rounding to the nearest five feet has been dropped in favor of rounding to the nearest foot in order to eliminate the apparent conflicts raised between SI and inch-pound units. Some differences still exist, but they are due to rounding and the differences are not deemed to be significant.</td>
</tr>
<tr>
<td>Tables 10.3.2.2.1(a) and (b)</td>
<td>Table 10.3.2.1(a)</td>
<td>The tables have been reformatted and condensed to a single table to simplify the content for the user and for closer coordination between the display of inch-pound and SI units of measure. The following elements have been revised:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The exposures have been grouped to display those that are similar by segregating the exposures into Groups 1 through 3.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The distances (D) from exposures have been displayed for the pressures and pipe IDs previously shown in Tables 10.3.2.2.1(a) and (b). In the 2010 Edition there were 16 different exposures shown, each with an assigned row in the table. In the new tables there are 13 different exposures shown. The 3 exposures not shown were moved to Section 10.3.2.5 as they are applicable to systems regardless of pipe ID or system pressure.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Proposed Table 10.3.2.1(a) displays piping and pressure “typical” of the systems identified in the existing tables. Pipe ID is listed in metric units of measure only as it is the metric unit of measure that is used in the determination of distance.</td>
</tr>
<tr>
<td>Table 10.3.2.2.1(a) note g</td>
<td>10.3.2.5(2)</td>
<td>No change</td>
</tr>
</tbody>
</table>

55/L139/Include/A2012/ROP
<table>
<thead>
<tr>
<th>Old Section No.</th>
<th>New Section No.</th>
<th>Reason for change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 10.3.2.2.1(a) note h first sentence.</td>
<td>10.3.2.6</td>
<td>Editorial</td>
</tr>
<tr>
<td>Table 10.3.2.2.1(a) note h second sentence</td>
<td>10.3.2.5(3)</td>
<td>Editorial changes to note “h” as found in 10.3.2.5(3). Extract of second sentence of note “h” only.</td>
</tr>
<tr>
<td>Table 10.3.2.1(b)</td>
<td>A new table has been added to include information previously found in A.10.3.2.2.1.1 (B) and Table A.10.3.2.2.1.1 (E).</td>
<td></td>
</tr>
<tr>
<td>10.3.2.2.1.1</td>
<td>10.3.2.2</td>
<td>Editorial</td>
</tr>
<tr>
<td>10.3.2.2.1.1(A)</td>
<td>deleted</td>
<td>The section has been deleted as no requirements were established that were different from those already imposed by 10.3.2.2.1.</td>
</tr>
<tr>
<td>10.3.2.2.1.1(C)</td>
<td>deleted</td>
<td>The provision is not needed in light of the creation of Table 10.3.2.1(b) and the charging language provided in 10.3.2.1.</td>
</tr>
<tr>
<td>10.3.2.2.1.1(D)</td>
<td>10.3.2.2.2</td>
<td>Editorial</td>
</tr>
<tr>
<td>A.10.3.2.2.1(E)</td>
<td>A.10.3.2.2.1</td>
<td>The introduction of Table 10.3.2.1(b) addresses the principles embodied in existing A.10.3.2.2.1.1(e) as shown in the table of typical pipe sizes and examples showing the calculation of pipe ID. Table 10.3.2.1(b) goes beyond just steel pipe and includes piping and tubing of any construction as it is simply a generic table based on pipe ID without regard to the type of pipe or tube involved. As a result the code is broadened</td>
</tr>
</tbody>
</table>

Table 10.3.2.2.1(a) note h first sentence.

Table 10.3.2.2.1(a) note h second sentence

Table 10.3.2.1(b)

A new table has been added to include information previously found in A.10.3.2.2.1.1 (B) and Table A.10.3.2.2.1.1 (E).

- The table is arranged by required distance (D) related to pipe ID displayed in 1/10th inch increments along with a metric value of pipe ID shown as (d).
- Distances are displayed in the table by Exposure Group for each of the four pressures shown in table 10.3.2.1(a). Both SI and inch-pound units of measure are displayed.
- The value of “d” is used in the equations represented in the formula row, i.e., D = 0.231d, and used to calculate distance D as shown in the table. For example, to calculate distance D for a pipe ID of 5.1 mm for Group 1 exposures the user multiplies 5.1 by 0.231 and the value is displayed to the nearest meter. The metric distance D is then converted to SI units of measure by multiplying the unrounded metric result by the conversion factor 3.281 and rounding the inch-pound unit to the nearest foot.
- The complex formulas shown in 55:A.10.3.2.2.1.1(b) have been eliminated.

A = pi * d²/4

Dpipe = Dleak/(0.1732)

This means that the I.D. of the of pipe for this 13.5 mm diameter leak would be 13.5/0.1732 = 77.94 mm

A 9 mm diameter leak would correspond to a pipe ID of 51.96 mm for a 3% of flow area leak.
<table>
<thead>
<tr>
<th>Old Section No.</th>
<th>New Section No.</th>
<th>Reason for change</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.3.2.2.1.1(F)</td>
<td>10.3.2.3</td>
<td>The text from 10.3.2.2.1.1(F) has been relocated to 10.3.2.3 without change.</td>
</tr>
<tr>
<td>A.10.3.2.2.1.1(F)</td>
<td>A.10.3.2.3</td>
<td>The text from the annex note has been relocated. The term psi was editorially changed to psig.</td>
</tr>
<tr>
<td>A.10.3.2.2.2</td>
<td>A.10.3.2.4</td>
<td>Relocated annex note with editorial change.</td>
</tr>
</tbody>
</table>
| 10.3.2.2.2 | 10.3.2.4.1 | Provisions have been added for the construction of fire barrier walls as a means of passive protection. The elements of construction include:  
- fire resistance  
- line of sight  
- ambient or natural ventilation  
- limitation on number of walls to avoid confinement  
- structural considerations  
- clearance for maintenance related activities  
- allowances for the use of an equivalent exterior building wall  
- minimum height requirements  
- minimum width (lateral) requirements  
The use of fire barrier walls has been used as a means to provide separation from people sensitive exposures (Groups 1 and 2) by reducing the distance by one-half if the walls are constructed as specified. The use of a wall can reduce the separation distance for Group 3 exposures to zero (existing Section 10.3.2.2.2). No reduction is allowed for separation from air intakes based on the dynamics of an air intake system.  
The minimum height of the wall is based on the research and systems tested by Sandia and SRI as published in the paper by Houf, Schefer, Evans, et. al. The minimum width of the wall in terms of horizontal distance has been determined based on judgment and the angle formed between the source and the fire barrier wall itself. There is ongoing examination of wall configurations that may be constructed with more than three walls, and the conditions that may be required to be imposed. The joint task group will continue the effort to further develop requirements for fire barrier walls with more than three sides as the work continues. |
| 10.3.2.2.3 | deleted | Conflicts in the exposures identified have been eliminated. Requirements are now included in the charging language of 10.3.2.4.1. |
| A.10.3.2.2.3 | A.10.3.2.4.1 | The Annex note from A.10.3.2.2.3 has been retained and modified in light of the completion of research into barrier walls for both construction concerns and risk performed by Sandia personnel. |
| 10.3.2.2.4 | 10.3.2.4.1(4) | The number of fire walls surrounding individual systems is limited to three in order to prevent confinement thereby allowing for adequate ventilation. |
| 10.3.2.4.2 | A. 10.3.2.4.2 | An annex note has been added to provide information about the methods that the task
The code user can always use Section 1.5 as a means to introduce alternative methods of achieving compliance. In this instance gas detection and flame detection have been discussed as the means, however, prescriptive requirements are yet to be developed. Providing minimal guidance to the code user, designer and code official demonstrates conditions that must be considered when addressing equivalency to otherwise required separation distance.

<table>
<thead>
<tr>
<th>Old Section No.</th>
<th>New Section No.</th>
<th>Reason for change</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.3.2.3</td>
<td>10.3.2.5(1)</td>
<td>Text relocated from 10.3.2.3 with editorial change.</td>
</tr>
<tr>
<td>Table 10.3.2.2.1(a) note g</td>
<td>10.3.2.5(2)</td>
<td>Text relocated from Table 10.3.2.2.1(a) and (b) without change.</td>
</tr>
<tr>
<td>Table 10.3.2.2.1(a) note h second sentence</td>
<td>10.3.2.5(3)</td>
<td>Text relocated from Table 10.3.2.2.1(a) and (b) with editorial change intended to further subdivide the requirement into two paragraphs and to include the tabular distance (of 15 feet) previously included in the Tables as a requirement.</td>
</tr>
<tr>
<td>10.3.1.2</td>
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<td>Relocation of requirements from 10.3.1.2 without change.</td>
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<td>Table 10.3.2.2.1(a) note h first sentence</td>
<td>10.3.2.6</td>
<td>Relocation of first sentence of a footnote to Tables 10.3.2.2.1(a) and (b) with editorial changes to establish an independent section for requirements related to co-locating hydrogen with other non-liquefied compressed gases to be used for the purpose of creating hydrogen/flammable gas blends.</td>
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<td></td>
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<td>10.6</td>
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<td>Relocated to 10.6.1.2 as a general requirement for indoor applications</td>
</tr>
<tr>
<td>10.7 through 10.7.8</td>
<td></td>
<td>Relocated to 10.2.8 through 10.2.8.9</td>
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<td>10.8 through 10.8.4.6</td>
<td></td>
<td>Relocated to 10.2.6 through 10.2.6.8</td>
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</tbody>
</table>
an ID is determined the distances are easily estimated and verified.

As work on Section 10.3 was conducted it became apparent that the organization of Chapter 10 could be improved. For example, Section 10.4 established requirements for outdoor locations when weather protection was used. Electrical classification for wiring was specified. The requirements of Chapter 6 appearing in 10.4 appeared to be redundant to the requirements of Chapter 6 triggered by 10.1. Having a general requirement for electrical buried in a section following the tables appeared to be out of order. The chapter was reorganized to follow a general outline that established the following major sections:

10.1 Applicability
10.2 General Requirements applicable to all bulk GH2 systems
10.3 Outdoor
10.3.1 Outdoor General Requirements
10.3.2 Specific requirements for outdoor systems
10.4 Underground Systems
10.5 Vaults above or below ground (remains reserved)
10.6 Indoor
10.6.1 Indoor General Requirements
10.6.2 Detached Buildings
10.6.3 Hydrogen Gas Rooms

Modifications have been made to correlate the use of the term “bulk hydrogen compressed gas system” throughout Chapter 10. The substantive modifications other than reformatting of the chapter are found in Section 10.3. Using the table below the user can follow the reorganization and the table becomes a road map to how the Chapter was reconstructed.

(See attached)

Committee Meeting Action: Accept in Principle

Revise the submitted text as follows:

****Insert-L139-CA-Include-Here****

Committee Statement: The committee agreed with the technical changes, but made changes to comply with the Manual of Style and to give direction on using the formulas of 10.3.2.1(b).

****Insert-L139-CS-Include-Here****
Chapter 10 Bulk Gaseous Hydrogen Compressed Gas Systems

10.1 Applicability.

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

10.1.1 This chapter shall not apply to individual systems using containers each having a total hydrogen content of less than 400 scf (11 m³)–5000 ft³ (sft) (141.6 m³) if each system is separated by a distance not less than 5 ft (1.5 m) or to systems located in control areas when the aggregate quantity contained is less than the Maximum Allowable Quantity per Control Area (MAQ).

10.1.2 Where individual systems, each having a total hydrogen content of less than 400 scf (11 m³), are located less than 5 ft (1.5 m) from each other, this code shall apply.

10.2 General Design of Gaseous Hydrogen Systems.

10.2.1 10.2.5 Marking.

10.2.1.1 10.2.5.1 Hazard identification signs shall be provided in accordance with Section 6.11.

10.2.1.2 10.2.5.2 In addition, the area in which a hydrogen system is located shall be permanently placarded as follows:

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

10.2.2 10.2.4 Piping Systems. Piping, tubing, valves, and fittings shall be designed and installed in accordance with 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 10.5.1 Prior to acceptance and initial operation, all piping installations shall be inspected and pressure tested in accordance with the ICC International Fuel Gas Code (IFGC), Section 705.

10.2.3 Piping, Tubing, and Fittings.

10.2.1.2 10.2.3.1 In addition to the requirements of 7.3.1.4, brazing materials used for joints in piping and tubing systems shall have a melting point above 1000°F (538°C).

10.2.1.3 10.2.3.2 Underground piping systems shall be in accordance with 7.1.17.

10.2.3 10.2.2 Hydrogen Venting Systems, Pressure Relief Devices. 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 10.2.2.1 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 10.2.2.2 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.

10.2.4 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
minimize 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.

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

10.2.5 Marking.

10.2.5.1 Hazard identification signs shall be provided in accordance with Section 6.11.

10.2.5.2 In addition, the area in which a hydrogen system is located shall be permanently placarded as follows:

WARNING: HYDROGEN — FLAMMABLE GAS
NO-SMOKING — NO OPEN FLAMES

10.2.5 10.2.6 Bonding and Grounding. The bulk hydrogen compressed gas system gaseous hydrogen system
shall be electrically bonded and grounded.

10.2.5.1 10.2.4.4 Mobile hydrogen supply units shall be electrically bonded to the storage system before
hydrogen is discharged from the supply unit.

10.2.6 10.8 Compression and Processing Equipment.

Compression and gas processing equipment integral to bulk hydrogen compressed gas storage systems shall be
designed for use with GH2 and for maximum pressures and temperatures to which it can be subjected under
normal operating conditions.

10.2.6.1 10.8.1 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.

10.2.6.2 10.8.2 Where GH2 compression equipment is operated unattended, it shall be equipped with a high
discharge and a low suction pressure automatic shutdown control.

10.2.6.3 10.8.3 Control circuits that automatically shut down shall remain down until manually activated or
reset after a safe shutdown is performed.

10.2.6.4 10.8.4 Stationary Compressors.

10.2.6.4.1 10.8.4.1 Valves.

10.2.6.4.1.1 10.8.4.1.1 Valves shall be installed such that each compressor can is able to be isolated for
maintenance.

10.2.6.4.1.2 10.8.4.1.2 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.

10.2.6.5 10.8.4.2 Foundations.

10.2.6.5.1 10.8.4.2.1 Foundations used for supporting equipment shall be designed and constructed to prevent
frost heaving.

10.2.6.5.2 10.8.4.2.2 The structural aspects of such foundations shall be designed and constructed in
accordance with the provisions of the building code.

10.2.6.6 10.8.4.3 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 bulk gas installation.

10.2.6.6 10.8.4.4 Relief Valves.

10.2.6.6.1 10.8.4.4.1 Each compressor shall be provided with a vent or relief device that will prevent overpressurizing of the pump under normal or upset conditions.

10.2.6.6.2 10.8.4.4.2 Pressure relief devices used to serve pumps or compression equipment shall be connected to a vent pipe system in accordance with 10.2.2.

10.2.6.7 10.8.4.5 Pressure Monitoring. The pressure on the compressor discharge shall be monitored by a control system.

10.2.6.8 10.8.4.6 Protection. Transfer piping and compressors shall be protected from vehicular damage.

10.2.7 10.5 Operation and Maintenance.

10.2.7.1 10.5.2 Operating Instructions.

10.2.7.1.1 10.5.2.1 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.

10.2.7.1.2 10.5.2.2 Instructions shall be maintained at the operating site at a location acceptable to the authority having jurisdiction.

10.2.7.2 10.5.3 Maintenance. Maintenance shall be performed annually by a qualified representative of the equipment owner. 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. Scheduled maintenance and retest activities shall be formally documented, and records shall be maintained a minimum of 3 years.

10.5.4 Clearance to Combustibles. Clearance to combustibles shall be in accordance with the requirements of 7.1.10.3.

10.2.8 10.7 Cargo Transport Unloading.

10.2.8.1 10.4.1.3 Vehicular protection shall be provided in accordance with 7.1.8.3.

10.2.8.2 10.7.1 Unloading connections on delivery equipment shall not be positioned closer to any of the exposures cited in Table 10.3.2.2.1(a) and-or Table 10.3.2.2.1(b) than the distances given for the bulk hydrogen compressed gas storage system.

10.2.8.3 10.7.2 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 rolling of the vehicle.

10.2.8.4 10.7.3 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.

10.2.8.5 10.7.4 Mobile hydrogen supply units shall be electrically bonded to the bulk hydrogen compressed gas storage system before hydrogen is discharged from the supply unit.

10.2.8.6 10.7.5 Transfer System Depressurization.
10.2.8.6.1 10.7.5.1 The transfer systems shall be capable of depressurizing to facilitate disconnection.
10.2.8.6.2 10.7.5.2 Bleed connections shall be connected to a hydrogen venting system in accordance with
10.2.3-10.2.2.
10.2.8.7 10.7.6 Where required, check valves on delivery systems shall be in accordance with 7.3.1.3.2.
10.2.8.8 10.7.7 Prohibitions on smoking or the use of open flame shall be in accordance with 7.6.3.2.
10.2.8.9 10.7.8 An emergency shutoff valve shall be provided in accordance with 7.3.1.11.

10.3 Location of Outdoor Bulk Gaseous-Hydrogen Compressed Gas Systems.

10.3.1 General Requirements.
10.3.1.1 Bulk hydrogen compressed gas systems located above ground either at grade or above grade shall be in
accordance with Section 10.3.
10.3.1.2 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.
10.3.1.3-10.4.1.2 Electrical wiring and equipment shall be in accordance with Table 10.3.1.3-10.4.1.2.

<table>
<thead>
<tr>
<th>Table 10.3.1.3-10.4.1.2 Electrical Area Classification</th>
</tr>
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<tr>
<td>Location</td>
</tr>
<tr>
<td>Storage equipment excluding</td>
</tr>
<tr>
<td>the piping system downstream</td>
</tr>
<tr>
<td>of the source valve</td>
</tr>
</tbody>
</table>

A.10.3.1.3-Table 10.3.2.1(a) note g Equipment classified as meeting Class I, Division 2, Group B
requirements of NFPA 70, National Electrical Code when the area is in accordance with Sec NFPA 497,
Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous
(Classified) Locations for Electrical Installations in Chemical Process Areas for additional details.

10.3.2 Specific Requirements.

10.3.2.1 The location of hydrogen systems shall be in accordance with Table 10.3.2.1.

<table>
<thead>
<tr>
<th>Table 10.3.2.1—Location of Gaseous-Hydrogen Systems</th>
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</thead>
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<tr>
<td>Location</td>
</tr>
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<tr>
<td>Outdoors</td>
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<tr>
<td>In a detached building</td>
</tr>
</tbody>
</table>

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10.3.2.2 Minimum Distance—Location

10.3.2.2.1* Minimum Distance. The minimum distance from a bulk hydrogen compressed gas system located outdoors to specified exposures shall be in accordance with Tables 10.3.2.1(a) or 10.3.2.1(b) 10.3.2.2.1(a) or Table 10.3.2.2.1(b). (See also Annex G.)

A.10.3.2.1 The exposures integral to Tables 10.3.2.1(a) and (b) have been arranged into groups based on similar risks. The following thresholds are applicable to the exposures identified in each group, as follows.

1) Group 1 Exposures. The distances specified are those required to reduce the radiant heat flux level to 500 Btu/hr \cdot ft^2 (1.577 W/m^2) at the property line or the distance to a point in the unignited hydrogen jet where the hydrogen content is reduced to a 4 percent mole fraction (volume fraction) of hydrogen whichever is greater. In all cases the distance required to achieve a 4 percent mole fraction was the greater distance and used to establish the requirements.

2) Group 2 Exposures. The distances specified are those required to reduce the radiant heat flux level to 1,500 Btu/hr \cdot ft^2 (4.732 W/m^2) for persons exposed a maximum of 3 minutes.

3) Group 3 Exposures. The distances specified are those required to reduce the radiant heat flux level to 6,340 Btu/hr \cdot ft^2 (20,000 W/m^2) or the visible flame length for combustible materials, or a radiant heat flux level of 8,000 Btu/hr \cdot ft^2 (25,237 W/m^2) or the visible flame length for non-combustible equipment. In both cases the visible flame length was used to establish the requirements.

10.3.2.2.1-10.3.2.2.1.1 (B)*—Alternative Internal Diameters. The separation distance for piping systems with internal diameters greater than those specified in Table 10.3.2.1(a) 10.3.2.2.1(a) and Table 10.3.2.2.1(b) for the pressure range selected shall be permitted with tabular distances determined based on the use of the equations in Table 10.3.2.1(b) 10.3.2.2.1.1(B).

### Table 10.3.2.2.1.1(B) — Separation Distance Based on Alternative Pipe or Tube Internal Diameters

<table>
<thead>
<tr>
<th>Notes</th>
<th>&gt;15 to ≤250 psi (103.4 to 1724 kPa)</th>
<th>&gt;250 to ≤3000 psi (1724 to ≤20,684 kPa)</th>
<th>&gt;3000 to ≤7500 psi (20,684 ≤51,711 kPa)</th>
<th>&gt;7500 to ≤15,000 psi (51,711 ≤103,421 kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>( D_a = 0.23179d^{0.09934} )</td>
<td>( D_a = 0.73903d^{0.09966} )</td>
<td>( D_a = 1.1062d^{0.09999} )</td>
<td>( D_a = 1.4507d^{0.09995} )</td>
</tr>
<tr>
<td>(b)</td>
<td>( D_b = 0.091137d^{1.1003} + e^{-0.084081d^{0.076944d^{0.726811d^{0.091137d^{1.1003}}}} )</td>
<td>( D_b = 0.36599d^{1.1162} + e^{-0.10771d^{0.18853d^{1.2531d^{0.36599d^{1.1162}}}}} )</td>
<td>( D_b = 0.60173d^{1.1063} + e^{-0.3656d^{0.0900252d^{0.7603d^{0.60173d^{1.1063}}}}} )</td>
<td>( D_b = 0.84053d^{1.1023} + e^{-0.40365d^{0.0000430074d^{0.7146d^{0.84053d^{1.1023}}}}} )</td>
</tr>
<tr>
<td>(c)</td>
<td>( D_e = 0.075952d^{1.1022} + e^{-0.0878694d^{0.0768144d^{0.830886d^{0.075952d^{1.1022}}}}} )</td>
<td>( D_e = 0.28889d^{1.092} + e^{-0.1099d^{0.18705d^{1.4705d^{0.28889d^{1.092}}}}} )</td>
<td>( D_e = 0.45889d^{1.0887} + e^{-0.46723d^{0.000027772d^{0.5845d^{0.45889d^{1.0887}}}}} )</td>
<td>( D_e = 0.6324d^{1.0689} + e^{-0.52477d^{0.0000826234d^{0.5213d^{-0.6324d^{1.0689}}}}} )</td>
</tr>
</tbody>
</table>

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Notes:
(1) Use of this table assumes a leak diameter of 3 percent of the pipe flow area or internal diameter where \(d\) = inside diameter (ID) of pipe or tube expressed in millimeters (mm), and \(D_a, b, c, d, \ldots\) = separation distances in meters (m).
(2) All pressures are gauge pressures.
(a) Unspilled jet concentration decay distance to 4 percent mole fraction (volume fraction) hydrogen
(b) \(D \text{ rad} =\) radiation heat flux level of 500 Btu/hr\(\cdot\)\text{ft}^2\(\cdot\)\text{in}^2\(\cdot\)\text{A}^2\(\cdot\)10^4 W/m\(^2\))
(c) \(D \text{ rad} =\) for heat flux level of 1500 Btu/hr\(\cdot\)\text{ft}^2\(\cdot\)\text{in}^2\(\cdot\)\text{A}^2\(\cdot\)10^3 W/m\(^2\)) exposure to employees for a maximum of 3 minutes
(d) The greater of \(D \text{ rad} =\) for combustible heat flux level of 6340 Btu/hr\(\cdot\)\text{ft}^2\(\cdot\)\text{in}^2\(\cdot\)\text{A}^2\(\cdot\)10^3 W/m\(^2\)) or the visible flame length
(e) The greater of \(D \text{ rad} =\) for noncombustible equipment heat flux level of 8000 Btu/hr\(\cdot\)\text{ft}^2\(\cdot\)\text{in}^2\(\cdot\)\text{A}^2\(\cdot\)10^3 W/m\(^2\)) or the visible flame length

A.10.3.2.2.1.1(B) The following is a sample calculation for separation distances using \(\frac{1}{4}\) in. ID tubing at gauge pressure of 250-3000 psi:
(1) Determine internal diameter (ID) where ID = OD \(-\) (2 \(\times\) wall thickness); wall thickness = 0.049 in. (known); outside diameter (OD) = 0.250 in.
\[\text{ID} = d = 0.250 - (2 \times 0.049) = 0.152 \text{ in.} = 3.86 \text{ mm}\]
To use the equations in Table 10.3.2.2.1.1(B) the ID values (the value of \(d\) in the equation) to be used must be expressed in millimeters.
(2) Next, determine separation distance(s). The separation distances \(D_a, D_b, \ldots\) are calculated in meters to two significant places after the decimal. To convert meters to feet, multiply meters by 3.281 and round-off to the nearest 5 ft.
For example, assuming the 250-3000 psi pressure range (second column), calculations for separation distance for the Table 10.3.2.2.1.1(B) footnotes (a) through (e) are as follows:

Where:
\[D_a, b, c, d, e = \text{calculated separation distance for } D_a, D_b, \ldots\]
\[e = 2.71828 \ldots\], the base of natural logarithms
Then:
(a) \[D_a = 0.74d^{0.99962}\]
\[D_a = 0.74(3.86)^{0.99962}\]
\[D_a = 2.85 \text{ m} = 9.4 \text{ ft} \approx 10 \text{ ft}\]
(b) \[D_b = 0.37d^{1.1152} + e^{0.10774d^{1.2531}} - 0.37d^{1.1152}\]
\[D_b = 0.37(3.86^{1.1152}) + e^{0.10774(3.86^{1.2531})} - 0.37(3.86^{1.1152})\]
\[D_b = 0.37(4.51) + e^{0.44185[(0.19)(3.86^{1.2531}) - (0.37)(3.86^{1.1152})]}\]
\[D_b = 1.67 + 1.67 = 3.34 \text{ m} = 11.0 \text{ ft} \approx 10 \text{ ft}\]
\[D_b = 1.67 - 0.42\]
\[D_b = 1.25 \text{ m} = 4.1 \text{ ft} \approx 5 \text{ ft}\]
(e) \[D_c = 0.29d^{1.095} + e^{0.10392d^{1.1795}} - 0.29d^{1.095}\]
\[D_c = 0.29(3.86^{1.095}) + e^{0.10392(3.86^{1.1795})} - 0.29(3.86^{1.095})\]

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\[D_e = 0.29(4.37) + e^{-0.4014[(0.19)(4.92) - (0.29)(4.37)]} \]
\[D_e = 1.27 + 0.67(0.94 - 1.27) \]
\[D_e = 1.27 - 0.22 \]
\[D_e = 1.05 \text{ m} = 3.45 \text{ ft} \rightarrow 5 \text{ ft} \]

(d) \[D_d = 0.31d^{0.99962} \]
\[D_d = 0.31(3.86)^{0.99962} \]
\[D_d = 0.31(3.84) = 1.19 \text{ m} = 3.9 \text{ ft} \rightarrow 5 \text{ ft} \]

(e) \[D_e = 0.31d^{0.99962} \]
\[D_e = 0.31(3.86)^{0.99962} \]
\[D_e = 0.31(3.84) = 1.19 \text{ m} = 3.9 \text{ ft} \rightarrow 5 \text{ ft} \]

The subscripts to \( D, a, b, c, d, \) and \( e \), relate to notes (a) through (e), respectively, in Table \ref{table:10.3.2.2.1}(B). To convert the distance in meters to feet, multiply by 3.2808. The resultant distance in feet is then rounded off to the nearest 5-foot dimension. For example, a distance of 5.2 ft would be rounded down to 5 ft. A distance of 7.6 ft would be rounded up to 10 ft.

[Delete Tables 10.3.2.2.1(a) and 10.3.2.2.1(b) in their entirety and replace with the following tables]
<table>
<thead>
<tr>
<th>Pressure</th>
<th>&gt; 15 to ≤ 250 psig (103.4 to 1724 kPa)</th>
<th>&gt; 250 to ≤ 3000 psig (1724 to 20,684 kPa)</th>
<th>&gt; 3000 to ≤ 7500 psig (20,684 to 51,711 kPa)</th>
<th>&gt; 7500 to ≤ 15000 psig (51,711 to 103,421 kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal Pipe Diameter (ID) ( 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>
</tr>
<tr>
<td>Exposures Group 1</td>
<td>m</td>
<td>ft</td>
<td>m</td>
<td>ft</td>
</tr>
<tr>
<td>(a) Lot lines</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) Air intakes (HVAC, compressors, other)</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>
</tr>
<tr>
<td>(d) Ignition sources such as open flames and welding</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exposures Group 2</td>
<td>m</td>
<td>ft</td>
<td>m</td>
<td>ft</td>
</tr>
<tr>
<td>(a) Exposed persons other than those servicing the system</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) parked cars</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exposures Group 3</td>
<td>m</td>
<td>ft</td>
<td>m</td>
<td>ft</td>
</tr>
<tr>
<td>(a) Buildings of non-combustible non-fire rated construction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) Buildings of combustible construction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(c) Flammable gas storage systems above or below ground</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(d) Hazardous Materials Storage Systems above or below ground</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(e) Heavy timber, coal or other slow-burning combustible solids</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Internal Pipe Diameter (ID) | > 15 to ≤ 250 psig  
> 103.4 to ≤ 1724 kPa | > 250 to ≤ 3000 psig  
> 1724 to ≤ 20,684 kPa | > 3000 to ≤ 7500 psig  
> 20,684 to ≤ 51,711 kPa | > 7500 to ≤ 15000 psig  
> 51,711 to ≤ 103,421 kPa |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<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>
</tr>
</tbody>
</table>

(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) Unopened openings in building and structures

(h) Utilities overhead including electric power, building services or hazardous materials piping systems
Table 10.3.2.1(b) Minimum Distance (D) from Outdoor Bulk Hydrogen Compressed Gas Systems to Exposures – By Maximum Pipe Size

<table>
<thead>
<tr>
<th>Pressure</th>
<th>Internal Pipe Diameter (ID)</th>
<th>Exposures&lt;sup&gt;h,ε&lt;/sup&gt;</th>
<th>Exposures&lt;sup&gt;h,ε&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Group 1</td>
<td>Group 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>m  ft</td>
<td>m  ft</td>
</tr>
<tr>
<td>&gt; 15 to ≤ 250 psig</td>
<td>D = 0.231d</td>
<td>0  1</td>
<td>0  2</td>
</tr>
<tr>
<td>&gt; 103.4 to ≤ 1724 kPa</td>
<td>D = 0.12584d - 0.47126</td>
<td>0  2</td>
<td>1  2</td>
</tr>
<tr>
<td></td>
<td>D = 0.096d</td>
<td>1  3</td>
<td>1  3</td>
</tr>
<tr>
<td>&gt; 250 to ≤ 3000 psig</td>
<td>D = 0.738d</td>
<td>1  4</td>
<td>1  4</td>
</tr>
<tr>
<td>&gt; 1724 to ≤ 20,684 kPa</td>
<td>D = 0.43616d - 0.91791</td>
<td>1  5</td>
<td>1  5</td>
</tr>
<tr>
<td></td>
<td>D = 0.307d</td>
<td>2  6</td>
<td>2  6</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Internal Pipe Diameter (ID)</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID (in)</td>
<td>d (mm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.2</td>
<td>5.1</td>
<td>18</td>
<td>7</td>
<td>8</td>
<td>24</td>
<td>10</td>
</tr>
<tr>
<td>0.3</td>
<td>7.6</td>
<td>28</td>
<td>13</td>
<td>11</td>
<td>36</td>
<td>18</td>
</tr>
<tr>
<td>0.4</td>
<td>10.2</td>
<td>37</td>
<td>18</td>
<td>15</td>
<td>48</td>
<td>25</td>
</tr>
<tr>
<td>0.5</td>
<td>12.7</td>
<td>46</td>
<td>24</td>
<td>19</td>
<td>60</td>
<td>33</td>
</tr>
<tr>
<td>0.6</td>
<td>15.2</td>
<td>55</td>
<td>30</td>
<td>23</td>
<td>72</td>
<td>41</td>
</tr>
<tr>
<td>0.7</td>
<td>17.8</td>
<td>64</td>
<td>36</td>
<td>27</td>
<td>84</td>
<td>49</td>
</tr>
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<td>0.8</td>
<td>20.3</td>
<td>74</td>
<td>41</td>
<td>31</td>
<td>97</td>
<td>56</td>
</tr>
<tr>
<td>0.9</td>
<td>22.9</td>
<td>83</td>
<td>47</td>
<td>34</td>
<td>109</td>
<td>64</td>
</tr>
<tr>
<td>1.0</td>
<td>25.4</td>
<td>92</td>
<td>53</td>
<td>38</td>
<td>121</td>
<td>72</td>
</tr>
<tr>
<td>1.1</td>
<td>27.9</td>
<td>101</td>
<td>58</td>
<td>42</td>
<td>133</td>
<td>80</td>
</tr>
<tr>
<td>1.2</td>
<td>30.5</td>
<td>111</td>
<td>64</td>
<td>46</td>
<td>145</td>
<td>87</td>
</tr>
<tr>
<td>1.3</td>
<td>33.0</td>
<td>120</td>
<td>70</td>
<td>50</td>
<td>157</td>
<td>95</td>
</tr>
<tr>
<td>1.4</td>
<td>35.6</td>
<td>129</td>
<td>75</td>
<td>54</td>
<td>169</td>
<td>103</td>
</tr>
<tr>
<td>1.5</td>
<td>38.1</td>
<td>138</td>
<td>81</td>
<td>57</td>
<td>181</td>
<td>111</td>
</tr>
<tr>
<td>1.6</td>
<td>40.6</td>
<td>147</td>
<td>87</td>
<td>61</td>
<td>193</td>
<td>118</td>
</tr>
<tr>
<td>1.7</td>
<td>43.2</td>
<td>157</td>
<td>92</td>
<td>65</td>
<td>205</td>
<td>126</td>
</tr>
<tr>
<td>1.8</td>
<td>45.7</td>
<td>166</td>
<td>98</td>
<td>69</td>
<td>217</td>
<td>134</td>
</tr>
<tr>
<td>1.9</td>
<td>48.3</td>
<td>175</td>
<td>104</td>
<td>73</td>
<td>229</td>
<td>142</td>
</tr>
<tr>
<td>2.0</td>
<td>50.8</td>
<td>184</td>
<td>110</td>
<td>77</td>
<td>241</td>
<td>149</td>
</tr>
</tbody>
</table>

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

b 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 \((\text{mm})\). The calculated distance \((D)\) is expressed in units of measure in meters \((\text{m})\). 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.

10.3.2.2.1.4 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 exceed the values shown in Table 10.3.2.1.2-1(a) when in accordance with and Table 10.3.2.1.2-1(b) for the pressure range indicated except as allowed by 10.3.2.2.1.1(B) or 10.3.2.2.1.1(C).

10.3.2.2.1* 10.3.2.2.1.1(E) 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 400 scf \((11.3 \text{ m}^3)\). The piping system size used in the application of Tables 10.3.2.1.2-1(a) and or 10.3.2.1.2-1(b) shall be determined based on that portion of the system with the greatest maximum internal diameter.

A.10.3.2.2.1-A.10.3.2.2.1.1(E) Systems that employ compressors downstream of a bulk supply typically operate at higher pressures than that of the bulk supply. As a result, the diameter of the piping system can vary with the pressure. The use of a higher pressure rating or variation of internal diameters is not warranted unless there is a storage component with a hydrogen content that exceeds 400 scf \((11.3 \text{ m}^3)\) located downstream of the primary storage source and upstream of the source valve. The volume of gas contained within the piping system is not included in determining the quantity in storage.

For example, a 3000 psig \((20,684 \text{ kPa})\) storage system that supplies a 6000 psig \((41,369 \text{ kPa})\) compressor that directly feeds a process with less than 400 scf \((11.3 \text{ m}^3)\) of intervening storage at a pressure of 6000 psig \((41,369 \text{ kPa})\) or less is considered a 3000 psig \((20,684 \text{ kPa})\) system. Conversely, a system with the primary storage of 3000 psig \((20,684 \text{ kPa})\) might supply a compressor that in turn delivers hydrogen to intermediate storage with a quantity of greater than 400 scf \((11.3 \text{ m}^3)\). (Note: Pressures given are gauge pressures.) The piping serving the intermediate storage system from a point of discharge on the compressor can have an internal diameter of less than that serving the primary storage system upstream of the compressor. Accordingly, each portion of the system must be analyzed with respect to the tabular distances. See the typical P&IDs shown in Figure A.3.3.12(a) through Figure A.3.3.12(f) for additional information in this regard.

The use of Table 10.3.2.1.2-1(B) is based on the maximum internal diameter of the piping system over the range of pressures specified. In practice, it is common to maintain a consistent size of piping throughout the system; however, there might be cases where the ID of the piping system varies. In such cases, the piping with the largest internal diameter in the system is used to establish the system pipe size for the purposes of using the table, regardless of the length of the piping. It is not uncommon for portions of the system equipped with pressure gauges, pressure transducers, or other instrumentation to be served by small-diameter piping systems. However, the maximum internal diameter of the piping system will control the establishment of distance for the exposures indicated.

Pipe sizes are typically expressed in nominal terms as illustrated in Table A.10.3.2.2.1.1(E) below. This is compared with tubing in which the outside diameter (OD) is expressed in exact terms. Designers commonly use pipe schedule to specify the wall thickness for a given material based on the design conditions. Typical pipe sizes found in commerce include those shown in Table A.10.3.2.2.1.1(E).
Table A.10.3.2.1.1(E)—Typical Pipe Sizes

<table>
<thead>
<tr>
<th>Nominal Pipe Size (in.)</th>
<th>O.D. (in.)</th>
<th>40</th>
<th>30</th>
<th>XH</th>
<th>XXH</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4</td>
<td>0.540</td>
<td>0.088</td>
<td>0.119</td>
<td>0.119</td>
<td>—</td>
</tr>
<tr>
<td>3/8</td>
<td>0.675</td>
<td>0.091</td>
<td>0.126</td>
<td>0.126</td>
<td>—</td>
</tr>
<tr>
<td>1/2</td>
<td>0.840</td>
<td>0.109</td>
<td>0.147</td>
<td>0.147</td>
<td>0.294</td>
</tr>
<tr>
<td>3/4</td>
<td>1.050</td>
<td>0.113</td>
<td>0.154</td>
<td>0.154</td>
<td>0.308</td>
</tr>
<tr>
<td>1</td>
<td>1.315</td>
<td>0.133</td>
<td>0.179</td>
<td>0.179</td>
<td>0.358</td>
</tr>
<tr>
<td>1 1/4</td>
<td>1.660</td>
<td>0.140</td>
<td>0.191</td>
<td>0.191</td>
<td>0.382</td>
</tr>
<tr>
<td>1 1/2</td>
<td>1.900</td>
<td>0.145</td>
<td>0.200</td>
<td>0.200</td>
<td>0.409</td>
</tr>
<tr>
<td>2</td>
<td>2.375</td>
<td>0.154</td>
<td>0.218</td>
<td>0.218</td>
<td>0.436</td>
</tr>
<tr>
<td>2 1/4</td>
<td>2.875</td>
<td>0.203</td>
<td>0.276</td>
<td>0.276</td>
<td>0.552</td>
</tr>
<tr>
<td>3</td>
<td>3.500</td>
<td>0.216</td>
<td>0.300</td>
<td>0.300</td>
<td>0.609</td>
</tr>
<tr>
<td>3 1/4</td>
<td>4.000</td>
<td>0.226</td>
<td>0.318</td>
<td>0.318</td>
<td>0.636</td>
</tr>
<tr>
<td>4</td>
<td>4.500</td>
<td>0.237</td>
<td>0.337</td>
<td>0.337</td>
<td>0.674</td>
</tr>
</tbody>
</table>

XH = extra heavy; XXH = extra extra heavy.

Note: Standard pipe schedule or pipe size as listed by ANSI/ASME B36.10M, *Welded and Seamless Wrought Steel Pipe*, and API Spec 5L Specification for Line Pipe.

To determine internal diameter (ID) of a selected pipe size, multiply by 2 the wall thickness for the selected schedule and subtract the result from the outside diameter (OD):

-ID = OD — (2 × wall thickness)

For example, for 2 in. Schedule 40 pipe:

Wall thickness = 0.154 in.; OD = 2.375 in.

Then:

-ID = 2.375 — (2 × 0.154) = 2.067 in.

When tubing is used in lieu of pipe, the OD of the tubing is designated in inches (e.g., 1/4, 3/8, 1/2, 1, 1 1/4, 1 1/2, 2) and the tubing is manufactured to those specific dimensions. Tube wall thickness is determined based on the working pressure and materials of construction. The calculation of internal diameter is the same as that used for conventional pipe:

-ID = OD — (2 × wall thickness)

For example, for 1/4 in. OD tubing, if the wall thickness is 0.049 in. and the OD is 0.250 in., then:

-ID = 0.250 — (2 × 0.049) = 0.152 in.

10.3.2.1.1 (A) Shutoff Valves on the Source of Supply. When shutoff valves are not connected directly to

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the source of supply, all interconnecting piping between the source connection and points downstream shall be included in the determination of internal diameter for the piping system.

10.3.2.2.1(C) The separation distance for piping systems with internal diameters less than those specified in Table 10.3.2.2.1(a) and Table 10.3.2.2.1(b) for the pressure range selected shall be allowed to be reduced with tabular distances determined based on the use of equations in Table 10.3.2.2.1(C).

10.3.2.2.2 10.3.2.2.1.1(D) Separation distances determined based on the use of piping systems with pipe ID greater than that indicated in Table 10.3.2.1(b) 10.3.2.2.1.1(D) shall be subject to review and approval by the AHJ.

A.10.3.2.2.2. The methodology used to determine the distances listed in Table 10.3.2.1(b) has been evaluated for piping up to and including internal diameters of approximately 3 inches (76 mm). The establishment of risk informed separation distances for piping systems with greater internal diameters are subject to a hazard analysis that demonstrates an equivalent level of risk under the provisions of Section 1.5.

10.3.2.3 10.3.2.2.1.1(F) Determination of System Pressure. The system pressure shall be determined by the maximum operating pressure of the storage array with content greater than 400 scf (11.3 m³), irrespective of those portions of the system elevated to a higher pressure.

A.10.3.2.3 A.10.3.2.2.1.1(F) Portions of a system might operate at higher pressures than the bulk supply; however, those portions of the system do not require the use of a pressure rating higher than that of the bulk supply unless there is a storage component exceeding 400 scf (11.3 m³) downstream of the primary storage source and upstream of the source valve. The volume of gas contained within the piping system is not included when the quantity in storage is determined. For example, a 3000 psig (20,684 kPa) storage system that supplies a 6000 psig (41,369 kPa) compressor that directly feeds a process with less than 400 scf (11.3 m³) of intervening storage at a pressure of 6000 psig (41,369 kPa) or less is considered a 3000 psig (20,684 kPa) system.

10.3.2.4 10.3.2.2.2 Reduction of Distance By Mitigation Means.

A.10.3.2.4 A.10.3.2.2.2 Distances to assumed lot lines established for the purpose of determining exterior wall and opening protection should not be confused with lot lines that are property lines in the true sense of the definition, and distances to assumed lot lines can be disregarded in the application of Tables 10.3.2.1.2.1(a) and 10.3.2.1.2.1(b). The lot lines specified in 10.3.2.2.2 are property lines used to separate one lot from another or to separate a property from a street or other public space.

A permit holder cannot exercise any right of control over the property of others, whether the ownership is public or private. In cases where the permit holder owns an adjacent lot or parcel, the separation from property lines assumes that the permit holder could transfer ownership of the adjacent property at some point, and therefore the requirements for property line separation should be observed.

10.3.2.4.1 10.3.2.2.2 Passive Means. Except for distances to lot lines, operable building openings, air intakes, and overhead utilities, the distances to Group 1 and 2 exposures shown in Tables 10.3.2.1.2.1(a) and 10.3.2.1.2.1(b) shall not apply be permitted to be reduced by one-half and shall not apply to Group 3 exposures where fire barrier walls having a minimum fire resistance rating of 2 hours constructed in accordance with the following 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) **10.3.2.4** Where fire barrier walls of three sides are used, the walls shall be in accordance with 11.3.2.4.

(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)* **Table 10.3.2.2.1(a) note f:** Where clearance is required between the bulk hydrogen compressed gas system and the barrier wall for the performance of service or maintenance related activities the a minimum horizontal clearance of 5 feet shall be provided between the structure and the system required for access for service-related activities.

(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.

(9) The minimum wall height shall be not less than 8 ft (2.1 m).

(10) The minimum wall length shall project not less than 5 ft (1.5 m) horizontally beyond the most remote point of the system or the exposure.

**A.10.3.2.4.1-A.10.3.2.2.3** The code has historically recognized that, in certain instances, fire barrier walls can serve as a means to reduce the limits of unacceptable consequences due to the release of hydrogen from high-pressure equipment. Testing other than that related to establish fire resistance of the fire barrier walls has not been documented. Researchers at Sandia National Laboratories have been investigating the use of fire barrier walls as a means of mitigation in the establishment of distances related to the installation of bulk gaseous hydrogen systems, and a technical paper has been presented detailing the early findings.

As stated by Sandia National Laboratories researchers Houf, Schefer, and Evans in "Analysis of Barriers for Mitigation of Unintended Releases of Hydrogen," the purpose of the Sandia study was to extend the available database on barrier walls as a hazard mitigation strategy and to provide technical data for risk-informed decisions in hydrogen codes and standards regarding barrier wall design and implementation. Additional research by Sandia's Jeff LaChance in a paper titled "NFPA Mitigation Analysis" the focus of the research included testing to assess the effectiveness of various barrier designs in terms of the following:

1. Deflecting jet-flames
2. Reducing the extent of the flammable cloud resulting from an unignited release
3. Reducing the magnitude of the radiative heat flux produced by a jet flame from an ignited release
4. Minimizing the amount of ignition overpressure produced from the barrier confinement

When the work is concluded, it is expected that the results will likely provide the basis for criteria for the proper configuration, design, and construction of such barriers in order that the walls do not create other hazards. The work to date has been limited; however, the results have been promising. Houf, Schefer, and Evans have determined that for the conditions investigated, 2000 psi (13.79 MPa) source pressure and a 1/8 in. (0.175 mm) diameter round leak, the barrier configurations studied were found to (1) reduce horizontal jet flame impingement hazard by deflecting the jet flame, (2) reduce radiation hazard distances for horizontal jet flames, and (3) reduce horizontal unignited jet flammability hazard distances. For the one-wall vertical barrier and the
three-wall barrier configurations examined in the tests, the simulations of the peak overpressure hazard from ignition were found to be approximately 5.8 psi (40 kPa) on the release side of the barrier and approximately 0.73 psi (5 kPa to 3 kPa) on the downstream side of the barrier.

As stated by Sandia National Laboratories researchers Houf, Schofer, and Evans in “Evaluation of Barrier Walls for Mitigation of Unintended Releases of Hydrogen,” the purpose of the Sandia study was to extend the available database on barrier walls as a hazard mitigation strategy and to provide technical data for risk-informed decisions in hydrogen codes and standards regarding barrier wall design and implementation. Additional analysis by Sandia (LaChance, Phillips and Houf) in a paper titled “Risk Associated with the Use of Barriers in Hydrogen Refueling Stations” provided insights on the effectiveness of various barrier designs in terms of the following:

1. Deflecting jet flames
2. Reducing the extent of the flammable cloud resulting from an unignited release
3. Reducing the magnitude of the radiative heat flux produced by a jet flame from an ignited release
4. Minimizing the amount of ignition overpressure produced from the barrier confinement

Houf, Schofer, and Evans have determined that for the conditions investigated, 2000 psi (13.79 MPa) source pressure and a 1/8 in. (3.175 mm) diameter round leak, the barrier configurations studied were found to (1) reduce horizontal jet flame impingement hazard by deflecting the jet flame, (2) reduce radiation hazard distances for horizontal jet flames, and (3) reduce horizontal unignited jet flammability hazard distances. For the one-wall vertical barrier and the three-wall barrier configurations examined in the tests, the simulations of the peak overpressure hazard from ignition were found to be approximately 5.8 psi (40 kPa) on the release side of the barrier and approximately 0.73 psi to 0.44 psi (5 kPa to 3 kPa) on the downstream side of the barrier. Although an overpressure can be expected due to latent ignition of a flammable cloud the overpressure is expected to be limited to a localized area. Special designs for overpressure in addition to the structural loads imposed by the building code have not been required.

The function of the fire barrier wall is to protect the exposure from the system and not the converse. The code assumes that other factors will enter into locating any material or structure in proximity to the bulk hydrogen compressed gas system. For example, if a property or lot line is involved opposite the hydrogen installation the proximity of a building to be constructed on the lot line is regulated by the building code based on the type and occupancy of structure to be constructed.

Investigation is continuing into the parameters for the construction of fire barrier walls. In the interim, a risk-informed approach to the establishment of distance has been introduced into Chapter 10 of this code. The Industrial and Medical Gases Technical Committee recognizes that previous editions of the code have allowed the use of fire barrier walls as a mitigation method. Until such time as the investigation by Sandia National Laboratories or others has been completed, 10.3.2.2.3 provides for the use, in limited cases, of fire barrier walls to mitigate effects on the downstream side of the wall by allowing a reduction of one-half of the separation distance otherwise required through the use of the risk-informed tables.

The resultant distances should be measured from a point on the unexposed (or downstream side) of the fire-barrier wall to the exposure. For example, the 45 ft (14.0 m) distance to lot lines shown for a 2,000 psi gauge (20,684 kPa gauge) system using piping with a maximum internal diameter (ID) of 0.747 in. (18.97 mm) can be reduced to 22.5 ft (7.0 m) between the property line and the fire barrier wall.

The concept of limiting the use of barrier walls is an interim determination that augments the requirements now found in the risk-informed approach to the establishment of separation distances. The outcome of the scientific research underway will measure the effect of the mitigation provided by the walls and will bring a firmness to

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the fire barrier requirements. The importance of completing the research is that all the factors integral to the
effectiveness of fire barrier walls have been established through the scientific process. The use of the
scientific process is a fundamental precept established in the acceptance of the risk-informed approach.

10.3.2.3* The distances in (1), (2), (4), and (10) in Table 10.3.2.2.1(a) and Table 10.3.2.2.1(b) shall be
permitted to be reduced by one-half where fire barrier walls having a minimum fire resistance rating of 2 hours
are located between the system and the exposure.

10.3.2.4.2* Active Means. Active control systems that mitigate the risk of system leaks and failures can
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.

A.10.3.2.4.2 To determine the acceptability of technologies, processes, products, facilities, materials, and uses
attending the design, operation or use of such systems, the AHJ is authorized to require the owner or agent to
provide, without charge to the jurisdiction, a technical opinion and report. The model fire prevention codes
provide the authority for the AHJ to seek technical assistance from independent third parties with expertise in
the matter to be reviewed at the submitter’s expense. The AHJ is authorized to require design submittals to be
prepared by, and bear the stamp of, a registered design professional or professional engineer.

Active means of control could include a means to detect leakage or fire coupled with automatic system shut
down, such as gas or flame detection. The use of gas or flame detection should consider, but is not limited to
the following:

1) Gas Detection. To utilize gas detection as a means of control the gas sensor would be placed at a point
between the bulk hydrogen compressed gas system and the exposure. Gas detection systems may be
limited in their ability to detect the presence of hydrogen in the open. The most effective if the
sensor is located within an enclosed space such as an equipment enclosure. If used, gas detection
systems should be either listed or approved.

2) Flame Detection. Flame detection systems may include combination UV/IR detection systems and be
installed in accordance with the requirements of NFPA 72.

Ultraviolet flame detectors typically use a vacuum photodiode Geiger–Muller tube to detect the
ultraviolet radiation that is produced by a flame. The photodiode allows a burst of current to flow for
each ultraviolet photon that hits the active area of the tube. When the number of current bursts per unit
time reaches a predetermined level, the detector initiates an alarm.

A single wavelength infrared flame detector uses one of several different photocell types to detect the
infrared emissions in a single wavelength band that are produced by a flame. These detectors generally
include provisions to minimize alarms from commonly occurring infrared sources such as incandescent
lighting or sunlight. An ultraviolet/infrared (UV/IR) flame detector senses ultraviolet radiation with a
vacuum photodiode tube and a selected wavelength of infrared radiation with a photocell and uses the
combined signal to indicate a fire. These detectors need exposure to both types of radiation before an
alarm signal can be initiated. A multiple wavelength infrared (IR/IR) flame detector senses radiation at
two or more narrow bands of wavelengths in the infrared spectrum. These detectors electronically
compare the emissions between the bands and initiate a signal where the relationship between the two
bands indicates a fire. [72, A.5.8.2]

10.3.2.5 Required Separation Distance For All Systems. Separation distances are shall be required for bulk
hydrogen compressed gas systems independent of system pressure or internal diameter of piping systems in
accordance with the following-10.3.2.5.1 through 10.3.2.5.3.
10.3.2.5.1 (4) 10.3.2.3 Unloading connections on delivery equipment shall not be positioned closer to any of the exposures cited in 10.3.2.1.2.1(a) or 10.3.2.1.2.1(b) than the distances given for the storage system.

(2) Table 10.3.2.2.1(a) note g Equipment classified as meeting Class I, Division 2, Group B requirements of NFPA 70, National Electrical Code when the area is in accordance with NFPA 497, Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas.

10.3.2.5.2 (3) Table 10.3.2.2.1(a) note h Bulk hydrogen storage systems are allowed to integrate (co-locate) other nonliquefied flammable gas systems 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. The minimum separation distance indicated requires a minimum separation 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 feet.

10.3.2.5.3 (4) 10.3.1.2 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.

10.3.2.6 Hydrogen And Other Flammable Gas Blends. Bulk hydrogen compressed gas storage systems are 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 Design Requirements at Specific Locations.

10.4.1 Outdoor Locations.

10.4.1.1 Where overhead cover is provided, it shall be in accordance with the provisions of 6.5.2.

10.4.1.2 Electrical wiring and equipment shall be in accordance with Table 10.4.1.2.

<table>
<thead>
<tr>
<th>Location</th>
<th>Classification</th>
<th>Extent of Classified Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage equipment excluding the piping system downstream of the source valve</td>
<td>Class I, Division 2</td>
<td>Between 0 ft (0 m) and 15 ft (4.6 m)</td>
</tr>
</tbody>
</table>

10.4.1.3 Vehicular protection shall be provided in accordance with 7.1.8.3.

10.4 Underground Bulk Hydrogen Compressed Gas Systems

10.4.1 10.4.2 Underground Systems. Bulk hydrogen compressed gas systems Gaseous hydrogen systems installed underground where compressed gas containers are to be buried in contact with earth or fill shall be in accordance with 10.4.2.

10.4.1.1 10.4.2.1 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.

10.4.1.1.1 10.4.2.1.1* Compressed gas containers shall be designed to include cyclic pressure life calculations using fracture mechanics methods.

10.4.1.1.2 10.4.2.1.2 Compressed Gas Container Examination.

10.4.1.1.2.1 10.4.2.1.2.1 Compressed gas containers shall be examined for internal and external surface flaws and inclusions before burial or at the time of manufacture.

10.4.1.1.2.2 10.4.2.1.2.2 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.

10.4.1.2 10.4.2.1.3 Composite Containers. (Reserved)

10.4.1.3 10.4.2.2 Corrosion Protection. Compressed gas containers and underground piping shall be protected from corrosion in accordance with 7.1.10.9 or 7.1.17 as applicable.

10.4.1.4 10.4.2.3* Outlet Connections.

10.4.1.4.1 10.4.2.3.1 Threaded compressed gas container outlet connections shall be designed with primary and secondary seals that shall be tested for functionality.

10.4.1.4.2 10.4.2.3.2 The seal design shall include a method of detecting a leak in the primary seal.

10.4.1.5 10.4.2.4 Piping Systems.

10.4.1.5.1 10.4.2.4.1 Joints in the piping system shall be butt welded and 100 percent inspected using nondestructive testing (NDT) methods in accordance with the requirements of ANSI/ASME B31.3, Process Piping, or other approved standards.

10.4.1.5.2 10.4.2.4.2 Valves, controls, safety devices, and instrumentation shall be above ground and accessible to authorized personnel.

10.4.1.6 10.4.2.5 Location. Compressed gas containers shall be located in accordance with 10.4.2.5.1 through 10.4.2.5.4.

10.4.1.6.1 10.4.2.5.1 Underground compressed gas containers shall not be located beneath buildings.

10.4.1.6.2 10.4.2.5.2 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.

10.4.2.5.3 Compressed Gas Container Separation Distances.

10.4.1.6.3 10.4.2.5.3.1 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).

10.4.1.6.4 10.4.2.5.3.2 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.

10.4.1.6.5 10.4.2.5.4 A minimum distance of 1 ft (0.3 m), shell to shell, shall be maintained between adjacent underground containers.

10.4.1.6.6 10.4.2.5.5* A minimum distance of 3 ft (0.9 m) shall be maintained between compressed gas containers and buried utilities.

10.4.1.7 10.4.2.6 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.

10.4.1.7.1 10.4.2.7.2 The concrete shall extend a minimum of 1 ft (0.3 m) horizontally beyond the footprint of
the tank in all directions.

10.4.1.8 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.

10.4.1.9 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.

10.4.1.10 Venting of Underground Compressed Gas Containers. Vent pipes for underground compressed gas containers shall be in accordance with 10.2.1.

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

10.4.1.12 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.

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

10.6 Indoor Bulk Hydrogen Compressed Gas Systems

10.6.1 General.

10.6.1.1 The location of bulk hydrogen compressed gas systems shall be in accordance with Table 10.6.1.1.

<table>
<thead>
<tr>
<th>Location</th>
<th>Quantity of Hydrogen</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≤MAQ</td>
</tr>
<tr>
<td>Outdoors</td>
<td>A</td>
</tr>
<tr>
<td>In a detached building</td>
<td>A</td>
</tr>
<tr>
<td>In a gas room, in accordance with</td>
<td>A</td>
</tr>
<tr>
<td>Section 6.4</td>
<td></td>
</tr>
<tr>
<td>Not in a gas room</td>
<td>A</td>
</tr>
</tbody>
</table>

A: Allowed. NA: Not allowed.

10.4.6 Indoor Hydrogen System Location.

10.4.6.1 Hydrogen systems of less than 3500 scf (99 m³) and greater than the MAQ, where located inside buildings, shall be located in the building so that the system will be as follows:

1. In a ventilated area in accordance with the provisions of Section 6.15
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

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by a listed detection system per Article 500.7(K) of NFPA 70, National Electrical Code, 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) Isolation valves used to isolate the fuel supply shall be of a fail-safe design.
(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

10.4.6.2 Systems Installed in One Room.

10.4.6.2.1 More than one system of 3500 scf (99 m³) 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.

10.4.6.2.2 The separation distance between multiple systems of 3500 scf (99 m³) 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 in accordance with the requirements
of Section 6.9.

10.6.1.2 10.6* Fire Protection.

Fire protection shall be in accordance with the requirements of Section 6.9.

10.6.2 10.4.4 Detached Buildings.

10.6.2.1 10.4.4.1 Detached buildings shall be constructed of noncombustible or limited-combustible materials
in accordance with the requirements of Section 6.5.

10.6.2.2 10.4.4.2 Ventilation shall be provided in accordance with the requirements of Section 6.15.

10.6.2.2.1 10.4.4.2.1 Outlet openings shall be located at the high point of the room in exterior walls or the roof.

10.6.2.2.2 10.4.4.2.2 Inlet and outlet openings shall each have a minimum total area of 1 ft²/1000 ft³ (1 m²/305
m³) of room volume.

10.6.2.2.3 10.4.4.2.3 Discharge from outlet openings shall be directed or conducted to the atmosphere.

10.6.2.3 10.4.4.3* Explosion control shall be provided in accordance with the requirements of Section 6.8.

10.6.2.4 10.4.4.4 Electrical equipment shall be in accordance with Article 501 of NFPA 70, National Electrical
Code, for Class I, Division 2 locations.

10.6.2.5 10.4.4.5 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 10.4.4.4.

10.6.3 10.4.5 Hydrogen Gas Rooms.

10.6.3.1 10.4.5.1 Floors, walls, and ceilings shall be constructed of noncombustible or limited-combustible
materials in accordance with the requirements of the building code.

10.6.3.1.1 10.4.5.1.1 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.

10.6.3.1.2 10.4.5.1.2 Not less than 25 percent of the perimeter wall shall be an exterior wall.

10.6.3.1.3 10.4.5.1.3 Openings to other parts of the building shall not be permitted.

10.6.3.1.4 10.4.5.1.4 Windows and doors shall be in exterior walls only.

10.6.3.2 10.4.5.2 Ventilation shall be as provided in Section 6.15.

10.6.3.3 10.4.5.3 Explosion control shall be provided in accordance with the requirements of Section 6.8.

10.6.3.4 10.4.5.4 There shall be no sources of ignition from open flames, electrical equipment, or heating
equipment.

**10.6.3.5 10.4.5.5** Electrical equipment shall be in accordance with Article 501 of NFPA 70, National Electrical Code, for Class I, Division 2 locations.

**10.6.3.6 10.4.5.6** 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 10.6.3.6 10.4.5.5.

Also, in support of A.10.3.2.4.1 add the following informational references to Annex H under Section H.2.2.


REASONS:

A joint task group, known as Task Group 6, has been appointed by the Chairs of the NFPA 2, Hydrogen Technologies Code and the IMG TC. Revisions to separation distance tables in NFPA 55 were the focus of this group in the last code revision cycle. Feedback from industry and code users alike sought a simplification of requirements relative to the application of the tabular distances and the work of the task group continued.

One of the major stumbling blocks for readers of the existing tables was one where an assumption was made that distances should increase as system pressure increased. The use of pressure to pipe ID changes as pressure increases resulting in a decrease in the pipe ID and the corresponding leak rate which is generally based on 3% of the internal area of the largest section of pipe in the system under the pressure indicated.

Other complaints heard were that the table was too complex with too many pieces of data. Others found the use of complex exponential equations difficult when pipe IDs other than those common IDs listed in the table were encountered. Other comments were received that the metric units of measure were inconsistent and questions arose as to why there were two tables. To make things a bit more confusing a printing error resulted in quantity being placed into the table heading (corrected by Errata #1).

The task group addressed these issues with several changes in the manner in which the data is presented without changing either the criteria used or the end results.

- The table was simplified by grouping the exposures into three separate groups with Groups 1 and 2 being people sensitive groups and Group 3 being of a material or property nature.
- Table 10.3.2.1(a) has maintained the four common pressure ranges and it has been combined with Table 10.3.2.2.1(b) so that SI units are provided in the same table.
- Distances have been calculated first in inch-pound units of measure and rounded to the nearest foot (instead of five feet), and SI units have been determined using standard conversion formulas and rounding to the nearest meter using conventional rounding.
- The footnotes to Table 10.3.2.2.1 have been removed and placed into an annex note as they were informative.
- The pipe ID has been listed for the Typical Maximum Pipe Size (Table 10.3.2.1(a)).
- Table 10.3.2.1(b) is new. It replaces Table A.10.3.2.2.1.1(E) and the use of exponential formulas shown in A.10.3.2.2.1.1(B) in the 2010 Edition.
- Table 10.3.2.2.1(b) lists the pipe diameters in a range generally from 0.2 to 2 inches in increments of 1/10th of an inch. The resultant separation distance for each exposure group has been calculated and displayed in the table. The formulas have been simplified and are shown at the top of each column for each exposure group. For example, for Group 1 exposures in the 15 to 250 psig pressure range distance “D” is determined by multiplying the internal pipe ID in mm by 0.231 and rounding.
to the nearest foot or corresponding nearest meter. Interpolation between values can be used as indicated in table footnotes. The table is functional for pipe or tube as all values are based on ID.

- The exposures in each group are those established in Table 10.3.2.1(a).
- Comments received regarding an expected progression of distance with increasing pressures remain unresolved for Table 10.3.2.1(a). By referring to Table 10.3.2.1(b) it becomes clear that this is the case as the distances are normalized across any single row based on a single pipe ID. For example for a 0.7 inch ID pipe the distances across the pressure ranges in the table range as follows:

  >15 to ≤250 psi – 4 ft
  >250 to ≤3000 psi – 13 ft
  >3000 to ≤7500 psi – 20 ft
  >7500 to ≤15000 psi – 26 ft

- Table 10.3.2.1(a) displays the “typical” sizes based on pressure. On the other hand Table 10.3.2.2(b) allows a rapid assessment of pipe sizes in the field without the use of what might be viewed as cumbersome calculations. Once an ID is determined the distances are easily estimated and verified.

As work on Section 10.3 was conducted it became apparent that the organization of Chapter 10 could be improved. For example, Section 10.4 established requirements for outdoor locations when weather protection was used. Electrical classification for wiring was specified. The requirements of Chapter 6 appearing in 10.4 appeared to be redundant to the requirements of Chapter 6 triggered by 10.1. Having a general requirement for electrical buried in a section following the tables appeared to be out of order. The chapter was reorganized to follow a general outline that established the following major sections:

10.1 Applicability
10.2 General Requirements applicable to all bulk GH2 systems
10.3 Outdoor
10.3.1 Outdoor General Requirements
10.3.2 Specific requirements for outdoor systems
10.4 Underground Systems
10.5 Vaults above or below ground (remains reserved)
10.6 Indoor
10.6.1 Indoor General Requirements
10.6.2 Detached Buildings
10.6.3 Hydrogen Gas Rooms

Modifications have been made to correlate the use of the term “bulk hydrogen compressed gas system” throughout Chapter 10. The substantive modifications other than reformatting of the chapter are found in Section 10.3. Using the table below the user can follow the reorganization and the table becomes a road map to how the Chapter was reconstructed.

<table>
<thead>
<tr>
<th>Old Section No.</th>
<th>New Section No.</th>
<th>Insert Page No.</th>
<th>Reason for change</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1</td>
<td>10.1</td>
<td>1</td>
<td>Clarification. Chapter 9 applies to bulk oxygen systems.</td>
</tr>
<tr>
<td>10.1.1</td>
<td>10.1.1</td>
<td>1</td>
<td>Modifies definition of bulk hydrogen compressed gas system. Separate proposal issued and correlated.</td>
</tr>
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<td>10.1.2</td>
<td></td>
<td>deleted</td>
<td>Section deleted. Bulk systems are regulated as individual systems under the requirements of Chapter 10.</td>
</tr>
<tr>
<td>10.2</td>
<td>10.2</td>
<td>1</td>
<td>Existing Section 10.2 was titled design of gaseous hydrogen systems. The general requirements for all bulk GH2 systems have been moved to Section 10.2.</td>
</tr>
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<td>10.2.2</td>
<td>1</td>
<td>Relocated to 10.2.2. New Section 10.2.1 is now marking which was relocated from 10.2.5.</td>
</tr>
<tr>
<td>A.10.2.1</td>
<td></td>
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<td>There was no annex note to existing 10.2.1</td>
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<tr>
<td>10.2.4.3</td>
<td>10.2.4.3</td>
<td>2</td>
<td>Minor edits</td>
</tr>
<tr>
<td>10.2.4.4</td>
<td>10.2.5.1</td>
<td>2</td>
<td>Relocated to 10.2.5.1</td>
</tr>
<tr>
<td>10.2.5</td>
<td>10.2.1</td>
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<td>Relocated to 10.2.1</td>
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<td>10.2.1.2</td>
<td>1</td>
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<tr>
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<td>New Section No.</td>
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<td>Reason for change</td>
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</tr>
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<td>10.2.5</td>
<td>2</td>
<td>Relocated to 10.2.5</td>
</tr>
<tr>
<td>10.3</td>
<td>10.3</td>
<td>4</td>
<td>Title only. Minor edits.</td>
</tr>
<tr>
<td>10.3.1</td>
<td>10.3.1</td>
<td>4</td>
<td>The statement in 10.3.1.1 has been moved to 10.3.1 and terminology has been coordinated with the published definition for bulk hydrogen compressed gas system found in Chapter 3.</td>
</tr>
<tr>
<td>10.3.1.1</td>
<td>10.3.1.1</td>
<td>4</td>
<td>Relocated 10.3.1.1 to 10.3.1.1 with Editorial change.</td>
</tr>
<tr>
<td>10.3.1.2</td>
<td>10.3.2.5 (4)</td>
<td>17</td>
<td>The text has been moved without change to 10.3.2.5 item (4).</td>
</tr>
<tr>
<td>10.3.2</td>
<td>10.3.2</td>
<td>4</td>
<td>The existing heading has been deleted. The title to Section 10.3.2.2 has been revised and the section renumbered to 10.3.2.</td>
</tr>
<tr>
<td>10.3.2.1</td>
<td>10.6.1.1</td>
<td>20</td>
<td>Modified and relocated to 10.6.1.1 and applied to indoor situations only.</td>
</tr>
<tr>
<td>Table 10.3.2.1</td>
<td>Table 10.6.1.1</td>
<td>20</td>
<td>Modified and applied to indoor applications only.</td>
</tr>
<tr>
<td>10.3.2.2</td>
<td>10.3.2</td>
<td>4</td>
<td>The section number has been revised due to the deletion of 10.3.2.1.</td>
</tr>
<tr>
<td>10.3.2.2.1</td>
<td>10.3.2</td>
<td>4</td>
<td>Editorial. Tables 10.3.2.2.1(a) and (b) have been reformatted for simplification purposes and renumbered. The two tables (inch-pound and SI) have now been combined into a single table.</td>
</tr>
<tr>
<td>A.10.3.2.1</td>
<td></td>
<td>4-5</td>
<td>New.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Footnotes to the tables have been eliminated and either transferred to the Annex or included as text in specific requirements. NFPA's Manual of Style asks that requirements not be included in footnotes to tables.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Table 10.3.2.2.1(a) and (b) footnotes &quot;a&quot; through &quot;e&quot; have been reformatted and clarified. They have been included as Annex notes as they are informational in nature.</td>
</tr>
<tr>
<td>Tables 10.3.2.1(a) and (b)</td>
<td>Table 10.3.2.1(a)</td>
<td>8-9</td>
<td>Modified to allow the use of new Table 10.3.2.1(b) as an alternate to Table10.3.2.1(a).</td>
</tr>
<tr>
<td>10.3.2.2.1.1</td>
<td>10.3.2.2</td>
<td>12</td>
<td>The section has been deleted as no requirements were established that were different from those already imposed by new Section 10.3.2.2.1.</td>
</tr>
<tr>
<td>10.3.2.2.1.1(A)</td>
<td></td>
<td>deleted</td>
<td>Editorial revision to charging paragraph.</td>
</tr>
<tr>
<td>10.3.2.2.1.1 (B)</td>
<td>10.3.2.1.1</td>
<td>5</td>
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</tr>
<tr>
<td>Old Section No.</td>
<td>New Section No.</td>
<td>Insert Page No.</td>
<td>Reason for change</td>
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<td>-------------------</td>
</tr>
<tr>
<td>Table 10.3.2.1.1(B)</td>
<td>Table 10.3.2.1(b)</td>
<td>10-11</td>
<td>Deleted Table 10.3.2.1.1(B) in its entirety along with its annex note and revised to new Table 10.3.2.1(b)</td>
</tr>
<tr>
<td>A.10.3.2.2.1.1(B)</td>
<td></td>
<td>deleted</td>
<td>This Annex note had been deleted in its entirety as Table 10.3.2.1(b) now provides a simplified approach to calculation for the user.</td>
</tr>
<tr>
<td>10.3.2.2.1.1(C)</td>
<td></td>
<td>deleted</td>
<td>The provision is not needed in light of the creation of Table 10.3.2.1(b) and the charging language provided in 10.3.2.1.</td>
</tr>
<tr>
<td>10.3.2.2.1.1(D)</td>
<td>10.3.2.2.2</td>
<td>14</td>
<td>Editorial</td>
</tr>
</tbody>
</table>
| | A.10.3.2.2.2 | 14 | Annex note based on bounding data produced by Sandia National Laboratories study. Sandia ran computer code calculations for leak diameters up to 13.5 mm and then did the curve-fits to this data up to and including a nominal 3 inch (76.2 mm) pipe ID. A 3% leak is based on 3% of the internal pipe flow area. 

\[ A = \pi \times \frac{d^2}{4} \]

\[ D_{pipe} = D_{leak}/(0.1732) \]

This means that the I.D. of the of pipe for this 13.5 mm diameter leak would be 13.5/0.1732 = 77.94 mm 

A 9 mm diameter leak would correspond to a pipe ID of 51.96 mm for a 3% of flow area leak. |
<p>| 10.3.2.2.1.1(E) | 10.3.2.2.1 | 12 | Editorial |
| A.10.3.2.2.1.1(E) | A.10.3.2.2.1 | 12 | The introduction of Table 10.3.2.1(b) addresses the principles embodied in existing A.10.3.2.2.1.1(e) as shown in the table of typical pipe sizes and examples showing the calculation of pipe ID. Table 10.3.2.1(b) goes beyond just steel pipe and includes piping and tubing of any construction as it is simply a generic |</p>
<table>
<thead>
<tr>
<th>Old Section No.</th>
<th>New Section No.</th>
<th>Insert Page No.</th>
<th>Reason for change</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.3.2.2.1.1(F)</td>
<td>10.3.2.3</td>
<td>14</td>
<td>The text from 10.3.2.2.1.1(F) has been relocated to 10.3.2.3 without change.</td>
</tr>
<tr>
<td>A.10.3.2.2.1.1(F)</td>
<td>A.10.3.2.3</td>
<td>14</td>
<td>The text from the annex note has been relocated. The term psi was editorially changed to psig.</td>
</tr>
<tr>
<td>Tables 10.3.2.2.1(a) and (b)</td>
<td>Table 10.3.2.1(a)</td>
<td>8</td>
<td>The tables have been reformatted and condensed to a single table to simplify the content for the user and for closer coordination between the display of inch-pound and SI units of measure. The following elements have been revised:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- The exposures have been grouped to display those that are similar by segregating the exposures into Groups 1 through 3.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- The distances (D) from exposures have been displayed for the pressures and pipe IDs previously shown in Tables 10.3.2.2.1(a) and (b). In the 2010 Edition there were 16 different exposures shown, each with an assigned row in the table. In the new tables there are 13 different exposures shown. The 3 exposures not shown were moved to Section 10.3.2.5 as they are applicable to systems regardless of pipe ID or system pressure.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Proposed Table 10.3.2.1(a) displays piping and pressure “typical” of the systems identified in the existing tables. Pipe ID is listed in metric units of measure only as it is the metric unit of measure that is used in the determination of distance.</td>
</tr>
<tr>
<td>Table 10.3.2.2.1(a) note a</td>
<td>A.10.3.2.1 Group 1 Exposures</td>
<td>4-5</td>
<td>Relocated to Annex note for Group 1 Exposures.</td>
</tr>
<tr>
<td>Table 10.3.2.2.1(a) note b</td>
<td>A.10.3.2.1 Group 1 Exposures</td>
<td>5</td>
<td>Relocated to Annex note for Group 1 Exposures.</td>
</tr>
<tr>
<td>Table 10.3.2.2.1(a) note c</td>
<td>A.10.3.2.1 Group 2 Exposures</td>
<td>5</td>
<td>Relocated to Annex note for Group 2 Exposures.</td>
</tr>
<tr>
<td>Table 10.3.2.2.1(a) note d</td>
<td>A.10.3.2.1 Group 3 Exposures</td>
<td>5</td>
<td>Relocated to Annex note for Group 3 Exposures.</td>
</tr>
<tr>
<td>Table 10.3.2.2.1(a) note e</td>
<td>A.10.3.2.1 Group 3 Exposures</td>
<td>5</td>
<td>Relocated to Annex note for Group 3 Exposures.</td>
</tr>
<tr>
<td>Table 10.3.2.2.1(a) note f</td>
<td>10.3.2.4.1(6)</td>
<td>15</td>
<td>Relocated and edited for clarity</td>
</tr>
<tr>
<td>Old Section No.</td>
<td>New Section No.</td>
<td>Insert Page No.</td>
<td>Reason for change</td>
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</tr>
<tr>
<td>Table 10.3.2.2.1(a) note g</td>
<td>10.3.2.5(2)</td>
<td>17</td>
<td>Relocated with no change</td>
</tr>
<tr>
<td>Table 10.3.2.2.1(a) note h first sentence</td>
<td>10.3.2.6</td>
<td>18</td>
<td>Relocation of first sentence of a footnote to Tables 10.3.2.2.1(a) and (b) with editorial changes to establish an independent section for requirements related to co-locating hydrogen with other non-liquefied compressed gases to be used for the purpose of creating hydrogen/flammable gas blends.</td>
</tr>
<tr>
<td>Table 10.3.2.2.1(a) note h second sentence</td>
<td>10.3.2.5(3)</td>
<td>18</td>
<td>Editorial changes to note “h” as found in 10.3.2.5(3). Extract of second sentence of note “h” only. Text relocated from Table 10.3.2.2.1(a) and (b) with editorial change intended to further subdivide the requirement into two paragraphs and to include the tabular distance (of 15 feet) previously included in the Tables as a requirement.</td>
</tr>
<tr>
<td>Table 10.3.2.1(b)</td>
<td>10.3.2.1(b)</td>
<td>10-11</td>
<td>A new table has been added to include information previously found in A.10.3.2.2.1.1 (B) and Table A.10.3.2.2.1.1 (E).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• The table is arranged by required distance (D) related to pipe ID displayed in 1/10th inch increments along with a metric value of pipe ID shown as (d).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Distances are displayed in the table by Exposure Group for each of the four pressures shown in table 10.3.2.1(a). Both SI and inch-pound units of measure are displayed.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• The value of “d” is used in the equations represented in the formula row, i.e., , and used to calculate distance D as shown in the table. For example, to calculate distance D for a pipe ID of 5.1 mm for Group 1 exposures the user multiplies 5.1 by 0.231 and the value is displayed to the nearest meter. The metric distance D is then converted to SI units of measure by multiplying the unrounded metric result by the conversion factor 3.281 and rounding the inch-pound unit to the nearest foot.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• The complex formulas shown in 55:A.10.3.2.2.1.1(b) have been eliminated.</td>
</tr>
<tr>
<td>10.3.2.4</td>
<td>10.3.2.4.1</td>
<td>14</td>
<td>New heading added.</td>
</tr>
<tr>
<td>10.3.2.2</td>
<td>10.3.2.4.1</td>
<td>14</td>
<td>Provisions have been added for the construction of fire barrier walls as a means of passive protection. The elements of construction include:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• fire resistance</td>
</tr>
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<td></td>
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<td>• line of sight</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• ambient or natural ventilation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• limitation on number of walls to avoid confinement</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• structural considerations</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• clearance for maintenance related activities</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• allowances for the use of an equivalent exterior building wall</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>• minimum height requirements</td>
</tr>
<tr>
<td>Old Section No.</td>
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<td>Insert Page No.</td>
<td>Reason for change</td>
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<td>------------------</td>
</tr>
<tr>
<td>A.10.3.2.2.2</td>
<td>A.10.3.2.4</td>
<td>14</td>
<td>Relocated annex note to new A.10.3.2.4 with editorial change.</td>
</tr>
<tr>
<td>10.3.2.2.3</td>
<td></td>
<td>deleted</td>
<td>Conflicts in the exposures identified have been eliminated. Requirements are now included in the charging language of 10.3.2.4.1.</td>
</tr>
<tr>
<td>A.10.3.2.2.3</td>
<td>A.10.3.2.4.1</td>
<td>15-16</td>
<td>The Annex note from A.10.3.2.2.3 has been retained and modified in light of the completion of research into barrier walls for both construction concerns and risk performed by Sandia personnel.</td>
</tr>
<tr>
<td>10.3.2.2.4</td>
<td>10.3.2.4.1(4)</td>
<td>14-15</td>
<td>The number of fire walls surrounding individual systems is limited to three in order to prevent confinement thereby allowing for adequate ventilation.</td>
</tr>
<tr>
<td>10.3.2.4.2</td>
<td></td>
<td>17</td>
<td>New. A statement has been provided to direct the user to the Annex. Section 1.5 is applicable, but providing the user with a reference and an annex note provides minimal guidance until such time as active means of mitigation are developed further. It is contemplated that the joint task group will continue to work on the development of active means of mitigation through the comment phase.</td>
</tr>
<tr>
<td>A. 10.3.2.4.2</td>
<td></td>
<td>17</td>
<td>New. An annex note has been added to provide information about the methods that the task group has considered for means of active mitigation. The code user can always use Section 1.5 as a means to introduce alternative methods of achieving compliance. In this instance gas detection and flame detection have been discussed as the means, however, prescriptive requirements are yet to be developed. Providing minimal guidance to the code user, designer and code official demonstrates conditions that must be considered when addressing equivalency to otherwise required separation.</td>
</tr>
<tr>
<td>Old Section No.</td>
<td>New Section No.</td>
<td>Insert Page No.</td>
<td>Reason for change</td>
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</tr>
<tr>
<td></td>
<td>10.3.2.5</td>
<td>17</td>
<td>New. Distance limitations for exposures that are independent of pressure and/or pipe ID have been located in this new section.</td>
</tr>
<tr>
<td>10.3.2.3</td>
<td>10.3.2.5(1)</td>
<td>17</td>
<td>Text relocated to 10.3.2.5(1) with editorial change.</td>
</tr>
<tr>
<td>10.3.1.2</td>
<td>10.3.2.5(4)</td>
<td>18</td>
<td>Text relocated to 10.3.2.5(4) without change.</td>
</tr>
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<td>Deleted – title only</td>
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<td>Deleted - title only.</td>
</tr>
<tr>
<td>10.4.1.1</td>
<td>deleted</td>
<td></td>
<td>Deleted, compliance with Chapter 6 is required by 10.1.</td>
</tr>
<tr>
<td>10.4.1.2</td>
<td>10.3.1.3</td>
<td>4</td>
<td>Relocated to 10.3.1.3</td>
</tr>
<tr>
<td>Table 10.4.1.2</td>
<td>Table 10.3.1.3</td>
<td>4</td>
<td>Relocated to Table 10.3.1.3</td>
</tr>
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<td>10.4.1.3</td>
<td>10.2.8.1</td>
<td>3</td>
<td>Relocated to 10.2.8.1</td>
</tr>
<tr>
<td>10.4.2 through</td>
<td>10.4.1 through</td>
<td>18-20</td>
<td>Relocated to 10.4.1 through 10.4.1.12</td>
</tr>
<tr>
<td>10.4.2.11</td>
<td>10.4.1.12</td>
<td></td>
<td></td>
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<td>10.4.3</td>
<td>10.5</td>
<td>20</td>
<td>Relocated to 10.5</td>
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<tr>
<td>10.4.4 through</td>
<td>10.6.2 through</td>
<td>21</td>
<td>Relocated to 10.6.2 through 10.2.6.5</td>
</tr>
<tr>
<td>10.4.4.5</td>
<td>10.2.6.5</td>
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</tr>
<tr>
<td>10.4.5 through</td>
<td>10.6.3 through</td>
<td>21</td>
<td>Relocated to 10.6.3 through 10.6.3.6</td>
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<td>10.4.5.6</td>
<td>10.6.3.6</td>
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<tr>
<td>10.4.6</td>
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<td></td>
<td>See Log #137 Deleted and proposed (separate proposal) to be relocated to a new Section 7.6.3.</td>
</tr>
<tr>
<td>10.4.6.1</td>
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<td></td>
<td>See Log #137 Deleted and proposed (separate proposal) to be relocated to a new Section 7.6.3.</td>
</tr>
<tr>
<td>10.4.6.2</td>
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<td>See Log #137 Deleted and proposed (separate proposal) to be relocated to a new Section 7.6.3.</td>
</tr>
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<td>10.4.6.2.1</td>
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<td></td>
<td>See Log #137 Deleted and proposed (separate proposal) to be relocated to a new Section 7.6.3.</td>
</tr>
<tr>
<td>10.4.6.2.2</td>
<td>deleted</td>
<td></td>
<td>See Log #137 Deleted and proposed (separate proposal) to be relocated to a new Section 7.6.3.</td>
</tr>
<tr>
<td>10.5</td>
<td>10.2.7</td>
<td>3</td>
<td>Relocated to 10.2.7</td>
</tr>
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<td>10.5.1</td>
<td>10.2.2.1</td>
<td>1</td>
<td>Relocated to 10.2.2.1</td>
</tr>
<tr>
<td>10.5.2</td>
<td>10.2.7.1</td>
<td>3</td>
<td>Relocated to 10.2.7.1</td>
</tr>
<tr>
<td>10.5.2.1</td>
<td>10.2.7.1.1</td>
<td>3</td>
<td>Relocated to 10.2.7.1.1</td>
</tr>
<tr>
<td>10.5.2.2</td>
<td>10.2.7.1.2</td>
<td>3</td>
<td>Relocated to 10.2.7.1.2</td>
</tr>
<tr>
<td>Old Section No.</td>
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<td>Reason for change</td>
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</tr>
<tr>
<td>10.5.3</td>
<td>10.2.7.2</td>
<td>3</td>
<td>Relocated to 10.2.7.2</td>
</tr>
<tr>
<td>10.5.4</td>
<td></td>
<td>deleted</td>
<td>Deleted. Compliance with Chapter 7 is required by 10.1. Table 10.3.2.2.1(a) and (b) are specific. Section 7.1 is general. Specific requirements override general requirements in any code application.</td>
</tr>
<tr>
<td>10.6</td>
<td>10.6.1.2</td>
<td>21</td>
<td>Relocated to 10.6.1.2 as a general requirement for indoor applications</td>
</tr>
<tr>
<td>10.7 through 10.7.8</td>
<td>10.2.8 through 10.2.8.9</td>
<td>3-4</td>
<td>Relocated to 10.2.8 through 10.2.8.9</td>
</tr>
<tr>
<td>10.8 through 10.8.4.6</td>
<td>10.2.6 through 10.2.6.8</td>
<td>2-3</td>
<td>Relocated to 10.2.6 through 10.2.6.8</td>
</tr>
</tbody>
</table>
10.1.1 This chapter shall not apply to individual systems using containers having a total hydrogen content of less than 400 scf (11 m³) if each system is separated by a distance not less than 5 ft (1.5 m).

10.1.2 Where individual systems, each having a total hydrogen content of less than 400 scf (11 m³), are located less than 5 ft (1.5 m) from each other, this code shall apply:

10.1.1 Indoor Systems

10.1.1.1 This chapter shall not apply to individual indoor systems using containers having a total hydrogen content of less than the MAQ defined by Table 6.3.1.1 for the particular application.

10.1.1.2 Indoor systems using containers having a total hydrogen content of more than the MAQ defined by Table 6.3.1.1 for the particular application shall comply with this chapter.

10.1.2 Outdoor Systems

10.1.2.2 Outdoor systems up to 3,000 cubic feet (83 m³) are not subject to this chapter.

10.1.2.3 Outdoor systems over 3,000 cubic feet (83 m³) but less than 12,000 cubic feet (332 m³) shall comply with sub-clause 7.3.2 of NFPA 2 and its subordinate and referenced sub-clauses.

10.1.3 Where individual hydrogen systems are located within 5 feet of each other, they shall be treated as a single system.

Substantiation: The current bulk hydrogen definition of 400 scf is equivalent to 1.02 kg. The energy content of 1 kg of hydrogen is roughly the same as 1 gal of gasoline. Therefore, the current bulk threshold energy content is currently being set equivalent to 1 gal of gasoline. This does not seem reasonable.

The bulk threshold for liquefied hydrogen systems is 39.7 gallons which is much greater than 400 scf of gaseous hydrogen.

The indoor MAQ for hydrogen according to Table 6.3.1.1 is 1,000 cubic feet for unsprinklered areas without a gas cabinet or gas room or enclosure. Up to 4,000 scf is allowed for indoor sprinklered systems in a gas cabinet, gas room, or enclosure.

The outdoor MAQ for hydrogen gas is 3,000 cubic feet in accordance with the International Fire Code, IFC: 2006 Table 2703.1.1 (3).

There is no reason to invoke additional requirements for amounts below the MAQ in either case.

Additional requirements for outdoor systems using or storing more 3,000 cubic feet, but less than 12,000 cubic feet, of hydrogen are suggested using sub-clause 7.3.2 of NFPA 2 (non-bulk GH2).

Committee Meeting Action: Reject

Committee Statement: See the committee action on 55-21 (Log #136) which resolves the issue brought forward by this proposal.

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

Substantiation: The sentence makes it clear that chapter 10 applies only to supply systems in the gas form. Chapters 8 and 9 do not apply to bulk hydrogen compressed gas systems (chapter 8 is general cryogenics, and chapter 9 is bulk oxygen systems). Chapters 8 and 11 apply to the gas piping portion of bulk liquid hydrogen systems.

Committee Meeting Action: Accept
55-108 Log #10
(10.1.1)

Final Action: Accept in Principle

Submitter: Thomas L. Allison, Savannah River Nuclear Solutions

Recommendation: Revise text to read as follows:

10.1.1 This chapter shall not apply to Where individual systems... less than 5 ft. (1.5 m), Chapters 1 through 7 shall apply.

10.1.2 Where individual systems... less than 5 ft. (1.5 m) from each other, this code Chapters 1 through 7 and Chapter 10 shall apply.

Substantiation: The current text implies that none of NFPA 55 will apply for systems less than 400 scf and separated by 5 ft. or more. The revised text makes it clear that the general portions of the code still apply.

Committee Meeting Action: Accept in Principle

Committee Statement: See the committee action on 55-21 (Log #136) where this issue was resolved.

55-109 Log #44
(10.2.1)

Final Action: Accept in Principle

Submitter: Robert Wichert, FCHEA, and Chris Radley, Altergy

Recommendation: Revise text to read as follows:

10.2.1* Piping, tubing, valves, and fittings shall be designed and installed in accordance with 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) and ANSI/ASME B31.12 - 2008 Hydrogen Piping and Pipelines. Cast-iron pipe, valves, and fittings shall not be used.


Committee Meeting Action: Accept in Principle

Committee Statement: See the committee action on 55-110 (Log #108) where this issue was resolved. ANSI is not part of the title and should not be added.

55-110 Log #108
(10.2.1)

Final Action: Accept

Submitter: Larry L. Fluer, Fluer, Inc. / Rep. Compressed Gas Association

Recommendation: Revise text to read as follows:

10.2.1* 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.

Substantiation: The reference to section 7.3.1.3 points to ASME B31.3 piping code. The prohibitions against cast iron supplement the general requirements of ASME B31.3. The IFGC sections do not provide any more specific requirements. A new piping code, ASME B31.12, has now been issued for hydrogen piping and pipelines and provides more specific requirements than ASME B31.3.

Committee Meeting Action: Accept
Larry L. Fleur, Fluer, Inc.

A companion code change has been submitted to address the reorganization of Chapter 10 in its entirety. This submittal is limited to those changes submitted to Section 10.3 in the event the IMG TC seeks not to address the reorganization of the entire chapter. It is intended that the content of this submittal and that of the companion submittal for revision of Chapter 10 are coordinated. Having this submittal will assist the IMG TC in taking either path.

A joint task group, known as Task Group 6, has been appointed by the Chairs of the NFPA 2, Hydrogen Technologies Code and the IMG TC. Revisions to separation distance tables in NFPA 55 were the focus of this group in the last code revision cycle. Feedback from industry and code users alike sought a simplification of requirements relative to the application of the tabular distances and the work of the task group continued.

One of the major stumbling blocks for readers of the existing tables was one where an assumption was made that distances should increase as system pressure increased. The use of pressure to pipe ID changes as pressure increases resulting in a decrease in the pipe ID and the corresponding leak rate which is generally based on 3% of the internal area of the largest section of pipe in the system under the pressure indicated.

Other complaints heard were that the table was too complex with too many pieces of data. Others found the use of complex exponential equations difficult when pipe IDs other than those common IDs listed in the table were encountered. Other comments were received that the metric units of measure were inconsistent and questions arose as to why there were two tables. To make things a bit more confusing a printing error resulted in quantity being placed into the table heading (corrected by Errata #1).

The task group addressed these issues with several changes in the manner in which the data is presented without changing either the criteria used or the end results (other than due to the display of data or mathematical rounding).

- The table (10.3.2.2.1(a)) was simplified by grouping the exposures into three separate groups with Groups 1 and 2 being people sensitive groups and Group 3 being of a material or property nature. As the chapter was reorganized the table was renumbered to 10.3.2.1(a).
  
  - Table 10.3.2.1(a) has maintained the four common pressure ranges and it has been combined with Table 10.3.2.2.1(b) so that SI units are provided in the same table.
  
  - Distances have been calculated first in inch-pound units of measure and rounded to the nearest foot (instead of five feet), and SI units have been determined using standard conversion formulas and rounding to the nearest meter using conventional rounding.
  
  - The footnotes to Table 10.3.2.2.1 have been removed and placed into an annex note as they were informative.
  
  - The pipe ID has been listed for the Typical Maximum Pipe Size (Table 10.3.2.1(a)).
  
  - Table 10.3.2.1(b) is new. It replaces Table A.10.3.2.2.1.1(E) and the use of exponential formulas shown in A.10.3.2.2.1.1(B) in the 2010 Edition.
  
  - Table 10.3.2.2.1(b) lists the pipe diameters in a range generally from 0.2 to 2 inches in increments of 1/10th of an inch. The resultant separation distance for each exposure group has been calculated and displayed in the table. The formulas have been simplified and are shown at the head of each column for each exposure group. For example, for Group 1 exposures in the 15 to 250 psig pressure range distance “D” is determined by multiplying the internal pipe ID in mm by 0.231 and rounding to the nearest foot or corresponding nearest meter. Interpolation between values can be used as indicated in table footnotes. The table is functional for pipe or tube as all values are based on ID.
  
  - The exposures in each group are those established in Table 10.3.2.1(a).
  
  - Comments received regarding an expected progression of distance with increasing pressures remain unresolved for Table 10.3.2.1(a). By referring to Table 10.3.2.1(b) it becomes clear that this is the case as the distances are normalized across any single row based on a single pipe ID. For example for a 0.7 inch ID pipe the distances across the pressure ranges in the table range as follows:
    
    - 15 to =250 psi – 4 ft
    - 250 to =3000 psi – 13 ft
    - 3000 to =7500 psi – 20 ft
10.3 Location of Outdoor Bulk Gaseous-Hydrogen Compressed Gas Systems.

10.3.1 General Requirements.

10.3.1.1 Bulk hydrogen compressed gas systems located above ground either at grade or above grade shall be in accordance with Section 10.3.

10.3.1.2 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.

10.3.1.3-10.4.1.2 Electrical wiring and equipment shall be in accordance with Table 10.3.1.3-10.4.1.2.

<table>
<thead>
<tr>
<th>Location</th>
<th>Classification</th>
<th>Extent of Classified Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage equipment excluding the piping system downstream of the source valve</td>
<td>Class I, Division 2</td>
<td>Between 0 ft (0 m) and 15 ft (4.6 m)</td>
</tr>
</tbody>
</table>

10.3.2 Specific Requirements.

10.3.2.1 The location of hydrogen systems shall be in accordance with Table 10.3.2.1.

<table>
<thead>
<tr>
<th>Table 10.3.2.1 Location of Gaseous Hydrogen Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantity of Hydrogen</td>
</tr>
<tr>
<td>Location</td>
</tr>
<tr>
<td>Outdoors</td>
</tr>
<tr>
<td>In a detached building</td>
</tr>
<tr>
<td>In a gas room, in accordance with Section 6.4</td>
</tr>
<tr>
<td>Not in a gas room</td>
</tr>
</tbody>
</table>

A: Allowed. NA: Not allowed.

10.3.2.2 Minimum Distance - Location

10.3.2.1* 10.3.2.2.1* Minimum Distance. The minimum distance from a bulk hydrogen compressed gas system located outdoors to specified exposures shall be in accordance with Tables 10.3.2.1(a) or 10.3.2.1(b) 10.3.2.2.1(a) or Table 10.3.2.2.1(b). (See also Annex G.)
A.10.3.2.1 The exposures integral to Tables 10.3.2.1(a) and (b) have been arranged into groups based on similar risks. The following thresholds are applicable to the exposures identified in each group.

Group 1 Exposures. The distances specified are those required to reduce the radiant heat flux level to 500 Btu/hr · ft² (1,577 W/m²) at the property line or the distance to a point in the unignited hydrogen jet where the hydrogen content is reduced to a 4 percent mole fraction (volume fraction) of hydrogen whichever is greater. In all cases the distance required to achieve a 4 percent mole fraction was the greater distance and used to establish the requirements.

Group 2 Exposures. The distances specified are those required to reduce the radiant heat flux level to 1,500 Btu/hr · ft² (4,732 W/m²) for persons exposed a maximum of 3 minutes.

Group 3 Exposures. The distances specified are those required to reduce the radiant heat flux level to 6,340 Btu/hr · ft² (20,000 W/m²) or the visible flame length for combustible materials, or a radiant heat flux level of 8,000 Btu/hr · ft² (25,237 W/m²) or the visible flame length for non-combustible equipment. In both cases the visible flame length was used to establish the requirements.

10.3.2.1.1 10.3.2.1.1 (B)* Alternative Internal Diameters. The separation distance for piping systems with internal diameters greater than those specified in Table 10.3.2.1(a) and Table 10.3.2.1(b) for the pressure range selected shall be permitted with tabular distances determined based on the use of the equations in Table 10.3.2.1(b) 10.3.2.1.1(B).

### Table 10.3.2.1.1(B) – Separation Distance Based on Alternative Pipe or Tube Internal Diameters

<table>
<thead>
<tr>
<th>Notes</th>
<th>≥15 to ≤250 psi</th>
<th>&gt;250 to ≤3000 psi</th>
<th>&gt;3000 to ≤7500 psi</th>
<th>&gt;7500 to ≤15,000 psi</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>D₁ = 0.23179d₁^{0.99921}</td>
<td>D₂ = 0.73903d₂^{0.999962}</td>
<td>D₃ = 1.1062d₃^{0.99959}</td>
<td>D₄ = 1.4507d₄^{0.9995}</td>
</tr>
<tr>
<td>(b)</td>
<td>D₁ = 0.091137d₁^{1.1303} + e⁻₀.001137sd₁^{1.1303}</td>
<td>D₂ = 0.36590d₂^{1.1152} + e⁻₀.102714d₂^{1.1152}</td>
<td>D₃ = 0.60173d₃^{1.1063} + e⁻₀.36516d₃^{1.1063}</td>
<td>D₄ = 0.84053d₄^{1.1023} + e⁻₀.40365d₄^{1.1023}</td>
</tr>
<tr>
<td>(c)</td>
<td>D₁ = 0.075952d₁^{1.1022} + e⁻₀.087594d₁^{1.1022}</td>
<td>D₂ = 0.28894d₂^{1.0993} + e⁻₀.10392d₂^{1.0993}</td>
<td>D₃ = 0.45894d₃^{1.0883} + e⁻₀.46722d₃^{1.0883}</td>
<td>D₄ = 0.6324d₄^{1.0859} + e⁻₀.52477d₄^{1.0859}</td>
</tr>
<tr>
<td>(d)</td>
<td>D₁ = 0.096259d₁^{0.99928}</td>
<td>D₂ = 0.3072d₂^{0.99928}</td>
<td>D₃ = 0.45967d₃^{0.99928}</td>
<td>D₄ = 0.60297d₄^{0.99928}</td>
</tr>
<tr>
<td>(e)</td>
<td>D₁ = 0.096259d₁^{0.99928}</td>
<td>D₂ = 0.3072d₂^{0.99928}</td>
<td>D₃ = 0.45967d₃^{0.99928}</td>
<td>D₄ = 0.60297d₄^{0.99928}</td>
</tr>
</tbody>
</table>
Notes:
(1) Use of this table assumes a leak diameter of 3 percent of the pipe flow area or internal diameter where \( d \) = inside diameter (ID) of pipe or tube expressed in millimeters (mm), and \( D_{a,b,c,d,e} \) = separation distance in meters (m).
(2) All pressures are gauge pressures.

Notes are from Table 10.3.2.2.1(a) and Table 10.3.2.2.1(b) as follows:
(a) Unignited jet concentration decay distance to 4 percent mole fraction (volume fraction) hydrogen
(b) \( D_{rad} \) = radiation heat flux level of 500 Btu/hr/ft\(^2\) (1577 W/m\(^2\))
(c) \( D_{rad} \) for heat flux level of 1500 Btu/hr/ft\(^2\) (4732 W/m\(^2\)) exposure to employees for a maximum of 3 minutes
(d) The greater of \( D_{rad} \) for combustible heat flux level of 6340 Btu/hr/ft\(^2\) (20,000 W/m\(^2\)) or the visible flame length
(e) The greater of \( D_{rad} \) for noncombustible equipment heat flux level of 8000 Btu/hr/ft\(^2\) (25,237 W/m\(^2\)) or the visible flame length

A.10.3.2.2.1.1(B) The following is a sample calculation for separation distances using ¼ in. ID tubing at gauge pressure of 250–3000 psi:

(1) Determine internal diameter (ID) where ID = OD \((-2 \times \text{wall thickness})\); wall thickness = 0.049 in. (known); outside diameter (OD) = 0.250 in.: ID = \( d = 0.250 - (2 \times 0.049) = 0.152 \) in. = 3.86 mm

To use the equations in Table 10.3.2.2.1.1(B) the ID values (the value of \( d \) in the equation) to be used must be expressed in millimeters.

(2) Next, determine separation distance(s). The separation distances \( D_{a,b,c,d,e} \) etc., are calculated in meters to two significant places after the decimal. To convert meters to feet, multiply by 3.281 and round off to the nearest 5 ft.

For example, assuming the 250–3000 psi pressure range (second column), calculations for separation distance for the Table 10.3.2.2.1.1(B) footnotes (a) through (e) are as follows.

Where:
\( D_{a,b,c,d,e} \) = calculated separation distance for \( D_{a,b,c,d,e} \).

\( e = 2.71828 \ldots \), the base of natural logarithms

Then:
(a) \( D_a = 0.74d^{0.00062} \)
\( D_a = 0.74(3.86^{0.00062}) \)
\( D_a = 0.74(3.858) = 2.85 \text{ m} \rightarrow 9.4 \text{ ft} \rightarrow 10 \text{ ft} \)

(b) \( D_\mu = 0.37d^{1.1152} + e^{-0.10771d}(0.19d^{2.531} - 0.37d^{1.1152}) \)
\( D_\mu = 0.37(3.86^{1.1152}) + e^{-0.10771d}(0.19d^{2.531} - 0.37d^{1.1152}) \)
\( D_\mu = 0.37(4.51) + e^{-0.10771d}(0.19(5.43) - 0.37(4.51)) \)
\( D_\mu = 1.67 + 0.66(1.03 - 1.67) \)
\( D_\mu = 1.67 - 0.42 \)
\( D_\mu = 1.25 \text{ m} \rightarrow 4.1 \text{ ft} \rightarrow 5 \text{ ft} \)

(c) \( D_c = 0.29d^{1.092} + e^{-0.10392d}(0.19d^{1.705} - 0.29d^{1.092}) \)
55/L138/Include/A2012/ROP
\[ D_c = 0.29(3.86^{1.092}) + e^{0.10392(3.86)}[(0.19)(3.86^{1.705}) - (0.29)(3.86^{1.092})] \]
\[ D_c = 0.29(4.37) + e^{-0.4011}[(0.19)(4.92) - (0.29)(4.37)] \]
\[ D_c = 1.27 + 0.67(0.94 - 1.27) \]
\[ D_c = 1.27 - 0.22 \]

\[ D_c = 1.05 \text{ m} = 3.45 \text{ ft} \]

\[ D_d = 0.31e^{0.99962} \]
\[ D_d = 0.31(3.86^{0.99962}) \]
\[ D_d = 0.31(3.84) = 1.19 \text{ m} = 3.9 \text{ ft} \]

\[ D_e = 0.31e^{0.99962} \]
\[ D_e = 0.31(3.86^{0.99962}) \]
\[ D_e = 0.31(3.84) = 1.19 \text{ m} = 3.9 \text{ ft} \]

The subscripts to \( D, a, b, c, d, \) and \( e \), relate to notes (a) through (e), respectively, in Table 10.3.2.2.1(B). To convert the distance in meters to feet, multiply by 3.2808. The resultant distance in feet is then rounded off to the nearest 5 foot dimension. For example, a distance of 5.2 ft would be rounded down to 5 ft. A distance of 7.6 ft would be rounded up to 10 ft.

[Delete Tables 10.3.2.2.1(a) and 10.3.2.2.1(b) in their entirety and replace with the following tables]
Table 10.3.2.1(a) Minimum Distance (D) from Outdoor Bulk Hydrogen Compressed Gas Systems to Exposures – Typical Maximum Pipe Size

<table>
<thead>
<tr>
<th>Pressure</th>
<th>d mm</th>
<th>d = 52.5 mm</th>
<th>d = 18.97 mm</th>
<th>d = 7.31 mm</th>
<th>d = 7.16 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 15 to ≤ 250 psig</td>
<td>m</td>
<td>ft</td>
<td>m</td>
<td>ft</td>
<td>m</td>
</tr>
<tr>
<td>&gt; 103.4 to ≤ 1724 kPa</td>
<td>12</td>
<td>40</td>
<td>14</td>
<td>46</td>
<td>9</td>
</tr>
<tr>
<td>Exposures Group 1</td>
<td>m</td>
<td>ft</td>
<td>m</td>
<td>ft</td>
<td>m</td>
</tr>
<tr>
<td>(a) Lot lines</td>
<td>m</td>
<td>ft</td>
<td>m</td>
<td>ft</td>
<td>m</td>
</tr>
<tr>
<td>(b) Air intakes (HVAC, compressors, other)</td>
<td>m</td>
<td>ft</td>
<td>m</td>
<td>ft</td>
<td>m</td>
</tr>
<tr>
<td>(c) Operable openings in buildings and structures</td>
<td>m</td>
<td>ft</td>
<td>m</td>
<td>ft</td>
<td>m</td>
</tr>
<tr>
<td>(d) ignition sources such as open flames and welding</td>
<td>m</td>
<td>ft</td>
<td>m</td>
<td>ft</td>
<td>m</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pressure</th>
<th>d mm</th>
<th>d = 52.5 mm</th>
<th>d = 18.97 mm</th>
<th>d = 7.31 mm</th>
<th>d = 7.16 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 250 to ≤ 3000 psig</td>
<td>m</td>
<td>ft</td>
<td>m</td>
<td>ft</td>
<td>m</td>
</tr>
<tr>
<td>&gt; 1724 to ≤ 20,684 kPa</td>
<td>6</td>
<td>20</td>
<td>7</td>
<td>24</td>
<td>4</td>
</tr>
<tr>
<td>Exposures Group 2</td>
<td>m</td>
<td>ft</td>
<td>m</td>
<td>ft</td>
<td>m</td>
</tr>
<tr>
<td>(a) Exposed persons other than those servicing the system</td>
<td>m</td>
<td>ft</td>
<td>m</td>
<td>ft</td>
<td>m</td>
</tr>
<tr>
<td>(b) parked cars</td>
<td>m</td>
<td>ft</td>
<td>m</td>
<td>ft</td>
<td>m</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pressure</th>
<th>d mm</th>
<th>d = 52.5 mm</th>
<th>d = 18.97 mm</th>
<th>d = 7.31 mm</th>
<th>d = 7.16 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 3000 to ≤ 7500 psig</td>
<td>m</td>
<td>ft</td>
<td>m</td>
<td>ft</td>
<td>m</td>
</tr>
<tr>
<td>&gt; 20,684 to ≤ 51,711 kPa</td>
<td>5</td>
<td>17</td>
<td>6</td>
<td>19</td>
<td>4</td>
</tr>
<tr>
<td>Exposures Group 3</td>
<td>m</td>
<td>ft</td>
<td>m</td>
<td>ft</td>
<td>m</td>
</tr>
<tr>
<td>(a) Buildings of non-combustible non-fire rated construction</td>
<td>m</td>
<td>ft</td>
<td>m</td>
<td>ft</td>
<td>m</td>
</tr>
<tr>
<td>(b) Buildings of combustible construction</td>
<td>m</td>
<td>ft</td>
<td>m</td>
<td>ft</td>
<td>m</td>
</tr>
<tr>
<td>(c) Flammable gas storage systems above or below ground</td>
<td>m</td>
<td>ft</td>
<td>m</td>
<td>ft</td>
<td>m</td>
</tr>
<tr>
<td>(d) Hazardous Materials Storage Systems above or below ground</td>
<td>m</td>
<td>ft</td>
<td>m</td>
<td>ft</td>
<td>m</td>
</tr>
<tr>
<td>Pressure</td>
<td>Internal Pipe Diameter (ID)</td>
<td>d mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------</td>
<td>-----------------------------</td>
<td>------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 15 to ≤ 250 psig</td>
<td>d = 52.5 mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 103.4 to ≤ 1724 kPa</td>
<td>d = 18.97 mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 250 to ≤ 3000 psig</td>
<td>d = 7.31 mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 1724 to ≤ 20,684 kPa</td>
<td>d = 7.16 mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 3000 to ≤ 7500 psig</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 20,684 to ≤ 51,711 kPa</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 51,711 to ≤ 103,421 kPa</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 7500 to ≤ 15000 psig</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- (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) Utilities overhead including electric power, building services or hazardous materials piping systems
Table 10.3.2.1(b) Minimum Distance (D) from Outdoor Bulk Hydrogen Compressed Gas
Systems to Exposures – By Maximum Pipe Size

<table>
<thead>
<tr>
<th>Pressure</th>
<th>&gt; 15 to ≤ 250 psig</th>
<th>&gt; 250 to ≤ 3000 psig</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&gt;103.4 to ≤1724 kPa</td>
<td>&gt;1724 to ≤20,684 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>D = 0.231d</td>
</tr>
<tr>
<td></td>
<td>m</td>
<td>ft</td>
</tr>
<tr>
<td>0.2</td>
<td>5.1</td>
<td>1</td>
</tr>
<tr>
<td>0.3</td>
<td>7.6</td>
<td>2</td>
</tr>
<tr>
<td>0.4</td>
<td>10.2</td>
<td>2</td>
</tr>
<tr>
<td>0.5</td>
<td>12.7</td>
<td>3</td>
</tr>
<tr>
<td>0.6</td>
<td>15.2</td>
<td>4</td>
</tr>
<tr>
<td>0.7</td>
<td>17.8</td>
<td>4</td>
</tr>
<tr>
<td>0.8</td>
<td>20.3</td>
<td>5</td>
</tr>
<tr>
<td>0.9</td>
<td>22.9</td>
<td>5</td>
</tr>
<tr>
<td>1.0</td>
<td>25.4</td>
<td>6</td>
</tr>
<tr>
<td>1.1</td>
<td>27.9</td>
<td>6</td>
</tr>
<tr>
<td>1.2</td>
<td>30.5</td>
<td>7</td>
</tr>
<tr>
<td>1.3</td>
<td>33.0</td>
<td>8</td>
</tr>
<tr>
<td>1.4</td>
<td>35.6</td>
<td>8</td>
</tr>
<tr>
<td>1.5</td>
<td>38.1</td>
<td>9</td>
</tr>
<tr>
<td>1.6</td>
<td>40.6</td>
<td>9</td>
</tr>
<tr>
<td>1.7</td>
<td>43.2</td>
<td>10</td>
</tr>
<tr>
<td>1.8</td>
<td>45.7</td>
<td>11</td>
</tr>
<tr>
<td>1.9</td>
<td>48.3</td>
<td>11</td>
</tr>
<tr>
<td>2.0</td>
<td>50.8</td>
<td>12</td>
</tr>
<tr>
<td>2.1</td>
<td>53.3</td>
<td>12</td>
</tr>
<tr>
<td>Pressure</td>
<td>Group 1</td>
<td>Group 2</td>
</tr>
<tr>
<td>----------</td>
<td>--------</td>
<td>--------</td>
</tr>
<tr>
<td>&gt; 3000 to ≤ 7500 psig</td>
<td>D = 1.105d</td>
<td>D = 0.68311d - 1.3123</td>
</tr>
<tr>
<td>&gt; 7500 to ≤ 15000 psig</td>
<td>D = 0.68311d - 1.3123</td>
<td>D = 0.459d</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Internal Pipe Diameter (ID)</th>
<th>Exposures&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Exposures&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID (in)</td>
<td>d (mm)</td>
<td>m</td>
</tr>
<tr>
<td>0.2</td>
<td>5.1</td>
<td>6</td>
</tr>
<tr>
<td>0.3</td>
<td>7.6</td>
<td>8</td>
</tr>
<tr>
<td>0.4</td>
<td>10.2</td>
<td>11</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>
<td>25</td>
</tr>
<tr>
<td>1.0</td>
<td>25.4</td>
<td>28</td>
</tr>
<tr>
<td>1.1</td>
<td>27.9</td>
<td>31</td>
</tr>
<tr>
<td>1.2</td>
<td>30.5</td>
<td>34</td>
</tr>
<tr>
<td>1.3</td>
<td>33.0</td>
<td>36</td>
</tr>
<tr>
<td>1.4</td>
<td>35.6</td>
<td>39</td>
</tr>
<tr>
<td>1.5</td>
<td>38.1</td>
<td>42</td>
</tr>
<tr>
<td>1.6</td>
<td>40.6</td>
<td>45</td>
</tr>
<tr>
<td>1.7</td>
<td>43.2</td>
<td>48</td>
</tr>
<tr>
<td>1.8</td>
<td>45.7</td>
<td>51</td>
</tr>
<tr>
<td>1.9</td>
<td>48.3</td>
<td>53</td>
</tr>
<tr>
<td>2.0</td>
<td>50.8</td>
<td>56</td>
</tr>
</tbody>
</table>
a Linear interpolation of internal pipe diameters and distances between table entries is allowed.

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

10.3.2.2.1 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 exceed the values shown in Table 10.3.2.1.2-(a) when in accordance with and Table 10.3.2.1.2-(b) for the pressure range indicated except as allowed by 10.3.2.2.1.1(B) or 10.3.2.2.1.1(C).

10.3.2.2.1* 10.3.2.2.1.1(E) 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 400 scf (11.3 m³). The piping system size used in the application of Tables 10.3.2.1.2-(a) and or 10.3.2.1.2-(b) shall be determined based on that portion of the system with the greatest maximum internal diameter.

A.10.3.2.2.1-A.10.3.2.2.1.1(E) Systems that employ compressors downstream of a bulk supply typically operate at higher pressures than that of the bulk supply. As a result, the diameter of the piping system can vary with the pressure. The use of a higher pressure rating or variation of internal diameters is not warranted unless there is a storage component with a hydrogen content that exceeds 400 scf (11.3 m³) located downstream of the primary storage source and upstream of the source valve. The volume of gas contained within the piping system is not included in determining the quantity in storage.

For example, a 3000 psig (20,684 kPa) storage system that supplies a 6000 psig (41,369 kPa) compressor that directly feeds a process with less than 400 scf (11.3 m³) of intervening storage at a pressure of 6000 psig (41,369 kPa) or less is considered a 3000 psig (20,684 kPa) system. Conversely, a system with the primary storage of 3000 psig (20,684 kPa) might supply a compressor that in turn delivers hydrogen to intermediate storage with a quantity of greater than 400 scf (11.3 m³). (Note: Pressures given are gauge pressures.) The piping serving the intermediate storage system from a point of discharge on the compressor can have an internal diameter of less than that serving the primary storage system upstream of the compressor. Accordingly, each portion of the system must be analyzed with respect to the tabular distances. See the typical P&IDs shown in Figure A.3.3.12(a) through Figure A.3.3.12(f) for additional information in this regard.

The use of Table 10.3.2.1.(b)2.1.1(B) is based on the maximum internal diameter of the piping system over the range of pressures specified. In practice, it is common to maintain a consistent size of piping throughout the system; however, there might be cases where the ID of the piping system varies. In such cases, the piping with the largest internal diameter in the system is used to establish the system pipe size for the purposes of using the table, regardless of the length of the piping. It is not uncommon for portions of the system equipped with pressure gauges, pressure transducers, or other instrumentation to be served by small-diameter piping systems. However, the maximum internal diameter of the piping system will control the establishment of distance.
for the exposures indicated.

Pipe sizes are typically expressed in nominal terms as illustrated in Table A.10.3.2.2.1.1(E) below. This is compared with tubing in which the outside diameter (OD) is expressed in exact terms. Designers commonly use pipe schedule to specify the wall thickness for a given material based on the design conditions. Typical pipe sizes found in commerce include those shown in Table A.10.3.2.2.1.1(E).
**Table A.10.3.2.1.1(E) Typical Pipe Sizes**

<table>
<thead>
<tr>
<th>Nominal Pipe Size (in.)</th>
<th>O.D. (in.)</th>
<th>40</th>
<th>80</th>
<th>XH</th>
<th>XXH</th>
</tr>
</thead>
<tbody>
<tr>
<td>¼</td>
<td>0.540</td>
<td>0.088</td>
<td>0.119</td>
<td>0.119</td>
<td>—</td>
</tr>
<tr>
<td>⅜</td>
<td>0.675</td>
<td>0.094</td>
<td>0.126</td>
<td>0.126</td>
<td>—</td>
</tr>
<tr>
<td>½</td>
<td>0.840</td>
<td>0.109</td>
<td>0.147</td>
<td>0.147</td>
<td>0.294</td>
</tr>
<tr>
<td>⅜</td>
<td>1.050</td>
<td>0.113</td>
<td>0.154</td>
<td>0.154</td>
<td>0.308</td>
</tr>
<tr>
<td>¹</td>
<td>1.315</td>
<td>0.133</td>
<td>0.179</td>
<td>0.179</td>
<td>0.358</td>
</tr>
<tr>
<td>¾</td>
<td>1.660</td>
<td>0.140</td>
<td>0.191</td>
<td>0.191</td>
<td>0.382</td>
</tr>
<tr>
<td>¹½</td>
<td>1.900</td>
<td>0.145</td>
<td>0.200</td>
<td>0.200</td>
<td>0.400</td>
</tr>
<tr>
<td>²</td>
<td>2.375</td>
<td>0.154</td>
<td>0.218</td>
<td>0.218</td>
<td>0.436</td>
</tr>
<tr>
<td>²/₄</td>
<td>2.675</td>
<td>0.203</td>
<td>0.276</td>
<td>0.276</td>
<td>0.552</td>
</tr>
<tr>
<td>³</td>
<td>3.500</td>
<td>0.216</td>
<td>0.300</td>
<td>0.300</td>
<td>0.600</td>
</tr>
<tr>
<td>³/₄</td>
<td>4.000</td>
<td>0.236</td>
<td>0.318</td>
<td>0.318</td>
<td>0.636</td>
</tr>
<tr>
<td>⁴</td>
<td>4.500</td>
<td>0.237</td>
<td>0.337</td>
<td>0.337</td>
<td>0.674</td>
</tr>
</tbody>
</table>

XH = extra heavy; XXH = extra extra heavy.

Note: Standard pipe schedule or pipe size as listed by ANSI/ASME B36.10M, Welded and Seamless Wrought Steel Pipe, and API Spec 5L, Specification for Line Pipe.

To determine internal diameter (ID) of a selected pipe size, multiply by 2 the wall thickness for the selected schedule and subtract the result from the outside diameter (OD):

\[ ID = OD - (2 \times \text{wall thickness}) \]

For example, for 2 in. Schedule 40 pipe:

Wall thickness = 0.154 in.; OD = 2.375 in.

Then:

\[ ID = 2.375 - (2 \times 0.154) = 2.067 \text{ in.} \]

When tubing is used in lieu of pipe, the OD of the tubing is designated in inches (e.g., 1/₄, 5/₃₂, 1/₂₀, 1/₁₆, 1/₈, 1/₄, 1/₂, 2), and the tubing is manufactured to those specific dimensions. Tube wall thickness is determined based on the working pressure and materials of construction. The calculation of internal diameter is the same as that used for conventional pipe:

\[ ID = OD - (2 \times \text{wall thickness}) \]

For example, for 1/₄ in. OD tubing, if the wall thickness is 0.049 in. and the OD is 0.250 in., then:

\[ ID = 0.250 - (2 \times 0.049) = 0.152 \text{ in.} \]
\[ ID = 0.250 - (2 \times 0.049) = 0.152 \text{ in.} \]

**10.3.2.2.1.1 (A) – Shutoff Valves on the Source of Supply.** When shutoff valves are not connected directly to the source of supply, all interconnecting piping between the source connection and points downstream shall be included in the determination of internal diameter for the piping system.

**10.3.2.2.1.1(C) –** The separation distance for piping systems with internal diameters less than those specified in Table 10.3.2.1(a) and Table 10.3.2.1(b) for the pressure range selected shall be allowed to be reduced with tabular distances determined based on the use of equations in Table 10.3.2.2.1.1(B).

**10.3.2.2.1.1(D) –** Separation distances determined based on the use of piping systems with pipe ID greater than that indicated in Table 10.3.2.1(b) 10.3.2.2.1.1(B) shall be subject to review and approval by the AHJ.

**A.10.3.2.2.2.** The methodology used to determine the distances listed in Table 10.3.2.1(b) has been evaluated for piping up to and including internal diameters of approximately 3 inches (76 mm). The establishment of risk informed separation distances for piping systems with greater internal diameters are subject to a hazard analysis that demonstrates an equivalent level of risk under the provisions of Section 1.5.

**10.3.2.3 * 10.3.2.2.1.1(F) – Determination of System Pressure.** The system pressure shall be determined by the maximum operating pressure of the storage array with content greater than 400 scf (11.3 m³), irrespective of those portions of the system elevated to a higher pressure.

**A.10.3.2.3 A.10.3.2.2.1.1(F) –** Portions of a system might operate at higher pressures than the bulk supply; however, those portions of the system do not require the use of a pressure rating higher than that of the bulk supply unless there is a storage component exceeding 400 scf (11.3 m³) downstream of the primary storage source and upstream of the source valve. The volume of gas contained within the piping system is not included when the quantity in storage is determined. For example, a 3000 psig (20,684 kPa) storage system that supplies a 6000 psig (41,369 kPa) compressor that directly feeds a process with less than 400 scf (11.3 m³) of intervening storage at a pressure of 6000 psig (41,369 kPa) or less is considered a 3000 psig (20,684 kPa) system.

**10.3.2.4 * 10.3.2.2.2 – Reduction of Distance By Mitigation Means.**

**A.10.3.2.4 A.10.3.2.2.2 –** Distances to assumed lot lines established for the purpose of determining exterior wall and opening protection should not be confused with lot lines that are property lines in the true sense of the definition, and distances to assumed lot lines can be disregarded in the application of Tables 10.3.2.1.2.1(a) and 10.3.2.1.2.1(b). The lot lines specified in 10.3.2.2.2 are property lines used to separate one lot from another or to separate a property from a street or other public space.

A permit holder cannot exercise any right of control over the property of others, whether the ownership is public or private. In cases where the permit holder owns an adjacent lot or parcel, the separation from property lines assumes that the permit holder could transfer ownership of the...
adjacent property at some point, and therefore the requirements for property line separation should be observed.

**10.3.2.4.1** Passive Means. Except for distances to lot lines, operable building openings, air intakes, and overhead utilities, the distances to Group 1 and 2 exposures shown in Tables 10.3.2.1(a) and 10.3.2.1(b) shall not be permitted to be reduced by one-half and shall not apply to Group 3 exposures where fire barrier walls having a minimum fire resistance rating of 2 hours constructed in accordance with the following are located between the system and the exposure.

(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. **10.3.2.4** Where fire barrier walls of three sides are used, the walls shall be in accordance with 11.3.2.2.4.

(5) 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.

(6)* **Table 10.3.2.1(a) note f.** 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 feet shall be provided between the structure and the system required for access for service-related activities.

(7) 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.

(8) The minimum wall height shall be not less than 8 ft (2.1 m).

(9) The minimum wall length shall project not less than 5 ft (1.5 m) horizontally beyond the most remote point of the system or the exposure.

**A.10.3.2.4.1-A.10.3.2.2.3** The code has historically recognized that, in certain instances, fire barrier walls can serve as a means to reduce the limits of unacceptable consequences due to the release of hydrogen from high-pressure equipment. Testing other than that related to establish fire resistance of the fire barrier walls has not been documented. Researchers at Sandia National Laboratories have been investigating the use of fire barrier walls as a means of mitigation in the establishment of distances related to the installation of bulk gaseous hydrogen systems, and a technical paper has been presented detailing the early findings.

As stated by Sandia National Laboratories researchers Houf, Schefer, and Evans in “Analysis of
Barriers for Mitigation of Unintended Releases of Hydrogen,” the purpose of the Sandia study was to extend the available database on barrier walls as a hazard mitigation strategy and to provide technical data for risk-informed decisions in hydrogen codes and standards regarding barrier wall design and implementation. Additional research by Sandia’s Jeff LaChance in a paper titled “NFPA Mitigation Analysis” the focus of the research included testing to assess the effectiveness of various barrier designs in terms of the following:

1. Deflecting jet flames
2. Reducing the extent of the flammable cloud resulting from an unignited release
3. Reducing the magnitude of the radiative heat flux produced by a jet flame from an ignited release
4. Minimizing the amount of ignition overpressure produced from the barrier confinement

When the work is concluded, it is expected that the results will likely provide the basis for criteria for the proper configuration, design, and construction of such barriers in order that the walls do not create other hazards. The work to date has been limited; however, the results have been promising. Houf, Schefer, and Evans have determined that for the conditions investigated, 2000 psi (13.79 MPa) source pressure and a 1/8 in. (3.175 mm) diameter round leak, the barrier configurations studied were found to (1) reduce horizontal jet flame impingement hazard by deflecting the jet flame, (2) reduce radiation hazard distances for horizontal jet flames, and (3) reduce horizontal unignited jet flammability hazard distances. For the one-wall vertical barrier and the three-wall barrier configurations examined in the tests, the simulations of the peak overpressure hazard from ignition were found to be approximately 5.8 psi (40 kPa) on the release side of the barrier and approximately 0.73 psi to 0.44 psi (5 kPa to 3 kPa) on the downstream side of the barrier.

As stated by Sandia National Laboratories researchers Houf, Schefer, and Evans in “Evaluation of Barrier Walls for Mitigation of Unintended Releases of Hydrogen,” the purpose of the Sandia study was to extend the available database on barrier walls as a hazard mitigation strategy and to provide technical data for risk-informed decisions in hydrogen codes and standards regarding barrier wall design and implementation. Additional analysis by Sandia (LaChance, Phillips and Houf) in a paper titled “Risk Associated with the Use of Barriers in Hydrogen Refueling Stations” provided insights on the effectiveness of various barrier designs in terms of the following:

1. Deflecting jet flames
2. Reducing the extent of the flammable cloud resulting from an unignited release
3. Reducing the magnitude of the radiative heat flux produced by a jet flame from an ignited release
4. Minimizing the amount of ignition overpressure produced from the barrier confinement

Houf, Schefer, and Evans have determined that for the conditions investigated, 2000 psi (13.79 MPa) source pressure and a 1/8 in. (3.175 mm) diameter round leak, the barrier configurations
studied were found to (1) reduce horizontal jet flame impingement hazard by deflecting the jet flame, (2) reduce radiation hazard distances for horizontal jet flames, and (3) reduce horizontal unignited jet flammability hazard distances. For the one-wall vertical barrier and the three-wall barrier configurations examined in the tests, the simulations of the peak overpressure hazard from ignition were found to be approximately 5.8 psi (40 kPa) on the release side of the barrier and approximately 0.73 psi to 0.44 psi (5 kPa to 3 kPa) on the downstream side of the barrier. Although an overpressure can be expected due to latent ignition of a flammable cloud the overpressure is expected to be limited to a localized area. Special designs for overpressure in addition to the structural loads imposed by the building code have not been required.

The function of the fire barrier wall is to protect the exposure from the system and not the converse. The code assumes that other factors will enter into locating any material or structure in proximity to the bulk hydrogen compressed gas system. For example, if a property or lot line is involved opposite the hydrogen installation the proximity of a building to be constructed on the lot line is regulated by the building code based on the type and occupancy of structure to be constructed.

Investigation is continuing into the parameters for the construction of fire barrier walls. In the interim, a risk-informed approach to the establishment of distance has been introduced into Chapter 10 of this code. The Industrial and Medical Gases Technical Committee recognizes that previous editions of the code have allowed the use of fire barrier walls as a mitigation method. Until such time as the investigation by Sandia National Laboratories or others has been completed, 10.3.2.2.3 provides for the use, in limited cases, of fire barrier walls to mitigate effects on the downstream side of the wall by allowing a reduction of one half of the separation distance otherwise required through the use of the risk-informed tables.

The resultant distances should be measured from a point on the unexposed (or downstream side) of the fire-barrier wall to the exposure. For example, the 45 ft (14.0 m) distance to lot lines shown for a 3,000 psi-gauge (20,684 kPa gauge) system using piping with a maximum internal diameter (ID) of 0.747 in. (18.97 mm) can be reduced to 22.5 ft (7.0 m) between the property line and the fire-barrier wall.

The concept of limiting the use of barrier walls is an interim determination that augments the requirements now found in the risk-informed approach to the establishment of separation distances. The outcome of the scientific research underway will measure the effect of the mitigation provided by the walls and will bring a firmness to the fire barrier requirements. The importance of completing the research is that all the factors integral to the construction of fire barrier walls will have been established through the scientific process. The use of the scientific process is a fundamental precept established in the acceptance of the risk-informed approach.

**10.3.2.2.3** The distances in (1), (2), (4), and (10) in Table 10.3.2.2.1(a) and Table 10.3.2.2.1(b) shall be permitted to be reduced by one half where fire barrier walls having a minimum fire resistance rating of 2 hours are located between the system and the exposure.

**10.3.2.4.2** Active Means. Active control systems that mitigate the risk of system leaks and failures can be used as a means to reduce separation distances where approved by the AHJ under the authority granted by Section 1.5.
A.10.3.2.4.2 To determine the acceptability of technologies, processes, products, facilities, materials, and uses attending the design, operation or use of such systems, the AHJ is authorized to require the owner or agent to provide, without charge to the jurisdiction, a technical opinion and report. The model fire prevention codes provide the authority for the AHJ to seek technical assistance from independent third parties with expertise in the matter to be reviewed at the submitter’s expense. The AHJ is authorized to require design submittals to be prepared by, and bear the stamp of, a registered design professional or professional engineer.

Active means of control could include a means to detect leakage or fire coupled with automatic system shut down.

Gas Detection. To utilize gas detection as a means of control the gas sensor would be placed at a point between the bulk hydrogen compressed gas system and the exposure. Gas detection systems may be limited in their ability to detect the presence of hydrogen in the open. They are most effective if the sensor is located within an enclosed space such as an equipment enclosure. If used, gas detection systems should be either listed or approved.

Flame Detection. Flame detection systems may include combination UV/IR detection systems and be installed in accordance with the requirements of NFPA 72.

Ultraviolet flame detectors typically use a vacuum photodiode Geiger–Muller tube to detect the ultraviolet radiation that is produced by a flame. The photodiode allows a burst of current to flow for each ultraviolet photon that hits the active area of the tube. When the number of current bursts per unit time reaches a predetermined level, the detector initiates an alarm.

A single wavelength infrared flame detector uses one of several different photocell types to detect the infrared emissions in a single wavelength band that are produced by a flame. These detectors generally include provisions to minimize alarms from commonly occurring infrared sources such as incandescent lighting or sunlight. An ultraviolet/infrared (UV/IR) flame detector senses ultraviolet radiation with a vacuum photodiode tube and a selected wavelength of infrared radiation with a photocell and uses the combined signal to indicate a fire. These detectors need exposure to both types of radiation before an alarm signal can be initiated. A multiple wavelength infrared (IR/IR) flame detector senses radiation at two or more narrow bands of wavelengths in the infrared spectrum. These detectors electronically compare the emissions between the bands and initiate a signal where the relationship between the two bands indicates a fire. [72, A.5.8.2]

10.3.2.5 Required Separation Distance For All Systems. Separation distances are required for bulk hydrogen compressed gas systems independent of system pressure or internal diameter of piping systems in accordance with the following:

(1) 10.3.2.3 Unloading connections on delivery equipment shall not be positioned closer to any of the exposures cited in 10.3.2.1.2.4(a) or 10.3.2.1.2.4(b) than the distances given for the storage system.

(2) Table 10.3.2.2.1(a) note g Equipment classified as meeting Class I, Division 2, Group B requirements of NFPA 70, National Electrical Code when the area is in 55/L138/Include/A2012/ROP
accordance with NFPA 497, *Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas.*

(3) **Table 10.3.2.2.1(a) note h** Bulk hydrogen storage systems are allowed to integrate (co-locate) other nonliquefied flammable gas systems 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. The minimum separation distance indicated requires a minimum separation 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 feet.

(4) **10.3.1.2** 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.

**10.3.2.6 Hydrogen And Other Flammable Gas Blends.** Bulk hydrogen compressed gas storage systems are allowed to integrate (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.

Also, in support of A.10.3.2.4.1 add the following informational references to Annex H under Section H.2.2.


Table 10.3.2.1(a) displays the "typical" sizes based on pressure. On the other hand Table 10.3.2.2(b) allows a rapid assessment of pipe sizes in the field without the use of what might be viewed as cumbersome calculations. Once an ID is determined the distances are easily estimated and verified.

This is not original material; its reference/source is as follows:
NFPA 2 - NFPA 55 Joint Task Group
Committee Meeting Action: Accept in Principle
Committee Statement: See the committee action on 55-105 (Log #139) that addressed this issue.

55-112 Log #CP12 (Table 10.3.2.2.1(b)(2))
Final Action: Accept

Submitter: Technical Committee on Industrial and Medical Gases,
Recommendation: Revise Annex Note to Table 10.3.2.2.1(b)(2) to read as follows:
This addresses exposed persons who are not involved with servicing the system, but are on the premises. Inspecting, monitoring the system inventory, delivering to the system, or working on the system are activities that are included in system servicing. The permit holder is responsible for managing and administering the controls which can include, but are not limited to controls such as painted lines or signs.

Substantiation: The current wording of "service person" can cause confusion to an AHJ as to who that includes. The proposed annex note is to provide clarification of the intent of the requirement and who is or is not included in the definition of service person.

Committee Meeting Action: Accept

55-113 Log #9 (Table 10.3.2.2.1(a))
Final Action: Reject

Submitter: Thomas L. Allison, Savannah River Nuclear Solutions
Recommendation: Delete line 5 from table or explain the hazard that requires up to 45 ft separation from air intake.
Substantiation: Hydrogen is lighter than air and rapidly disperses when released. Hydrogen is not toxic and occurs naturally in the air we breath. A flammable mixture is obviously not the concern since smoking is permitted at over 25 ft. There seems to be no basis for the distances indicated in the table.

Committee Meeting Action: Reject
Committee Statement: Engineering models using pressurized hydrogen releases show that the plume is momentum dominated and that buoyancy effects do not become significant until the separation distances in the table are reached. See also the Fire Protection Research Foundation reports that are referenced in Annex E.

55-114 Log #1 (Table 10.3.2.2.1(a) and (b))
Final Action: Accept in Principle

Submitter: William E. Hancock, Performance Design Technologies
Recommendation: Minimum distance requirements for the S.I. unit table are miscalculated. 15 feet is translated as 5.04, 5.6, 3.64, 4.31, 4.13, or 4.7 meters. Please revise appropriately.
Substantiation: See above.
Committee Meeting Action: Accept in Principle
Committee Statement: See the committee action on 55-117 (Log #CP1) which resolves the issue.
Remove limits associated with Note f “The minimum clearance between the structure and the system required for access for service related activities”. This limit is inconsistent with standard construction practice that requires a 3’ maintenance clearance and also inconsistent with practical applications since some sides of the system do not require maintenance clearance.

Delete Row (6) from both tables.

Add additional note to both tables: Provide adequate maintenance clearance to fire walls and other structures in accordance with manufacturer’s instructions.

The imposition of a 5 ft maintenance clearance is not consistent with common construction practices that normally require a three foot maintenance clearance to obstructions or to property lines. Three feet is sufficient to satisfy standard building code language for maintenance clearance to switchgear and equipment. There is no reason for additional clearance requirements to be given in the standard. Additionally, the imposition of an all-around clearance requirement is inconsistent with practical construction since maintenance requirements do not apply to all sides of typical equipment. Requiring compliance with manufacturer’s instructions is sufficient.

Delete row (2) in both tables. Row (2) is not needed since row (1) provides more conservative separation distances to passersby.

Within a particular installation, those granted access are best regulated by the owners. Attempting to regulate access to service personnel only, might exclude operators or owners who are rightly expected to have access to the equipment. It is not unusual to have bundles of hydrogen tanks in welding shops where operators and others are in contact with the tanks. This has not been shown to be an unacceptable risk. Residential owners will also need access. If the intent is to have all bulk storage in a fenced enclosure, additional justification is required.

The reasons provided by the proponent, including residence and use of tanks in welding shops are not entirely clear to the committee. Row 2 of the table addresses two levels of persons, including those who are authorized to access the system as well as those who are not. The committee feels that there is some merit to provide further guidance on how to accomplish the intent of spacial separation through the employment of an annex note or through additional proposals that may better express resolution to the concern without removing the existing language.

Revise text to read as follows:

Minimum distance requirements for the S.I. unit table are miscalculated. 15 ft is translated as 5.04, 5.6, 3.64, 4.31, 4.13, or 4.7 meters. Please revise appropriately.

Committee Meeting Action: Accept in Principle
Committee Statement: See the committee action on 55-105 (Log #139) that addressed this issue.
Revise 10.3.2.2.1.1, 10.3.2.2.1.1(B), 10.3.2.2.1.1(C), and 10.3.2.2.1.1(D) as follows:

10.3.2.2.1.1 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 exceed:

- 8 mm for systems having a maximum inventory of less than 100 kg or a water volume of less than 3000 L
- 55/SP0.46 (mm), SP being the service pressure expressed in MPa, for systems having a maximum inventory of more than 100 kg and a water volume of more than 3000 L, the values shown in Table 10.3.2.2.1(a) and Table 10.3.2.2.1(b) for the pressure range indicated except as allowed by 10.3.2.2.1.1(B) or 10.3.2.2.1.1(C).

(B) Alternative Internal Diameters. The separation distance for piping systems with internal diameters greater than the limits specified in 10.3.2.2.1.1 that are specified in Table 10.3.2.2.1(a) and Table 10.3.2.2.1(b) for the pressure range selected shall be permitted with tabular distances determined based on the use of equations in Table 10.3.2.2.1(D). Table 10.3.2.2.1(a) or Table 10.3.2.2.1(b) corrected by a multiplicative factor K calculated as follows:

For systems having a maximum inventory of less than 100 kg or a water volume of less than 3000 L: K = ID/8
For systems having a maximum inventory of more than 100 kg and a water volume of more than 3000 L: K = SP0.46 x ID/55

With:
SP : System pressure expressed in MPa
ID : Maximum Internal diameter, expressed in mm

(C) The separation distance for piping systems with internal diameters less than those specified in Table 10.3.2.2.1(a) and Table 10.3.2.2.1(b) for the pressure range selected shall be allowed to be reduced with tabular distances determined based on the use of equations in Table 10.3.2.2.1(D).

(B) Separation distances determined based on the use of Table 10.3.2.2.1(D) shall be subject to review and approval by the AHJ.

Delete Table 10.3.2.2.1.1(B) and replace Table 10.3.2.2.1(a) and Table 10.3.2.2.1(b) with the following:

***INSERT TABLE 55_L26_10.3.2.2.1.1(a)_R HERE***

Table 10.3.2.2.1 (a) Minimum Distance from Outdoor Gaseous Hydrogen Systems to Exposures (U.S. units)

<table>
<thead>
<tr>
<th>Category</th>
<th>Stored quantity</th>
<th>System pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Not greater than 100 kg</td>
<td>Not greater than 55 MPa</td>
</tr>
<tr>
<td>2</td>
<td>Water volume greater than 3000 L</td>
<td>System pressure greater than 55 MPa</td>
</tr>
<tr>
<td>3</td>
<td>Water volume greater than 3000 L</td>
<td>Stored quantity greater than 100 kg</td>
</tr>
</tbody>
</table>

For each category, sub-categories are defined in function of the complexity level (CL) of the hydrogen system defined by the total count of joints and valves the system includes, with valves counting as four joints.

For Category 1 and Category 2 systems, the following sub-categories are defined:

- Simple (S) : CL <= 60
- Complex (C) : CL > 60

For Category 3 systems, the following sub-categories are defined:

- Simple (S) : CL <= 45
- Complex (C) : CL > 45

***INSERT TABLE 10.3.2.2.1(b)***
<table>
<thead>
<tr>
<th>Exposure</th>
<th>Category 1&lt;sup&gt;+&lt;/sup&gt; (≤ 55 Mpa &amp; ≤ 100 kg)</th>
<th>Category 2&lt;sup&gt;+&lt;/sup&gt; (&gt; 55 Mpa &amp; ≤ 3000L)</th>
<th>Cat. 3&lt;sup&gt;+&lt;/sup&gt; (&gt; 100kg &amp; &gt;3000L)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>System Complexity</td>
<td>System Complexity</td>
<td>System Complexity</td>
</tr>
<tr>
<td></td>
<td>S (ft)</td>
<td>C (ft)</td>
<td>S (ft) C (ft)</td>
</tr>
<tr>
<td>(1) Lot lines</td>
<td>7</td>
<td>10</td>
<td>10 17</td>
</tr>
<tr>
<td>(2) Exposed persons other than those involved in servicing of the system</td>
<td>7</td>
<td>10</td>
<td>10 17</td>
</tr>
<tr>
<td>(3) Buildings and Structures</td>
<td>10</td>
<td>17</td>
<td>13 23</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>17</td>
<td>27 27</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>5</td>
<td>5 5</td>
</tr>
<tr>
<td>(4) Openings in buildings of fire-rated or non-fire-rated construction</td>
<td>13</td>
<td>20</td>
<td>17 27</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>20</td>
<td>23 33</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>17</td>
<td>13 23</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>17</td>
<td>27 27</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>17</td>
<td>27 27</td>
</tr>
<tr>
<td>(5) Air intakes (HVAC, compressors, other)</td>
<td>13</td>
<td>20</td>
<td>17 27</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>20</td>
<td>23 33</td>
</tr>
<tr>
<td>(6) Fire barrier walls or structures used to shield the bulk system</td>
<td>5</td>
<td>5</td>
<td>5 5</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>5</td>
<td>5 5</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>7</td>
<td>5 10</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>10</td>
<td>17 13</td>
</tr>
<tr>
<td>(7) Unclassified electrical equipment</td>
<td>17</td>
<td>17</td>
<td>17 17</td>
</tr>
<tr>
<td>(8) Utilities (overhead) including electric power, building services,</td>
<td>17</td>
<td>17</td>
<td>17 17</td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>17</td>
<td>17 17</td>
</tr>
<tr>
<td>(9) Ignition sources such as open flames and welding</td>
<td>7</td>
<td>10</td>
<td>10 17</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>10</td>
<td>10 17</td>
</tr>
<tr>
<td>(10) Parked cars</td>
<td>7</td>
<td>10</td>
<td>10 17</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>10</td>
<td>13 17</td>
</tr>
<tr>
<td>(11) Flammable gas storage systems including other hydrogen systems</td>
<td>7</td>
<td>10</td>
<td>8 13</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>10</td>
<td>27 27</td>
</tr>
<tr>
<td>(12) Aboveground vents or exposed piping and components of</td>
<td>7</td>
<td>10</td>
<td>8 13</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>10</td>
<td>27 27</td>
</tr>
<tr>
<td>(13) Hazardous materials (other than flammable gases) storage below</td>
<td>7</td>
<td>10</td>
<td>8 13</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>10</td>
<td>27 27</td>
</tr>
<tr>
<td>(14) Hazardous materials storage (other than flammable gases) above</td>
<td>7</td>
<td>10</td>
<td>8 13</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>10</td>
<td>27 27</td>
</tr>
<tr>
<td>(15) Ordinary combustibles including fast burning solids such as</td>
<td>7</td>
<td>10</td>
<td>8 13</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>10</td>
<td>27 27</td>
</tr>
<tr>
<td>(16) Heavy timber, coal or other slow burning combustible solids</td>
<td>7</td>
<td>10</td>
<td>8 13</td>
</tr>
</tbody>
</table>

55/L26/Table 10.3.2.2.1(a)/R/A2012/ROP
a Three categories are defined for gaseous hydrogen systems according to water volume, service pressure, and stored quantity, as follows:

Category 1: Stored quantity not greater than 100 kg AND System pressure not greater than 55 MPa
Category 2: Water volume not greater than 3000 L AND System pressure greater than 55 MPa
Category 3: Water volume greater than 3000 L AND Stored quantity greater than 100 kg

b For each category, sub-categories are defined in function of the complexity level (CL) of the hydrogen system defined by the total count of joints and valves the system includes, with valves counting as four joints.

Joints and valves on piping having an internal diameter smaller than the maximum internal diameter of the hydrogen system may be counted by applying an equivalence factor equal to the square of the ratio of diameters.

Joints and valves on piping operating at a pressure lower than the system pressure may be counted by applying an equivalence factor equal to the ratio of pressures.

For Category 1 and Category 2 systems, the following sub-categories are defined:

Simple (S) : CL <= 60
Complex (C) : CL > 60

For Category 3 systems, the following sub-categories are defined:

Simple (S) : CL <= 45
Complex (C) : CL > 45

**Substantiation:** In a risk informed approach, separation distance requirements should be in tune with the risk actually represented by a system with regards to the neighboring exposures, and reflect particular aversion for escalation scenarios threatening critical exposures such as occupied locations or storage of large amounts of flammable fluids.

This is not the case of the safety distance requirements for bulk gaseous hydrogen systems of the current edition of NFPA 55, as they are all based on the same leak size hypothesis (3% pipe section area leak) without regards to essential risk factors such as system complexity, nor consideration of exposure criticality.

Furthermore, the resulting distances are very sensitively determined by the Maximum Internal Diameter, a parameter of detail design which does not reflect alone the actual risk impact of a system on its environment, and which can vary significantly between two systems which would otherwise not be seen as having largely differing risk impacts (such as tube trailers).

This raises the following problems:

- The requirements and perceived risk diverge
- The application of a reduced safety distance, which should be justified by a higher level of safety, is permitted simply by modifying a detail design parameter (MID), a change that does not significantly improve the true level of safety. The AHJ has little basis to judge whether this reduction is acceptable.
- The rationale does not allow to take into account specific prevention and mitigation measures reducing the risk impact of a system, and therefore the corresponding separation distance requirements.
- The approach goes against standardization of lay-out requirements, as these are now determined by a detail design parameter which varies between otherwise similar systems.
- The approach requires detail design to be known before performing lay-out, whereas, often, site selection – which depends on lay-out requirements - needs to be performed before detail design is completed. There is a likelihood that the equipment finally selected will not comply with the MID hypothesis used to predetermine the lay-out.
- Changes to an installation (such as renewal of equipment) that happens to involve a pipe-diameter change that objectively does not impact risk may no longer be possible.

The proposal is based on a different rationale which allows to avoid the above problems:

The revised separation distances result from the application of a leak size which is not constant, but which depends both on the type of hydrogen system and on the nature of the exposure. The risk model determines the leak size to be used in function of

1) the system leak frequency profile, reflected by system complexity and estimated in the risk model from the number of joints and valves in the system; the increased likelihood of leak resulting from higher complexity results in the choice of a larger reference leak size.

2) the criticality of the exposure: a more stringent risk criteria is applied for critical exposures, resulting in the selection of a larger leak size hypothesis.

This results in separation distances that are much more consistent with actual risk as far as it can be estimated.

Furthermore, the proposal focuses on producing an expert checked table providing separation distances to be applied directly as-is in almost all cases, simplifying the use of the code and supporting lay-out standardization.
Application of separation distances different from those in the table is only foreseen for systems having a maximum internal diameter (small systems) or leak magnitude indicator (large systems) greater than the hypothesis used to produce the standard table. In this case a multiplicative factor is applied to the reference distances to reflect the larger potential leak size.

No further validation by the AHJ is therefore required.
The statistical data source and the consequence model used to produce the proposed revise distance table are the same as those used previously.

Note: Supporting material is available for review at NFPA Headquarters.

This is not original material; its reference/source is as follows:
Frederic Barth - chairman of EIGA WG11 - Hydrogen Energy.
Committee Meeting Action: Reject
Committee Statement: The proponent stated that main reasons for making these changes are that the separation distances for different size and complexity of GH2 systems should not be based upon the same leak size hypothesis (3% of pipe size based on the pipe internal diameter). The technical committee concluded that the substantiation provided for this significant change was not sufficient. The documentation provided essentially stands alone and does not refer to any publicly available, retrievable reports or publications. The documentation and lack of independent review of the methodology used to evaluate the risk aspects of the proposal were considerations that had an impact on the committee’s decision to reject the proposal. For example, the method used and the results have not been subjected to an independent peer review process and are have not been results disseminated and reviewed throughout the scientific community such as would occur through publication in a scientific or technical journal. Others, who are skilled in matters of risk evaluation and currently participating in the international process to develop a fueling standard, presented to the committee a comparison of the elements of this proposal to the existing requirements of NFPA 55. This comparison provided the committee with a greater depth of understanding between the methodology used by the proponent and that of the joint task group studying these issues.
The risk methods utilized had the appearance of being used to justify existing situations/installations. As a result, the committee members expressed a need to further study the proposal and to dialogue with the technical support team that has been assisting NFPA with this process.

The proposal introduces subjectivity into the establishment of separation distances by assuming that systems with different complexity levels and pipe sizes could experience a leak with an assumed area that is a different % of pipe cross sectional area without providing a clear method to arrive at the values selected. The committee wishes to avoid subjectivity so that results are defensible, repeatable by others, and also open to revision. The committee was not convinced that these qualities are apparent in the method used by the proponent.

The method used to develop the proposal did not show evidence of being consensus-based with a range of industry representatives, fire safety officials, and code developers involved in the development process.

The proposal was incomplete in that it did not address proposed changes to other sections of NFPA 55 such as the Annex material and other code chapters as would be necessary to make such a revision complete.

The committee did not agree with the proponent’s perceived claim that technological development in the hydrogen industry would be blocked by any approach other than the one being put forward.

While the committee did not agree with all aspects of the proposal as submitted, there is technical merit to the approach that could be beneficial, such as the simple system component concept. To that end, the proponent is encouraged to further develop and make available any peer reviewed technical data that supports the proposal and to explore a way to work with the NFPA 55 committee to achieve harmony.

55-119  Log #45 (10.3.2.1.1(B))
Final Action: Accept in Principle
Submitter: Robert Wichert, FCHEA, and Chris Radley, Altergy
Recommendation: Provide these equations using standard US units (inches and feet).
Substantiation: Some AHJs may be more familiar with feet and inches and may tend to enforce limits based on those units.
Committee Meeting Action: Accept in Principle
Committee Statement: See the committee action on 55-105 (Log #139) that addressed this issue.
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55-120 Log #48
(Table 10.3.2.1.1(B))

Final Action: Accept in Principle

Submitter: Robert Wichert, FCHEA, and Chris Radley, Altergy

Recommendation: Change all exponents to at most three significant figures using a conservative method. Change all numerical values to at most three significant figures using a conservative method. Combine equation branches where possible to simplify the calculations. Use numerical values for “e”.

Substantiation: The current use of six significant digits in the formulas cannot be supported by the uncertainty of the underlying data. A detailed analysis is necessary to establish formulas that are both supportable and conservative. In many instances, the difference between the given exponents and “1” is so small that differences in the end result are less than one percent for all reasonable arguments. The use of Euler’s number, e, (2.718…) is not explained and could be better expressed as a numerical value to avoid confusion on the part of the AHJ.

Committee Meeting Action: Accept in Principle

Committee Statement: See the committee action on 55-105 (Log #139) that addressed this issue.

55-121 Log #49

Final Action: Accept in Principle

Submitter: Robert Wichert, FCHEA, and Chris Radley, Altergy

Revise text to read as follows:

10.3.2.2.2* Except for the separation distances to lot lines (1), operable building openings (4a), air intakes (5), and overhead utilities (8), the distances in Table 10.3.2.2.1(a) and Table 10.3.2.2.1(b) shall not apply where fire barrier walls having a minimum fire resistance rating of 2 hours are located between the system and the exposure.

10.3.2.2.3* The separation distances to lot lines (1), exposed persons (2), building openings (4), and parked cars (10) in Table 10.3.2.2.1(a) and Table 10.3.2.2.1(b) shall be permitted to be reduced by one-half where fire barrier walls having a minimum fire resistance rating of 2 hours are located between the system and the exposure.

Substantiation: The current text is inconsistent. Consistency is preferable in this instance.

Committee Meeting Action: Accept in Principle

Committee Statement: See the committee action on 55-105 (Log #139) that addressed this issue.

55-122 Log #50

Final Action: Reject

Submitter: Robert Wichert, FCHEA, and Chris Radley, Altergy

Recommendation: Delete sub-clause 10.3.2.2.4 entirely.

Substantiation: The basis of the referenced sub-clause, 11.3.2.2.4, is to allow liquid hydrogen to flow and avoid pooling. Such considerations do not apply to gaseous hydrogen.

Committee Meeting Action: Reject

Committee Statement: The justification for the barrier is not tied to pooling of a cryogenic liquid, but is tied more to limiting confinement for the purposes of improved natural ventilation, emergency access, and explosion mitigation.
Where fire barrier walls of three sides are used, the walls shall be in accordance with 11.3.2.2.4. 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).

10.3.2.2.4.1 The connecting angles between fire barrier walls can 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.

A.10.3.2.2.4.1 See Figure A.8.13.2.7.2.1 which addresses bulk cryogenic systems located in a courtyard. This figure also applies to the case where the any or all of the three walls are constructed as fire barrier walls providing the distances to walls constructed as fire barrier walls for exposure protection is not less than that required by Tables 10.3.2.2.1 (a) or (b).

Substantiation: The proposed text adds clarification for systems that are surrounded by three walls when they are intended to be fire barrier walls. Figure A.8.13.2.7.2.1 illustrates a court where the 3 walls could be serving as fire barrier walls as long as the three walls do not create a confined space, they should be allowed just as if they were not fire barrier walls. The notes in the annex for A.8.13.2.7.2.1 and the corresponding figure specifically refer the user to the material specific chapters including statements referring to the requirements of distance tables in the material specific chapters.

Committee Meeting Action: Accept

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10.4.1 Outdoor Locations.

10.4.1.1 Weather and security protection provided by an outdoor hydrogen enclosure shall meet the requirements of 10.4.1.1.1.

10.4.1.1.1 Outdoor hydrogen enclosures shall be constructed of noncombustible or limited combustible materials.

10.4.1.1.2 Ventilation shall be provided in accordance with the requirements of Section 6.15.

10.4.1.1.3 The distance from the outdoor hydrogen enclosure and the structural supports to buildings, lot lines, public ways means of egress to a public way or other exposures shall not be less than the distance required by 10.3.2.2 for Outdoor Storage.

10.4.1.1.4 Where the outdoor hydrogen enclosure is constructed of noncombustible materials, reductions in the separation distance shall be permitted based on the use of fire barrier walls where permitted in accordance with the requirements of 10.3.2.2.2 and 10.3.2.2.3.

Substantiation: Weather and security protection can be provided by an engineered outdoor enclosure meeting the requirements of 6.15 and 10.3.2.2 without requiring indoor construction. The current restrictions on overhead cover are too restrictive.

Committee Meeting Action: Reject
Committee Statement: There is no definition for the structure being described and other questions are raised as to what is meant by an enclosed box, including ventilation, etc. The committee points the proponents to the Fire Protection Research Foundation report, Siting Requirements for Hydrogen Supplies Serving Fuel Cells in Non-Combustible Enclosures.
55-125 Log #110 Final Action: Accept

(10.4.2.2)

**Submitter:** Larry L. Fluer, Fluer, Inc. / Rep. Compressed Gas Association

**Recommendation:** Revise text to read as follows:

10.4.2.2 **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.

**Substantiation:** Protection from corrosion from contact with soil or surfaces that accumulate water is the subject of Section 7.1.15. It should be included in 10.4.2.2 as an applicable cross reference as well.

**Committee Meeting Action:** Accept

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55-126 Log #52 Final Action: Accept in Principle

(10.4.2.4.1)

**Submitter:** Robert Wichert, FCHEA, and Chris Radley, Altery

**Recommendation:** Revise text to read as follows:

10.4.2.4.1 Joints in the piping system shall be butt welded and 100 percent inspected using nondestructive testing (NDT) methods in accordance with the requirements of ANSI/ASME B31.12 - 2008 Hydrogen Piping and Pipelines, ANSI/ASME B31.3, Process Piping, or other approved standards.

**Substantiation:** B31.12 - 2008 *Hydrogen Piping and Pipelines* is the best guidance for hydrogen design.

**Committee Meeting Action:** Accept in Principle

Revise the suggested text to read as follows:

10.4.2.4.1 Joints in the piping system shall be butt welded and 100 percent installed and inspected using nondestructive testing (NDT) methods in accordance with the requirements of ASME B31.12 - 2008 Hydrogen Piping and Pipelines, ANSI/ASME B31.3, Process Piping, or other approved standards.

**Committee Statement:** The committee agrees with the proponent, but deleted ANSI from B31.12. The committee deleted B31.3 because it is superseded by B31.12. The committee found no reason to deviate from B31.12, which has been addressed by the other changes to the paragraph.
10.4.4 Detached Buildings.

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

10.4.4.2 Ventilation shall be provided in accordance with the requirements of Section 6.15:

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

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

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

10.4.4.3* Explosion control shall be provided in accordance with the requirements of Section 6.8.

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

10.4.4.5 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 10.4.4.4:

10.4.4.5.1 Hydrogen Gas Rooms:

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

10.4.4.5.1.2 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.

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

10.4.4.5.1.4 Windows and doors shall be in exterior walls only.

10.4.4.5.2 Ventilation shall be provided in accordance with the requirements of Section 6.15.

10.4.4.5.3 Explosion control shall be provided in accordance with the requirements of Section 6.8.

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

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

10.4.4.5.6 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 10.4.4.5:

10.4.5 Hydrogen Gas Rooms.

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

10.4.5.1.1 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.

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

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

10.4.5.1.4 Windows and doors shall be in exterior walls only.

10.4.5.2 Ventilation shall be provided in accordance with Section 6.15.

10.4.5.3 Explosion control shall be provided in accordance with the requirements of Section 6.8.

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

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

10.4.5.6 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 10.4.5.5:

10.4.6 Indoor Hydrogen System Location.

10.4.6.1 Hydrogen bulk systems located indoors shall be in accordance with this chapter's 1 through 7 and 10.

10.4.6.2 Indoor hydrogen bulk supply systems exceeding 15,000 scf shall be located in detached buildings in accordance with Section 6.5.

10.4.6.3 Ventilation shall be provided in accordance with the requirements of Section 6.15.

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

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

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

10.4.6.4 Hydrogen systems of less than 3500 scf (99 m³) and greater than the MAQ, where located inside buildings, shall be located in the building so that the system will be as follows:

1. In a ventilated area in accordance with the provisions of Section 6.15
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 intake of ventilation, air conditioning equipment, and air compressors
   (a) The distance shall be permitted to be reduced to 10 ft (3.1 m) where the room or area is protected by a listed detection system per Article 500.7(f) of NFPA 70, National Electrical Code, 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) Isolation valves used to isolate the fuel supply shall be of a fail-safe design.
   (c) A distance of 50 ft (15 m) from other flammable gas storage
5. Protected against damage in accordance with the provisions of 7.1.6.3.10.4.6.2 Systems Installed in One Room.

10.4.6.2.1 More than one system of 3500 scf (99 m³) 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.

10.4.6.2.2 The separation distance between multiple systems of 3500 scf (99 m³) 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 in accordance with the requirements of Section 6.9:

Substantiation: None given.
Committee Meeting Action: Accept in Principle
Correlating Proposal No. 1 to 55-127 (Log #31)
1. The following revisions are proposed to Section 6.15 (See 55-127 (Log #31) Sections 10.4.4.2.2 and 10.4.4.2.3)

6.15 Ventilation.
Indoor storage and use areas and storage buildings for compressed gases and cryogenic fluids shall be provided with mechanical exhaust ventilation or fixed natural ventilation, where natural ventilation can be shown to be acceptable for the material as stored.

6.15.1 6.15.2 Compressed Air. The requirements of Section 6.15 and 6.15.1 shall not apply to cylinders, containers, and tanks containing compressed air.

6.15.2 Ventilation Systems. In addition to the requirements of 6.15 ventilation systems shall be designed and installed in accordance with the requirements of the mechanical code.

6.15.3 6.15.4 Mechanical Exhaust Ventilation. Where mechanical exhaust ventilation is provided, the system shall be operational during the time the building or space is occupied.

6.15.3.1 6.15.4 Continuous Operation. When operation of ventilation systems is required systems shall operate continuously unless an alternative design is approved by the AHJ.

6.15.2 Compressed Air. The requirements of Section 6.15 and 6.15.1 shall not apply to cylinders, containers, and tanks containing compressed air.

6.15.3.2 6.15.8 Mechanical Ventilation Rate. Mechanical exhaust or fixed natural ventilation shall be provided at a rate of not less than 1 ft³/min/ft² (0.3048 m³/min/m²) of floor area over the area of storage or use.

6.15.4 Continuous Operation. Systems shall operate continuously unless an alternative design is approved by the AHJ.

6.15.3.3 6.15.5 Shutoff Controls. Where powered ventilation is provided, a manual shutoff switch shall be provided outside the room in a position adjacent to the principal access door to the room or in an approved location.

6.15.3.4 6.15.6 Manual Shutoff Switch. The switch shall be the breakglass or equivalent type and shall be labeled as follows:

**WARNING: VENTILATION SYSTEM EMERGENCY SHUTOFF**

6.15.4.7 Inlets to the Exhaust System.

6.15.4.7.1 The exhaust ventilation system design shall take into account the density of the potential gases released.

6.15.4.7.2 For gases that are heavier than air, exhaust shall be taken from a point below the 12 in. (304.8 mm) threshold level.

6.15.4.7.3 For gases that are lighter than air, exhaust shall be taken from a point above the 12 in. (304.8 mm) threshold level.

6.15.4.8 Floor Level Exhaust. The location of both the exhaust and inlet air openings shall be designed to provide air movement across all portions of the floor or ceiling of the room or area to prevent the accumulation of vapors within the ventilated space.

6.15.5 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.

6.15.6 Ventilation Discharge. Ventilation discharge systems shall discharge terminate not less than a minimum of 50 ft (15 m) from intakes of air-handling systems, air-conditioning equipment, and air compressors.

6.15.7 Air Intakes. Storage and use of compressed gases shall be located not less than 50 ft (15 m) from air intakes. For material-specific requirements, see Sections 7.4 through 7.10.

2. Add the following new definition to Chapter 3 (See the change to 6.15 above).

3.3 Fixed Natural Ventilation. The movement of air into and out of a space through permanent openings that are arranged in such a way that the required ventilation cannot be reduced by operating windows, doors louvers or similar devices.

3. Revise Section 8.14.11.3.2.2 as follows:
8.14.11.3.2.2 Ventilation. Indoor areas in which cryogenic fluids are dispensed shall be ventilated in accordance with the requirements of Section 6.15 and the IAPMO Uniform Mechanical Code.

Correlating Proposal No. 2 to 55-127 (Log #31)

Add a new Section 7.6.3.3 as follows (the section would be 7.6.4.3 if correlating proposal #4 below is accepted):

7.6.3.3 Heating. Heating, when 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.

Correlating Proposal No. 3 to 55-127 (Log #31)

Revise Section 6.4 as follows:

6.4 Gas Rooms.
When a gas room is used to increase the threshold quantity for a gas requiring special provisions, gas rooms or where otherwise required by the material or application specific requirements of Chapters 7 through 14 the room shall meet the requirements of 6.4.1 through 6.4.5.

A.3.3.47 Gas Room. Gas rooms must be constructed and utilized in accordance with Section 6.4:

Correlating Proposal No. 4 to 55-127 (Log #31)

Relocate the following provisions from Section 10.4.6 to a new Section 7.6.3 and renumber the existing sections of 7.6, i.e. 7.6.3 through 7.6.5 accordingly.

*Also, see actions on 55-70 (Log #137).

7.6.3 16.4.6 Indoor Non-Bulk Hydrogen Compressed Gas System Location.

7.6.3.1 16.4.6.1 Hydrogen systems of less than 3500 scf (99 m³) and greater than the MAQ, where located inside buildings shall be located in the building so that the system will be as follows: in accordance with the following:

1. In a ventilated area in accordance with the provisions of Section 6.15.
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, National Electrical Code, 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. Isolation valves used to isolate the fuel supply shall be of a fail-safe design. 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.

7.6.3.2 16.4.6.2 Systems Installed in One Room.

7.6.3.2.1 16.4.6.2.1 More than one system of 3500 scf (99 m³) 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.

7.6.3.2.2 16.4.6.2.2 The separation distance between multiple systems of 3500 scf (99 m³) 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 in accordance with the requirements of Section 6.9.

7.6.3.2.3 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 7.6.3.2.1 or 7.6.3.2.2 when such facilities are provided with Protection Level 2 controls and the applicable requirements of...
Committee Statement: The proponent was in attendance at the meeting and clarified that this proposal was intended to amend Chapter 10 to make it apply to only outdoor bulk gaseous hydrogen because requirements for building related controls are covered already under Chapter 6.

Correlating Proposal No. 1 to 55-127 (Log #31)
The deletion of Section 10.4.4.2.2 results in a requirement for ventilation that is not found in Section 6.15. The size of the inlet and outlet openings resultant to the calculated rate of 1 cfm/sf is based on achieving the required rate of ventilation based on the footprint of the space rather than a sizing based on room volume. Natural ventilation is frequently provided by the use of buildings with one open side, or otherwise equipped with a combination of louvers and gravity vents.

The concept of fixed natural ventilation was established in NFPA 51A, Standard for Acetylene Cylinder Charging Plants, which was recently accepted by the IMG TC. The integration of NFPA 51A into NFPA 55 will also bring the need for the definition into NFPA 55. The revisions to Section 6.15 are complementary to the changes anticipated with NFPA 51A. The use of 1 cfm/sf has become the national norm for ventilation systems where hazardous materials are involved.

Correlating Proposal No. 2 to 55-127 (Log #31)
Requirements for heating systems are found in Sections 10.4.4.5, 10.4.5.4 and 10.4.5.6. Before these sections are deleted a fundamental requirement should be placed into Section 7.6 that will address heating systems for all flammable gases. Heating systems are regulated by the model mechanical codes and fuel gas codes. The establishment of a requirement that such systems be listed and labeled is in keeping with the requirements of these companion codes. Establishing a requirement in Section 7.6 will serve to correlate the deletions integral to the proposal in Log #31 and appropriately broadens the requirement to address all flammable gases.

Correlating Proposal No. 3 to 55-127 (Log #31)
Gas rooms are no different than gas cabinets when used for the purpose of increasing the MAQ threshold quantities. The definition of a gas room is found in Section 3.3.47 as follows:

3.3.47* Gas Room. A separately ventilated, fully enclosed room in which only compressed gases, cryogenic fluids, associated equipment, and supplies are stored or used.

The annex note is essentially a requirement when such rooms are used. The requirements to use a gas room are found in various sections of the code in addition to the requirements of Section 6.3. Table 6.3.1.1 uses a gas room on an equivalent basis with that of a gas cabinet, and as such the room is not unlike an appliance which is used as a means of isolation and control. In some cases (Chapter 11) the code uses gas rooms to address application specific circumstances. The revisions to Section 6.4 are made to avoid those circumstances of designating any room with compressed gases as a gas room.

The deletion of Section 10.4.5 for gas rooms raises a question as to what is a “hydrogen gas room” (an undefined term). The construction of interior partitions are established by the model building codes and are dependent in part on the function (occupancy) of the ancillary spaces. There is no reason that a “hydrogen gas room” (if such a room is needed) should be any different from any other gas room containing a flammable or non-flammable gas. With the addition of the changes to Section 6.4 the deletion of Section 10.4.5.1.1 is accommodated.

Correlating Proposal No. 4 to 55-127 (Log #31)
A revised Section 7.6.3 has been proposed in lieu of the proposed deletion of Section 10.4.6.1 in 55-127 (Log #31). Minor modifications have been made in support of the transfer of provisions for the primary purposes of clarification. A new provision has been added to address the unique nature of gas filling facilities. Specific reasons are stated below.

Section 7.6.3
Reason The increase in the threshold for bulk 5000 cubic feet, as proposed in 55-21 (Log #136), results in systems of
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3500 cubic feet or less being classified as “non-bulk” systems.

Section 7.6.3.1

Reason Elimination of redundant language. Editorial.

Section 7.6.3.1(4)

Reason Item 4 The termination point for air intakes to HVAC systems is normally found outdoors. It is possible for air compressor inlets or points of recirculation in HVAC systems can be located indoors. A modification has been proposed to establish the distance to intakes for systems located within the same room or area. If distance alone was used as the criteria separation would be required even when there were no communicating openings between areas.

Section 7.6.3.1(4)(a)

Reason Clarification to show that the room where the detection system is required is the room containing the hydrogen system.

Section 7.6.3.1(4)(b)

Reason Requirements are established for emergency shut off valves in 7.3.1.11. Reference back to the fundamental requirement is appropriate.

Section 7.6.3.2.3

Reason Provisions are needed to address the unique nature of filling facilities where portable systems such as cylinder packs (See 3.3.29) are filled and serviced. Cylinder packs are typically filled on a manifold system where multiple packs may be connected for processing. Although it is redundant to include a reference to the applicable requirements of Chapters 1 through 7 the reference was added to avoid a misinterpretation that no other requirements are applicable.

55-128 Log #111

(10.5.1) Final Action: Accept

Submitter: Larry L. Fluer, Fluer, Inc. / Rep. Compressed Gas Association

Recommendation: Revise text to read as follows:

10.5.1 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.

Substantiation: The IFGC points to ASME B31.3 piping code and does not provide any more specific requirements. A new piping code, ASME B31.12, has now been issued for hydrogen piping and pipelines and provides more specific requirements than ASME B31.3.

Committee Meeting Action: Accept
10.7.1 Unloading connections on delivery equipment shall not be positioned closer to any of the exposures cited in Table 10.3.2.2.1(a) and Table 10.3.2.2.1(b) than the distances given for the storage system. Separation distances may be reduced to those defined in Table 10.3.2.3.1.3 of NFPA 2 if an SAE J2600 nozzle is used on the unloading connection.

Substantiation: If an SAE J2600 nozzle is used to perform the cargo transport unloading, then the process is very similar to that defined in Sections 10.3.2.3, and 10.3.3.3.5 of NFPA 2 and their subparagraphs. The SAE J2600 nozzle provides additional risk reduction and additional assurances that help to mitigate the risk of unloading. In addition, NFPA 58 Table 6.5.3 and Sections 6.5.4.4 and 6.26.5 allow closer setbacks for a heavier-than-air flammable gas.

Committee Meeting Action: Reject
Committee Statement: Cargo transport unloading is not passenger vehicle refueling. Use of SAE J2600 does not appear to be suitable for this application.

55-130 Log #112
(10.7.2)

Submitter: Larry L. Fluer, Fluer, Inc. / Rep. Compressed Gas Association
Recommendation: During transfer of hydrogen from cargo vehicles, the hand or emergency brake of the vehicle shall be set, and chock blocks shall be used to prevent rolling of the vehicle from moving.

Substantiation: The term rolling could be inferred to mean turning over such as might be caused by high winds. The intent is to stop movement of the wheels and landing gear.

Committee Meeting Action: Accept

55-131 Log #113
(10.8.4.4.1)

Submitter: Larry L. Fluer, Fluer, Inc. / Rep. Compressed Gas Association
Recommendation: Each compressor shall be provided with a vent or relief device that will prevent over pressurizing of the

Substantiation: Editorial. Compressors are machines that are used to compress gases which typically results in raising the pressure. Pumps are normally associated with liquid systems. The term compressor should be used for consistency within the section.

Committee Meeting Action: Accept
55-132     Log #114
(10.8.4.5.1 (New) )

Recommendation: Revise text to read as follows:

10.8.4.5 Pressure Monitoring. The pressure on the compressor discharge shall be monitored by a control system.
10.8.4.5.1 Excessive discharge pressures shall cause the compressor to shut down.

Substantiation: Simply monitoring the system is not sufficient. Without shutting the compressor off the system may be continuously venting thereby creating potential vent stack fires. A requirement to shut down the compressor tells the designer what the control system is intended to perform.

Committee Meeting Action: Accept in Principle
Revise the proposed text to read as follows:

10.8.4.5 Pressure Monitoring. The pressure on the compressor discharge shall be monitored by a control system.
10.8.4.5.1 Discharge pressures in excess of the equipment design pressures shall cause the compressor to shut down.

Committee Statement: The committee removed the vague term excessive and added clarity of what qualifies as excessive.
Piping and tubing shall be in accordance with the requirements of ANSI/ASME B31.12, Hydrogen Piping and Pipelines, B31.3, Process Piping.

11.2.3.1 Piping and tubing shall be in accordance with the requirements of ANSI/ASME B31.12, Hydrogen Piping and Pipelines, B31.3, Process Piping.

11.2.3.2 Piping or tubing used at operating temperatures below -20°F (-29°C) shall be fabricated from materials meeting the impact test requirements of Chapter III of ANSI/ASME B31.12, Hydrogen Piping and Pipelines, B31.3, Process Piping, when tested at the minimum operating temperature to which the piping will be exposed when in service.

11.2.3.3 Joints in piping and tubing shall be in accordance with the requirements of ANSI/ASME B31.12, Hydrogen Piping and Pipelines, B31.3, Process Piping.

Substantiation: The new ASME B31.12 contains specific requirements for piping in hydrogen service. The forward to the 2008 Edition of ASME contains, in pertinent part, the following information:

"As a result of preliminary studies [conducted by ASME], it was concluded that gaps exist between existing piping and pipeline codes and standards, and hydrogen infrastructure applications. A Project Team was formed under the B31 Standards Committee to develop a new B31.12 Code for hydrogen piping and pipelines. The Project Team was subsequently restructured under the B31 Standards Committee as a Section Committee.

The first edition of the B31.12 Code applies to design, construction, operation, and maintenance requirements for piping, pipelines, and distribution systems in hydrogen service. Typical applications are power generation, process plants, refining, transportation, distribution, and automotive filling stations. This Code is comprised of Part GR, General Requirements, including common requirements referenced by all other parts; Part IP, Industrial Piping; and Part PL, Pipelines, including distribution systems. These Parts incorporate information specific to hydrogen service and either reference or incorporate applicable parts of ASME B31.3, Process Piping; ASME B31.1, Power Piping; ASME B31.8, Gas Transmission and Distribution Piping Systems; ASME B31.8S, Managing System Integrity of Gas Pipelines; and Section VIII, Division 3 of the ASME Boiler and Pressure Vessel Code, where appropriate.

Material performance factors have been included to account for the adverse effects of hydrogen gas on the mechanical properties of carbon and low alloy steels operating within the hydrogen embrittlement range. Many materials included in B31.3 have been omitted from B31.12's tables due to their unsuitability for hydrogen service."

Committee Meeting Action: Accept
Connections downstream of the shutoff valve shall be in accordance with ANSI/ASME B31.12, Hydrogen Piping and Pipelines B31.3, Process Piping.

Substantiation: The new ASME B31.12 contains specific requirements for piping in hydrogen service. The forward to the 2008 Edition of ASME contains, in pertinent part, the following information:

"As a result of preliminary studies [conducted by ASME], it was concluded that gaps exist between existing piping and pipeline codes and standards, and hydrogen infrastructure applications. A Project Team was formed under the B31 Standards Committee to develop a new B31.12 Code for hydrogen piping and pipelines. The Project Team was subsequently restructured under the B31 Standards Committee as a Section Committee.

The first edition of the B31.12 Code applies to design, construction, operation, and maintenance requirements for piping, pipelines, and distribution systems in hydrogen service. Typical applications are power generation, process plants, refining, transportation, distribution, and automotive filling stations. This Code is comprised of Part GR, General Requirements, including common requirements referenced by all other parts; Part IP, Industrial Piping; and Part PL, Pipelines, including distribution systems. These Parts incorporate information specific to hydrogen service and either reference or incorporate applicable parts of ASME B31.3, Process Piping; ASME B31.1, Power Piping; ASME B31.8, Gas Transmission and Distribution Piping Systems; ASME B31.8S, Managing System Integrity of Gas Pipelines; and Section VIII, Division 3 of the ASME Boiler and Pressure Vessel Code, where appropriate.

Material performance factors have been included to account for the adverse effects of hydrogen gas on the mechanical properties of carbon and low alloy steels operating within the hydrogen embrittlement range. Many materials included in B31.3 have been omitted from B31.12’s tables due to their unsuitability for hydrogen service."

Electrical wiring and equipment shall be in accordance with Table 11.2.6 and

Substantiation: The existing wording raises a question as to what is meant by "storage equipment, excluding the piping system downstream of the source valve". Does this mean "Storage container" or "Bulk system, excluding the piping system downstream of the source valve"? The reference to "excluding the piping system downstream of the source valve" implies that the "bulk system" is the intended point of control. NFPA 497 uses the term "Storage Container" when applying electrical area classifications for liquid Hydrogen. Clarifying language has been added to the table to identify the points of concern.

Committee Meeting Action: Accept
<table>
<thead>
<tr>
<th>Location</th>
<th>Division</th>
<th>Extent of Classified Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Points where connections to the hydrogen system are regularly made and disconnected</td>
<td>1</td>
<td>Within 3 ft (1 m) of the system fill connection, system pressure relief vent outlets or other points of release when the system is operating as designed.</td>
</tr>
<tr>
<td>The bulk liquefied hydrogen system fill connection, pressure relief vent outlets or, other points on the system where hydrogen is vented to the atmosphere under the designed operating conditions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage equipment, excluding the piping system downstream of the source valve</td>
<td>2</td>
<td>Between 3 ft (1 m) and 25 ft (7.6 m) from the system fill connection, system pressure relief vent outlets or other points of release when the system is operating as designed.</td>
</tr>
</tbody>
</table>
Revise text to read as follows:

Pressure on each pump and compressor discharge shall be monitored by the control system.
Excessive discharge pressures shall cause the pump or compressor to shut down.

Substantiation: Simply monitoring the system is not sufficient. Without shutting the pump or compressor off the system may be continuously venting thereby creating potential vent stack fires. A requirement to shut down the pump or compressor tells the designer what the control system is intended to perform.

Committee Meeting Action: Accept in Principle
Revise the proposed text to read as follows:

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

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

Committee Statement: The committee removed the vague term excessive and added clarity of what qualifies as excessive.
Larry L. Fluer, Fluer, Inc.

The types of exposure represented in column 1 of the existing table for LH2 are proposed to be correlated with the exposures listed in Table 10.3.2.2.1 for GH2 systems. A companion proposal has been issued to Table 10.3.2.2.1 separately.

****Insert Table 11.3.2.2 Here****

Revise Section 11.3.2.2.1 as follows:

11.3.2.2.1 The distances in 1, 4, 6, 7, 8, 9,10 and 11 in Table 11.3.2.2 shall be permitted to be reduced by two-thirds, but not to less than 5 ft (1.5 m), for insulated portions of the system.

Substantiation: The separation distances developed between GH2 systems and exposures has been the subject of a multi-year study by a joint task group staffed by members of the NFPA 2 and NFPA 55 Technical Committees. The separation distances for Bulk LH2 systems are currently under study. The charge for the group has been to validate and/or revise the required distances using a documented approach which results in a validated and/or revised distance based on the use of scientific means.

The work for LH2 is ongoing and consideration has been given to the use of quantity as a measure or basis for distance determination. Preliminary modeling has been performed by researchers at Sandia National Laboratories, and a base system has been developed in the form of a Piping and Instrumentation Diagram (P&ID) with typical pipe diameters considered. A survey has been sent to installers and maintainers of systems of this nature to assist in gathering hydrogen specific data. At this juncture in the study further revisions or modification to the quantity approach is premature, however, revisions have been proposed in an effort to align the list of exposures specified and/or to be specified in Table 10.3.2.2.1. There are currently subtle differences in the table for LH2 that cannot be resolved at this juncture including distance to sprinklered buildings or buildings with sprinklered or noncombustible contents.

The revisions proposed serve to align the exposure terminology and there have been no revisions made to any of the separation distances listed. Exposures have now been grouped into three major groups and a companion proposal has been submitted to Table 10.3.2.2.1 to group exposure in a similar manner. An annex note has been prepared for submittal with revisions to Table 10.3.2.2.1 that explains the “grouping” of exposures as follows. The proposed groupings for exposure in Table 11.3.2.2 have been arranged to parallel those found in Table 10.3.2.2.1, however, the inclusion of a similar annex note for Table 11.3.2.2 would be premature given the fact that there have been no revisions made to any of the exposure distances which have yet to be validated and or revised based on thermal flux or other criteria:

A.10.3.2.1 The exposures integral to Tables 10.3.2.1(a) and (b) have been arranged into groups based on similar risks. The following thresholds are applicable to the exposures identified in each group.

Group 1 Exposures. The distances specified are those required to reduce the radiant heat flux level to 500 Btu/hr · ft² (1,577 W/m²) at the property line or the distance to a point in the unignited hydrogen jet where the hydrogen content is reduced to a 4 percent mole fraction (volume fraction) of hydrogen whichever is greater. In all cases the distance required to achieve a 4 percent mole fraction was the greater distance and used to establish the requirements.

Group 2 Exposures. The distances specified are those required to reduce the radiant heat flux level to 1,500 Btu/hr · ft² (4,732 W/m²) for persons exposed a maximum of 3 minutes.

Group 3 Exposures. The distances specified are those required to reduce the radiant heat flux level to 6,340 Btu/hr · ft² (20,000 W/m²), or the visible flame length for combustible materials, or a radiant heat flux level of 8,000 Btu/hr · ft² (25,237 W/m²) or the visible flame length for non-combustible equipment. In both cases the visible flame length was used to establish the requirements.

Committee Meeting Action: Accept in Principle

Revise Section 11.3.2.2.1 as follows:

11.3.2.2.1 The distances in 1, 4, 6, 7, 9,10 and 11 in Table 11.3.2.2 shall be permitted to be reduced by two-thirds, but not to less than 5 ft (1.5 m), for insulated portions of the system.
<table>
<thead>
<tr>
<th>Type of Exposure</th>
<th>Total Liquefied Hydrogen Storage</th>
<th>ft</th>
<th>m</th>
<th>ft</th>
<th>m</th>
<th>ft</th>
<th>m</th>
<th>ft</th>
<th>m</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. 11. Public ways, railroads, and property Lot lines</td>
<td>39.7 gal to 3500 gal</td>
<td>25</td>
<td>7.6</td>
<td>50</td>
<td>15</td>
<td>75</td>
<td>23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. 3. Air compressor intakes or inlets for heating air-conditioning or ventilating or air conditioning equipment (HVAC), compressors, other</td>
<td>150 L to 13,250 L</td>
<td>75</td>
<td>23</td>
<td>75</td>
<td>23</td>
<td>75</td>
<td>23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. 2. Wall openings</td>
<td>3501 gal to 15,000 gal</td>
<td>75</td>
<td>23</td>
<td>75</td>
<td>23</td>
<td>75</td>
<td>23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Operable openings in buildings and structures</td>
<td>13,251 L to 56,781 L</td>
<td>75</td>
<td>23</td>
<td>75</td>
<td>23</td>
<td>75</td>
<td>23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. 2. Ignition sources such as open flames and welding</td>
<td>15,001 gal to 75,000 gal</td>
<td>75</td>
<td>23</td>
<td>75</td>
<td>23</td>
<td>75</td>
<td>23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. 40. Places of public assembly</td>
<td>56,782 L to 283,906 L</td>
<td>75</td>
<td>23</td>
<td>75</td>
<td>23</td>
<td>75</td>
<td>23</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Group 2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>6. 4. Building or structure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Walls adjacent to system</td>
<td>Buildings constructed of noncombustible or limited-combustible materials</td>
<td>75</td>
<td>23</td>
<td>75</td>
<td>23</td>
<td>75</td>
<td>23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) Sprinklered building or structure or unsprinklered building or structure having noncombustible contents</td>
<td>50</td>
<td>15</td>
<td>50</td>
<td>15</td>
<td>50</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2) Unsprinklered building or structure with combustible contents</td>
<td>50</td>
<td>15</td>
<td>15</td>
<td>5</td>
<td>5</td>
<td>1.5</td>
<td>100</td>
<td>30.5</td>
<td></td>
</tr>
<tr>
<td>(i) Adjacent wall(s) with fire resistance rating less than 3 hours</td>
<td>50</td>
<td>15</td>
<td>50</td>
<td>15</td>
<td>50</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(ii) Adjacent wall(s) with fire resistance rating of 3 hours or greater</td>
<td>50</td>
<td>15</td>
<td>15</td>
<td>5</td>
<td>5</td>
<td>1.5</td>
<td>100</td>
<td>30.5</td>
<td></td>
</tr>
<tr>
<td>7. 6. Flammable gas storage or systems (other than hydrogen) above or below ground</td>
<td>75</td>
<td>23</td>
<td>75</td>
<td>23</td>
<td>75</td>
<td>23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. 5. Between stationary liquefied hydrogen containers</td>
<td>50</td>
<td>15</td>
<td>75</td>
<td>23</td>
<td>75</td>
<td>23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. 4. All classes of flammable and combustible liquids (above ground and vent or fill openings if below ground)</td>
<td>50</td>
<td>15</td>
<td>15</td>
<td>5</td>
<td>5</td>
<td>1.5</td>
<td>100</td>
<td>30.5</td>
<td></td>
</tr>
<tr>
<td><strong>Group 3</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. 5. Hazardous materials storage or systems including liquid oxygen storage and other oxidizers, above or below ground</td>
<td>75</td>
<td>23</td>
<td>75</td>
<td>23</td>
<td>75</td>
<td>23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. 8. Heavy timber, coal or other slow-burning combustible solids</td>
<td>50</td>
<td>15</td>
<td>15</td>
<td>5</td>
<td>5</td>
<td>1.5</td>
<td>100</td>
<td>30.5</td>
<td></td>
</tr>
<tr>
<td><strong>(b) Inoperable Unopenable openings in buildings and structures</strong></td>
<td>12. 3. Wall openings</td>
<td>25</td>
<td>7.6</td>
<td>50</td>
<td>15</td>
<td>50</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.12. Inlet to underground sewers</td>
<td>5</td>
<td>1.5</td>
<td>5</td>
<td>1.5</td>
<td>5</td>
<td>1.5</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>-----------------------------------</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.13. Encroachment by Utilities overhead including electric power, line, building services or hazardous materials piping systems</td>
<td>50</td>
<td>15</td>
<td>50</td>
<td>15</td>
<td>50</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Horizontal distance from the vertical plane below the nearest overhead wire of an electric trolley, train, or bus line</td>
<td>25</td>
<td>7.5</td>
<td>25</td>
<td>7.5</td>
<td>25</td>
<td>7.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) Horizontal distance from the vertical plane below the nearest overhead electrical wire</td>
<td>15</td>
<td>4.6</td>
<td>15</td>
<td>4.6</td>
<td>15</td>
<td>4.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(c) Piping containing other hazardous materials</td>
<td>50</td>
<td>15</td>
<td>50</td>
<td>15</td>
<td>50</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a Portions of wall less than 10 ft (3.1 m) (measured horizontally) from any part of a system shall have a fire resistance rating of not less than 1 hour.
b Exclusive of windows and doors.
c The separation distances for Class IIIB combustible liquids shall be permitted to be reduced to 15 ft (4.6 m).
Committee Statement: The committee agrees with the proposed changes, but revised the exposure references to match.

Recommendation: Revise text to read as follows:

Table 11.3.2.2
11.* Lot Lines
A. Table 11.3.2.2 (11). The public way includes streets, alleys, sidewalks or similar rights of way that allow for free access by the public. Railroads are typically placed on easements which allow for access by the public or travel where members of the public are transported by the rail system. Lot lines (property lines) are those property lines between parcels and should not be construed to be the imaginary property lines that are drawn for the purposes of protecting the exterior walls of multiple buildings placed on the same lot or parcel. Railroad easements that are not accessible to the public other than by rail travel can be used as a means of spatial separation with the required separation being measured between the hydrogen system and the nearest railroad track. It should be noted that in these cases, the addition or relocation of track may result in an encroachment which will necessitate relocation of the hydrogen system at the owner’s expense.

Substantiation: This table entry needs further clarification so that it applies to possible public exposures. The right of way associated with a railroad are considered private property owned by the railroad, and in many cases would not typically present a public exposure. In instances where there is no construction indicated other than the rails themselves it is reasonable to measure the separation distance as that distance between the installed system and the nearest railroad track. In some instances natural boundaries on adjacent properties may be considered property lines if no future buildings or structures can be built against them. In such cases an easement should be provided by the adjacent property owner and recorded in favor of the permittee or user of the hydrogen system. Such easements are subject to the approval of the AHJ.

Committee Meeting Action: Accept in Principle
Revise the proposed text to read as follows:

Table 11.3.2.2
1.* Lot Lines
A. Table 11.3.2.2 (1). Lot lines (property lines) are those property lines between parcels and should not be construed to be the imaginary property lines that are drawn for the purposes of protecting the exterior walls of multiple buildings placed on the same lot or parcel. Railroad easements that are not accessible to the public other than by rail travel can be used as a means of spatial separation with the required separation being measured between the hydrogen system and the nearest railroad track. It should be noted that in these cases, the addition or relocation of track may result in an encroachment which will necessitate relocation of the hydrogen system at the owner’s expense.

Committee Statement: Changes were made to the proposal to coordinate with the actions taken on 55-137 (Log #140). The explanatory note could be expanded further in the comment phase to include the use of natural barriers, such as rivers.
<table>
<thead>
<tr>
<th>Log #</th>
<th>Final Action: Accept in Principle</th>
</tr>
</thead>
<tbody>
<tr>
<td>55-139</td>
<td>Log #118</td>
</tr>
<tr>
<td>(11.3.2.2.2)</td>
<td></td>
</tr>
</tbody>
</table>

**Submitter:** Larry L. Fluer, Fluer, Inc. / Rep. Compressed Gas Association

**Recommendation:** Revise text to read as follows:

11.3.2.2.2* For uninsulated portions of the system, the distances in 1, 4, 6, 7, 8, and 11 in Table 11.3.2.2 shall be permitted to be reduced by the use of fire barrier walls having a fire resistance rating of not less than 2 hours when constructed in accordance with 8.7.2.1 and 11.3.2.2.3.

**Substantiation:** NFPA 50B had a single paragraph listing which exposure distances could be reduced by using a firewall or the insulated portion of the system. That paragraph made it clear that using either a firewall or the insulated part of the system reduced only certain exposures. When the paragraph was rewritten in separate bullet items, section 11.3.2.2.2 seemed to indicate that all distances could be reduced, but the intent of NFPA 50B was to reduce only certain distances. The wording was also rewritten to clarify that firewalls can reduce the distances to insulated or uninsulated portions of the system. Below is the text from NFPA 50B, 1999 (last) edition:

3-2.2* The minimum distance in feet from liquefied hydrogen systems of indicated storage capacity located either outdoors, in a separate building, or in a special room to any specified exposure shall be in accordance with Table 3-2.2.  

*Exception: The distances in numbers 1, 4, 6, 7, 8, and 11 in Table 3-2.2 shall be permitted to be reduced by two-thirds, but not to less than 5 ft (1.5 m), for insulated portions of the systems. For uninsulated portions of the system, the distances shall be permitted to be reduced by the use of protective structures having a minimum fire resistance rating of 2 hours. The protective structure or the insulated liquefied hydrogen tank shall interrupt the line of sight between uninsulated portions of the liquefied hydrogen storage system and the exposure.  

**Committee Meeting Action:** Accept in Principle

Revise the proposed text to read as follows:

11.3.2.2.2* For uninsulated portions of the system, the distances in 1, 6, 7, 9, 10, and 11 in Table 11.3.2.2 shall be permitted to be reduced by the use of fire barrier walls having a fire resistance rating of not less than 2 hours when constructed in accordance with 8.7.2.1 and 11.3.2.2.3.

**Committee Statement:** The committee agrees with the proposal, but revised the listed exposures to correlate with the action taken on 55-137 (Log #140).
55-140     Log #119
(11.3.2.3)

Submitter: Larry L. Fluer, Fluer, Inc. / Rep. Compressed Gas Association
Recommendation: Revise text to read as follows:

11.3.2.3 Unloading connections and pressure relief vents on delivery equipment shall not be positioned closer to any of the exposures cited in Table 11.3.2.2 than the distances given for the storage system.

Substantiation: The delivery of LH2 from trailers/tankers can be by pumping or pressure transfer. In some cases hydrogen is released from relief vents on the delivery equipment. The exposures in Table 11.3.2.2 are fixed relative to the tank. On the other hand the points of release from delivery equipment is variable based on the fact that the delivery equipment utilizes flexible hose and the equipment is moveable. The design of delivery areas must give consideration to the position of delivery vehicles relative to exposures and the space allocated for delivery should be determined accordingly. A key element in consideration of the designated delivery space is the position of vents on the delivery equipment relative to exposures. The design of delivery areas should be designed such that points of transfer as well as points where vapor could be released from the delivery vehicle during delivery are positioned in a manner that provides separation between the points of potential release and exposures identified in the table.

Committee Meeting Action: Reject
Committee Statement: The committee believes that this proposal could result in an unenforceable provision as it is worded. For lack of an appropriate fix, the committee urges the proponent to consider the need further during the comment stage.

55-141     Log #120
(11.3.3)

Submitter: Larry L. Fluer, Fluer, Inc. / Rep. Compressed Gas Association
Recommendation: Revise text to read as follows:

11.3.3 Installation of LH2 Inside Buildings Other Than Detached Buildings and Gas Rooms.
Portable LH2 containers 39.7 gallons (150 liters) or less capacity of 50 gal (189 L) or less capacity located as allowed in Table 11.3.2.1 and in compliance with 11.3.1 where housed inside buildings, not located in a gas room, and exposed to other occupancies shall comply with the following minimum requirements:

Substantiation: By using 50 gallons or less as a threshold to trigger provisions in 55:11.3.3 the document creates an inconsistency. Containers with a volume of 39.7 gallons (150 L) or greater are considered to be bulk within the context of 55: Chapter 11. By using a term 50 gallons or less a condition of non-bulk is created. A correlating change was submitted and accepted into NFPA 2 to address the inconsistency.

Committee Meeting Action: Accept
User storage sites shall be fenced or otherwise secured and posted to prevent entry by unauthorized personnel.

The basis of this requirement is to prevent unauthorized personnel or those unfamiliar with gas storage systems from tampering with the equipment. Where the LH2 is located in an area open to the general public, a common practice is to fence and lock the storage or use area, with access restricted to supplier and user personnel. When the storage or use is located within the user’s secure area and is not accessible by the general public, it is not always necessary to fence or otherwise secure individual gas storage or use areas. Personnel access patterns may still mandate that the system be fenced, as determined by the supplier and the user.

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.

Substantiation: As explained by the annex note, the primary purpose of security is to prevent tampering and unauthorized access by the general public. Many facilities are either fully fenced or otherwise provided with access control, such as walls whereby only the users of these materials are permitted access. The intent of the code was not to require that any storage or use be under lock and key or that the security provided be such that storage or use by facility employees was hampered by security controls. It is reasonable to expect that facilities that are not accessible by the general public have administrative procedures in place that directs the proper storage and use areas as well as specifying how these materials will be allowed to be employed. New Section 11.4.1.4.1 does not mandate the use of administrative controls, but allows administrative controls to be used as a means to limit access. In areas not accessible by the general public the user has a choice as to whether to provide physical barriers as a means of protection or to otherwise restrict access through the use of policies and procedures. This flexibility is required by the code to address practical application of these requirements.

Committee Meeting Action: Accept

**Substantiation:** The new ASME B31.12 contains specific requirements for piping in hydrogen service. The forward to the 2008 Edition of ASME contains, in pertinent part, the following information:

“As a result of preliminary studies [conducted by ASME], it was concluded that gaps exist between existing piping and pipeline codes and standards, and hydrogen infrastructure applications. A Project Team was formed under the B31 Standards Committee to develop a new B31.12 Code for hydrogen piping and pipelines. The Project Team was subsequently restructured under the B31 Standards Committee as a Section Committee.

The first edition of the B31.12 Code applies to design, construction, operation, and maintenance requirements for piping, pipelines, and distribution systems in hydrogen service. Typical applications are power generation, process plants, refining, transportation, distribution, and automotive filling stations. This Code is comprised of Part GR, General Requirements, including common requirements referenced by all other parts; Part IP, Industrial Piping; and Part PL, Pipelines, including distribution systems. These Parts incorporate information specific to hydrogen service and either reference or incorporate applicable parts of ASME B31.3, Process Piping; ASME B31.1, Power Piping; ASME B31.8, Gas Transmission and Distribution Piping Systems; ASME B31.8S, Managing System Integrity of Gas Pipelines; and Section VIII, Division 3 of the ASME Boiler and Pressure Vessel Code, where appropriate.

Material performance factors have been included to account for the adverse effects of hydrogen gas on the mechanical properties of carbon and low alloy steels operating within the hydrogen embrittlement range. Many materials included in B31.3 have been omitted from B31.12’s tables due to their unsuitability for hydrogen service.”

**Committee Meeting Action:** Accept
Pressurized portions of process exhaust system piping shall be in accordance with ANSI/ASME B31.12, Hydrogen Piping and Pipelines, and B31.3, Process Piping.

Substantiation: The new ASME B31.12 contains specific requirements for piping in hydrogen service. The forward to the 2008 Edition of ASME contains, in pertinent part, the following information:

“As a result of preliminary studies conducted by ASME, it was concluded that gaps exist between existing piping and pipeline codes and standards, and hydrogen infrastructure applications. A Project Team was formed under the B31 Standards Committee to develop a new B31.12 Code for hydrogen piping and pipelines. The Project Team was subsequently restructured under the B31 Standards Committee as a Section Committee.

The first edition of the B31.12 Code applies to design, construction, operation, and maintenance requirements for piping, pipelines, and distribution systems in hydrogen service. Typical applications are power generation, process plants, refining, transportation, distribution, and automotive filling stations. This Code is comprised of Part GR, General Requirements, including common requirements referenced by all other parts; Part IP, Industrial Piping; and Part PL, Pipelines, including distribution systems. These Parts incorporate information specific to hydrogen service and either reference or incorporate applicable parts of ASME B31.3, Process Piping; ASME B31.1, Power Piping; ASME B31.8, Gas Transmission and Distribution Piping Systems; ASME B31.8S, Managing System Integrity of Gas Pipelines; and Section VIII, Division 3 of the ASME Boiler and Pressure Vessel Code, where appropriate.

Material performance factors have been included to account for the adverse effects of hydrogen gas on the mechanical properties of carbon and low alloy steels operating within the hydrogen embrittlement range. Many materials included in B31.3 have been omitted from B31.12’s tables due to their unsuitability for hydrogen service."

Committee Meeting Action: Accept

Substantiation: “Special” and “special room” are not defined terms and need not be defined. Sterilization building is defined. There are no defined special sterilization buildings or rooms, but rather, rooms within defined sterilization buildings. Only certain of these rooms require ignition control, and will be subject to the provisions of 14.7.1.1.

Committee Meeting Action: Accept
Technical Committee on Industrial and Medical Gases,
Delete 14.5.5 as follows:

Ethylene oxide shall not be piped outside the confines of the process area.

1. "Process Area" not defined.
2. Constrictive scope and not practical as there are multiple safe arrangements used in industry for introducing EO gas into the chamber:
   a. EO drum/vaporizer adjacent to chamber in sterilizer room; that is; Liquid to gas conversion local to chamber. This is the arrangement believed to be implied in section 14.5.5.
   b. EO drum/vaporizer adjacent to each other, but remote from chamber; that is; Liquid to gas conversion remote; gas transferred to chamber in sterilizer room.
   c. EO drum remote from chamber, vaporizer adjacent to chamber in sterilizer room; that is; Liquid transferred to sterilizer room, then conversion to gas local to chamber.
3. Section 14.4 - “Piping Systems”, provides requirements for piping systems, materials, valves, fittings, joining methods, etc. for proper control of ethylene oxide flow, thus safely allowing for application of any of the above configurations/arrangements.

Committee Meeting Action: Reject
Committee Statement: The committee recognizes there is a concern with the location for EO piping systems. There are other uses for the term "process area" in NFPA 55 without definition. Exclusion from non-production areas is the main concern.

Technical Committee on Industrial and Medical Gases,
Remove appendix statement to 14.11.2.5 and delete par 14.11.2.5.1

14.11.2.5 (asterisk) Explosion control shall be provided in accordance with Section 6.8.
14.11.2.5.1 When explosion venting is provided, interior walls and other walls of the sterilization room not designed as explosion venting shall be designed to withstand an overpressure of at least 100 psf (690 kPa).

A.14.11.2.5 For information on venting of deflagrations, see NFPA 68, Standard on Explosion Protection by Deflagration Venting.

Substantiation: 1. The appendix statement is redundant since Section 6.8 now refers specifically to NFPA 68 (see Log #75).
2. The deleted sub paragraph 14.11.2.5.1 is not needed and is inconsistent with NFPA 68. NFPA 55 Section 14.11.2.5.1 states that "When explosion venting is provided, interior walls and other walls of the sterilization room not designed as explosion venting shall be designed to withstand an overpressure of at least 100 psf." NFPA 68, section 7.2 defines the method of sizing the vent area for low strength enclosures, but is limited to materials with a fundamental burning velocity less than 60 cm/sec. Since the fundamental burning velocity of ETO is 108 cm/sec it seems a high strength enclosure (>216 psf) is required.

Committee Meeting Action: Reject
Committee Statement: The committee recognizes that there are still areas of concern regarding this material and encourage work for the comment phase.
Technical Committee on Industrial and Medical Gases,

Recommendation: Revise 14.11.2.5 as follows:

14.11.2.5.1 When explosion venting is provided, interior walls and other walls of the sterilization room not designed as explosion venting shall be designed to withstand an overpressure of at least 100 psi (690 kPa), 100 psf (4.8 kPa).

Substantiation: The identified pressure value was incorrectly incorporated (transferred) into NFPA 55, Chapter 14, from NFPA 560 (2007 Edition). The appropriate and preexisting overpressure requirement should be 100 pounds per square foot and not 100 pounds per square inch.

Committee Meeting Action: Accept

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Technical Committee on Industrial and Medical Gases,

Recommendation: Add a new chapter 15 as follows:

****Insert-Include-CP13-Here****

Substantiation: The committee is creating chapter 15 to pull NFPA 51A into NFPA 55 for eventual withdrawal of NFPA 51A. The committee is acting on the task group’s recommendations.

Committee Meeting Action: Accept
Add to Chapter 3 and renumber as appropriate:

3.3.* Acetylene.

3.3. High Pressure Acetylene. Acetylene at pressures exceeding a gauge pressure of 15 psi (103 kPa), but not exceeding a gauge pressure of 400 psi (2760 kPa).

3.3.1.2 Low Pressure Acetylene. Acetylene at a pressure not exceeding a gauge pressure of 1 psi (6.9 kPa).

3.3. Medium Pressure Acetylene. Acetylene at gauge pressures exceeding 1 psi (6.9 kPa) but not exceeding 15 psi (103 kPa). [51, 2007]

3.3. Acetylene Operations. Operations that include acetylene generation, storage, purification, compression, cylinder filling, cylinder storage, and calcium carbide storage.

3.3. Acetylene Plant. A facility engaged in the generation and compression of acetylene and in the filling of acetylene cylinders either as its sole operation or in conjunction with facilities for filling other compressed gas cylinders.

3.3.* Control Area. A building or portion of a building within which hazardous materials are allowed to be stored, dispensed, used, or handled in quantities not exceeding the maximum allowable quantities (MAQ). [5000, 2009]

3.3. Fixed Natural Ventilation. The movement of air into and out of a space through permanent openings that are arranged in such a way that the required ventilation cannot be reduced by operating windows, doors louvers or similar devices.

3.3. Material.

3.3.* Limited-Combustible (Material). Refers to a building construction material not complying with the definition of noncombustible material (see 3.3.391.11 of NFPA 5000) that, in the form in which it is used, has a potential heat value not exceeding 3500 Btu/lb (8141 kJ/kg), where tested in accordance with NFPA 259, Standard Test Method for Potential Heat of Building Materials, and includes either of the following: (1) materials having a structural base of noncombustible material, with a surfacing not exceeding a thickness of 1/8 in. (3.2 mm) that has a flame spread index not greater than 50; and (2) materials, in the form and thickness used, having neither a flame spread index greater than 25 nor evidence of continued progressive combustion, and of such composition that surfaces that would be exposed by cutting through the material on any plane would have neither a flame spread index greater than 25 nor evidence of continued progressive combustion when tested in accordance with ASTM E 84, Standard Test Method of Surface Burning Characteristics of Building Materials; or UL 723, Standard for Test of Surface Burning Characteristics of Building Materials. [5000, 2009]

3.3. Noncombustible Material. 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. Materials that are reported as passing ASTM E 136, Standard Method of Test for Behavior of Materials in a Vertical Tube Furnace at 750°C, are considered noncombustible materials. [5000, 2009]

3.3.* Mobile Acetylene Trailer System. A maniflowed group of cylinders held together as a unit on a transport vehicle for the purpose of containing and transporting large quantities of acetylene. [51, 2007]

3.3.* Secondary Containment. That level of containment that is external to and separate from primary containment. [400, 2010]
3.3. Unpierced Wall. A wall that is allowed to have pipes or conduits passing through it, or unopenable windows, glazed with safety glass or wired glass, set in it, but such openings are sealed to prevent the flow of air between adjacent rooms.

New Chapter 15:

15.1 General. This standard chapter shall apply to plants that are engaged in the generation and compression of acetylene and in the charging of acetylene cylinders, either as their sole operation or in conjunction with facilities for charging other compressed gas cylinders.

15.1.1 This standard chapter shall not apply to plants that only produce and compress acetylene for chemical operations or to plants that only produce and compress acetylene below a gauge pressure of 15 psi (103 kPa).

15.2 Location. Portions of plants housing acetylene generation and charging and acetylene cylinder storage operations where Protection Level controls are supplied shall be located in accordance with the requirements of the building code.

15.2.1 Cylinder Storage.

15.2.1.1 Charged cylinders shall be stored outside the charging room or out of doors in accordance with the requirements of chapter 7 of this Code, NFPA 55, Compressed Gases and Cryogenic Fluids Code.

15.2.1.2 Acetylene cylinders located in the charging room awaiting transportation shall be located not less than 15 ft (4.6 m) from the acetylene charging manifolds.

15.2.2 MATS Filling Stations. The mobile acetylene trailer, including fill connections, shall be located a minimum distance of:

(1) 25 ft (7.6 m) from property lines.
(2) 50 feet (15.2 m) from buildings of combustible construction.
(3) 15 ft (4.6 m) from buildings of noncombustible construction not associated with the filling or discharging of the mobile acetylene trailer.
(4) 15 ft (7.6 m) horizontal distance from the vertical plane below the nearest overhead electrical utility power lines.
(5) 15 ft (4.6 m) horizontal distance from the vertical plane below overhead piping containing flammable liquids, flammable gases or oxidizing materials.
(6) 50 ft (15.2 m) from air intakes.

15.2.2.1 The minimum required distances, except for air intake openings, shall not apply when fire barriers without openings or penetrations having a minimum fire resistance rating of 2 hours interrupt the line of sight between the discharge and the exposure.

15.3 Building-Related Controls

15.3.1 Buildings where acetylene operations are conducted shall be constructed of non-combustible or limited-combustible materials.

15.3.2* Single-Story Buildings. Acetylene cylinder charging plants shall be limited to single-story buildings without basements or crawl spaces.

15.3.3* Buildings or rooms housing acetylene operations, excluding calcium carbide storage rooms, shall be provided with explosion control in accordance with 6.8 of this Code, NFPA 55,
Compressed Gases and Cryogenic Fluids Code.

15.3.4 Exits shall be provided for areas with Protection Level controls in accordance with the building code.

15.3.5 Location of Acetylene Operations within Multiple-Occupancy Buildings.
15.3.5.1 Portions of plants housing multiple occupancies that include acetylene operations shall be permitted to be used for charging of other gases provided that oxidizing gas operations are located at least 20 ft (6 m) from flammable gas operations.
15.3.5.2 The 20 ft (6 m) separation distance shall not be required to be met if charging of oxidizing gas cylinders or storage of such filled cylinders is separated from charging or storage of flammable gas cylinders by a masonry wall at least 5 ft (1.5 m) high having a fire resistance rating of at least 1 hour.

15.3.5.3 When mixed-occupancy buildings are to be separated by the use of occupancy separations, fire-resistive separations shall be provided in accordance with the building code.

15.3.6 Ventilation. Rooms housing acetylene operations shall be provided with mechanical exhaust or fixed natural ventilation that ventilates the space at a rate of not less than 1 ft³/min/ft² (.03 m³/min/.09 m²) of floor area over the area of storage or use.

15.3.6.1 Rooms or areas where gases other than acetylene are stored or used shall be ventilated in accordance with 6.15 of this Code. NFPA 55, Compressed Gases and Cryogenic Fluids Code.

15.3.6.2 Calcium carbide storage rooms shall be ventilated in accordance with the Building Code 5.2.7.

15.3.6.3 Continuous Operation. When mechanical exhaust systems are provided, the systems shall operate continuously unless an alternate design is approved by the authority having jurisdiction.

15.3.6.3.1 Reduction in Ventilation. Mechanical exhaust ventilation shall be permitted to be reduced below 1 ft³/min · ft² (0.03 m³/min · 0.09 m²), provided that full ventilation is automatically restored when the acetylene concentration exceeds 25 percent of the lower flammable limit (LFL) when measured by a gas detection system in accordance with 15.3.10 Section 4.5.

15.3.6.4 Shutoff Controls. Where powered exhaust ventilation is provided, a manual shutoff switch shall be provided outside of the room in a position adjacent to the principal access door to the room or in an approved location.

15.3.6.4.1 The switch shall be of the break-glass or equivalent type and shall be labeled as follows:

WARNING: VENTILATION SYSTEM EMERGENCY SHUTOFF

15.3.6.5 Inlets to the Exhaust System. Inlets to exhaust systems serving rooms used for acetylene operations shall be located within 12 in. (304.8 mm) of the highest point in the room.

15.3.6.6 Recirculation of Exhaust. Exhaust ventilation shall not be recirculated within the room or building.

15.3.6.7 Ventilation Discharge. The point of termination for the exhaust ventilation system discharge shall be a minimum of 50 ft (15 m) from air intakes to building ventilation systems.
15.3.7 Heating.
15.3.7.1 Heating equipment in operating areas shall be of either the steam or hot water type.
15.3.7.2* Electric heaters listed for installation in hazardous locations shall be allowed to be used in operating areas regulated by 15.3.8.2 4.7.2 when installed and used in accordance with the manufacturer’s instructions and the listing.
15.3.7.3 Boilers, water heaters, and other heating equipment containing one or more of the following potential hazards shall be located in a separate building or room not directly communicating with areas devoted to acetylene operations.
   (1) Open flames
   (2) Release of sparks or spark generation during operation
   (3) Exposed surface temperatures exceeding the lowest autoignition temperature of any of the materials present

15.3.7.4 Buildings or rooms used for acetylene operations, excluding calcium carbide storage rooms and cylinder storage areas, shall be maintained at a temperature above 40°F (4.4°C) during time of operation.

15.3.8 Electrical Equipment.
15.3.8.1 Rooms containing electrical equipment and wiring not conforming with 4.7.2 shall be separated from acetylene operations by an unpierced wall.
15.3.8.2 Electrical equipment and wiring in rooms housing acetylene operations, except rooms used exclusively for calcium carbide storage, shall conform to NFPA 70, National Electrical Code, Article 501, for Class I, Division 2 locations.
15.3.8.3 An emergency electrical shutoff switch shall be provided to shut off acetylene compressors and generators.
   15.3.8.3.1 A shutoff switch shall be located at each exterior exit door, horizontal exit door, and door to exit enclosures from the fill plant.
   15.3.8.3.2 Each exit door provided with a shutoff switch shall be marked with a sign indicating the location of the shutoff switch.
   15.3.8.3.3 When the shutoff switch is located on the outside of the door, the inside of the door shall be marked with a sign to indicate that the switch is located outside the room served.
   15.3.8.3.4 The signage shall indicate the following:
   **WARNING:** Generator and Compressor (other equipment as necessary) Emergency Shutoff Switch (indicate whether switch is located inside room or outside room at exit)

15.3.9 Fire Protection
15.3.9.1 MATS* Mobile Acetylene Trailer Systems (MATS). At mobile acetylene charging plants a fire sprinkler system in accordance with NFPA 13, extra hazard group 1 shall be installed in the areas occupied by trailers in charging or discharging stations.
   15.3.9.1.1 Where the public water is not sufficient to meet the requirements for water flow or capacity, the supply shall be subject to approval by the AHJ.
   15.3.9.1.2 At least one portable fire extinguisher rated in accordance with NFPA 10, Standard
for Portable Fire Extinguishers, at not less than 20 B:C shall be mounted on each trailer.

15.3.9.1.3 Mobile Acetylene Trailer Systems fire protection requirements apply to charging or discharging stations located indoors or outdoors.

15.3.9.2 Other Fire Protection.

15.3.9.2.1 Fire Protection Equipment. Fire protection equipment shall not be blocked or obstructed.

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15.3.9.2.5 Fire Protection Equipment. Fire protection equipment shall not be blocked or obstructed.

15.3.9.2.6 Fire Protection Equipment. Fire protection equipment shall not be blocked or obstructed.

15.3.10* Gas Detection System.

Rooms in which acetylene operations are conducted shall be provided with a listed or approved flammable gas detection system.

15.3.10.1 Gas Detection System. Gas detection systems shall not be required for structures equipped with fixed natural ventilation and constructed as weather protection in accordance with the requirements of 6.5.2 of this Code. NFPA 55, Compressed Gases and Cryogenic Fluids Code.

15.3.10.2 System Design.

15.3.10.2.1 System Design. The flammable gas detection system shall be listed or approved for use with acetylene and any other flammable gases used in the room.

15.3.10.3 Operation. The gas detection system shall be designed to activate when the level of flammable gas exceeds 25 percent of the LFL for the gas or mixtures present at the anticipated normal temperature and pressure (NTP).
15. 3.10.3.1 Activation of Gas Detection System. Activation of the gas detection system shall result in the following:

1. Initiation of distinct audible and visual alarm signals both inside and outside of the operations room
2. Activation of the mechanical ventilation system when reduced mechanical ventilation is provided to increase the ventilation to a rate not less than $1 \text{ ft}^3/\text{min} \cdot \text{ft}^2$ ($0.03 \text{ m}^3/\text{min} \cdot 0.09 \text{ m}^2$)
3. Shutdown of the gas generation system when the concentration of flammable gas equals or exceeds 50 percent of the LFL

15.3.10.3.2 Failure of Gas Detection System. Failure of the gas detection system shall result in activation of the mechanical ventilation system, cessation of acetylene generation, and the sounding of a trouble signal in an approved location.

15.4 Design, Installation and Testing

15.4.1 Equipment

15.4.1.1* Acetylene Generator Design. Acetylene generators shall be designed by competent, experienced persons knowledgeable of the chemical and physical properties of acetylene and calcium carbide and the fundamentals of pressure-vessel design.

15.4.1.2 Installation.

15.4.1.2.1 Acetylene generators shall be installed within a room or building not exceeding one story in height.

15.4.1.2.2 The installation of acetylene generators in two-story buildings or rooms with mezzanines shall be permitted provided that the second story or mezzanine is used only for charging the generators with calcium carbide.

15.4.1.2.3 Outdoor installations shall be permitted where generators are protected from rain, freezing, and groundwater.

15.4.1.2.4 The foundation under a generator shall be constructed so that the generator will be level and piping shall be supported and arranged so that excessive strain is not placed on the generator or the piping connections.

15.4.1.2.5 When water is supplied to the generator through a piped connection, means shall be provided to prevent overfilling of the generator.

15.4.1.2.6 Generators served by a connected water supply system shall be equipped with a means to prevent the backflow of acetylene from the generator into the water supply.

15.4.1.2.7 Piping used to transport calcium carbide residue from acetylene generators shall be equipped with a means to prevent backflow of residue into the generators during periods when the generators are not in operation.

15.4.1.3 Venting of Generator.

15.4.1.3.1 Operating Pressure. The maximum permissible generating pressure shall be a gauge
pressure of 15 psi (103 kPa).

**15.4.1.3.1.1 Pressure Relief Devices.** Each generator shall be provided with one or more pressure relief devices.

15.4.1.3.1.1 The pressure relief device(s) shall prevent pressure from exceeding the allowable pressure rating of the generator due to chemical reaction or thermal exposure.

15.4.1.3.1.2 The maximum setting of the generator pressure relief device(s) shall be a gauge pressure of 18 psi (124 kPa).

**15.4.1.3.2 Vent Pipes.**

15.4.1.3.2.1 The vent pipes shall be sized so that the pressure relief device served is allowed to operate at its full design flow.

15.4.1.3.2.2 The relief vent piping shall be installed without traps and in such a manner that condensation does not accumulate in the vent piping.

15.4.1.3.2.3 Vent pipes shall be constructed so that obstructions are not caused by rain, snow, ice, insects, or wildlife.

15.4.1.3.2.4 Vent pipes shall terminate in an exhaust hood or at a point outside the building.

15.4.1.3.2.4.1 The termination point for exhaust ducts serving vent pipes located in a hood shall be located in accordance with the *Uniform Mechanical Code* for product-conveying duct.

15.4.1.3.2.4.2 Vent pipes terminating outside the building shall be in accordance with 7.3.1.5 of this Code, NFPA 55, *Compressed Gases and Cryogenic Fluids*.

15.4.1.3.2.5 Generator chamber relief pipes shall not be interconnected but shall lead separately to the outdoors.

15.4.1.3.2.6 The use of multiple pressure relief devices serving the same section of a gas generator shall be allowed.

15.4.1.3.2.6.1* When multiple pressure relief devices are connected to a common vent line or manifold the cross-sectional area of the common vent line or manifold shall not be less than the aggregate cross-sectional venting area of the individual pressure relief devices connected.

**15.4.1.4* Location of Gasholder.** Gasholders shall be permitted to be located outdoors or inside of buildings.

15.4.1.4.1 *Outdoors.* The gasholder shall be located at least 50 ft (15 m) from places of public assembly and any flammable liquid or flammable gas storage and at least 25 ft (7.6 m) from any source of ignition, line of adjoining property that is able to be built upon, or public way.

15.4.1.4.2 *Indoors.*

15.4.1.4.2.1 Indoor gasholders shall be located in a room that complies with the requirements of Chapter 4 of this standard.

15.4.1.4.2.2 This room shall be permitted to house other acetylene equipment.

**15.4.1.5 Installation of Gasholder.**

15.4.1.5.1 The gasholder shall be equipped with inlet and outlet shutoff valves located and arranged so that they are able to be closed in an emergency.

15.4.1.5.2* The gasholder shall not be located beneath or in a location where it is exposed to the failure of electric power lines, piping containing all classes of flammable or combustible liquids,
or piping containing other flammable gases.

15.4.1.5.3 Weeds and grass within 25 ft (7.6 m) of the gasholder shall be kept cut, and the cuttings shall be removed.

15.4.1.5.4 Combustible material shall not be permitted within 25 ft (7.6 m) of the gasholder.

15.4.1.5.5 The gasholder shall be marked as follows:

WARNING: ACETYLENE — FLAMMABLE GAS — DANGER — KEEP FIRE AND OPEN FLAMES AWAY

15.4.1.6* Low and Medium Pressure Purifiers and Driers.

Purifiers and driers shall have inlet and outlet shutoff valves located and arranged so that they are able to be closed in an emergency.

15.4.1.7 Drain Lines from Low and Medium Pressure Acetylene Systems. Drain lines from low and medium pressure [15 psi (103 kPa) and lower] acetylene systems shall be permitted to be piped to an indoor drain where the effluent water drained from the system is visible to the operator from the drain valve location.

15.4.1.8 Acetylene Compressors and High Pressure Driers Installation.

15.4.1.8.1 Drain Lines, Vents, and Equipment.

15.4.1.8.1.1 Drain Lines from High Pressure Acetylene Systems.

15.4.1.8.1.1.1* Drain lines from high pressure [pressure above 15 psi (103 kPa)] acetylene oil separators, condensate traps, and driers shall be piped outdoors to a location not less than:

1. 25 feet (7.6 m) from building openings
2. 25 feet (7.6 m) from sources of ignition
3. 10 feet (3 m) from combustible material
4. 50 feet (15.2 m) from air intakes

15.4.1.8.1.1.1 The minimum required distances shall not apply when fire barriers without openings or penetrations having a minimum fire resistive rating of 2 hours interrupt the line of sight between the drain line discharge and the exposure. The configuration of the fire barriers shall be designed to allow natural ventilation to prevent the accumulation of hazardous gas concentrations.

15.4.1.8.1.1.2 Drain lines from high pressure acetylene systems where source pressures have been reduced to medium gauge pressure [15 psi (103 kPa) and lower] shall be permitted to be piped to an indoor drain where the effluent water drained from the system is visible to the operator from the drain valve location.

15.4.1.8.1.3 Pressure Relief Device Vent Pipes. Vent lines serving equipment provided with pressure relief devices shall be in accordance with 15.4.1.3.2 6.3.2.

15.4.1.8.2 Compressors.

15.4.1.8.2.1 Inlet and Outlet Piping Control Valves. The inlet and outlet piping of compressors shall be provided with shutoff valves located and arranged so that they are able to be closed in an emergency.

15.4.1.8.2.2 Pressure Relief Device Vent Pipes. Vent lines serving pressure relief valves shall be in accordance with 15.4.1.3.2 6.3.2.
15.4.1.8.2.3 Automatic Shutdown.

15.4.1.8.2.3.1 Inlet Lines.

15.4.1.8.2.3.1.1 Pressure Switches. The suction line to the compressor shall be provided with a pressure switch or device capable of automatically shutting down the compressor when the suction pressure falls below a pressure not less than 1 in. of water column (0.25 kPa) above atmospheric pressure.

15.4.1.8.2.3.1.2 Isolation of Pressure Switches. Shutoff valves shall not be installed on the inlet or suction line between the compressor and the pressure switch or device.

15.4.1.8.2.3.2 Discharge Lines.

15.4.1.8.2.3.2.1 The discharge line from the compressor shall be provided with a pressure switch or device to automatically shut down the compressor when the discharge pressure reaches the maximum allowable operating gauge pressure of the system or 400 psi (2800 kPa), whichever is less.

15.4.1.8.2.3.2.* When provided, valves installed between the compressor and the pressure switch or device shall be equipped with positive lock-open devices to ensure that the valves are maintained in a locked open position when the compressor is in operation.

15.4.1.8.2.3.2.3 Such lock-open devices shall be visible to the operator.

15.4.1.9 Compressor Design.

15.4.1.9.1 Compressors shall be designed and constructed for acetylene service.

15.4.1.9.2 Compressors shall be constructed so that the acetylene is cooled during and after each stage of compression.

15.4.1.9.3 Where compressors use water as a cooling medium, the flow of water from the cooling jackets and intercoolers shall be visible to the operator.

15.4.1.9.4 Pressure and Temperature Indicators.

15.4.1.9.4.1 Pressure Gauges. A pressure gauge shall be provided on the discharge piping following each stage of compression.

15.4.1.9.4.2 Temperature Indicators. A temperature indicator shall be provided on the final discharge piping at the point where the gas at service pressure exits the compressor.

15.4.1.9.5 A pressure relief device shall be provided on the discharge piping following each stage of compression.

15.4.1.9.5.1 The pressure relief device in the final compression stage shall be set at a gauge pressure not greater than 450 psi (3100 kPa).

15.4.1.9.5.2 Shutoff valves shall not be allowed between pressure relief devices and the compressor piping.

15.4.1.9.6 Transmission belts, where used in compressor rooms, shall be provided with static eliminators or be of the static-conducting type.

15.4.1.10 Acetylene Piping.

15.4.1.10.1 Piping systems shall be designed, fabricated, tested, and maintained in accordance with ASME B31.3, *Process Piping*.

15.4.1.10.1.1 Acetylene piping shall be identified in accordance with ANSI A13.1, *Scheme for
Identification of Piping Systems.

15.4.1.10.2 Piping for Pressure Not Exceeding a Gauge Pressure of 15 psi (103 kPa).
15.4.1.10.2.1 Piping and fittings shall be steel, wrought iron, malleable iron, or copper alloys meeting the requirements of 15.4.1.13.4.242.1.2.
15.4.1.10.2.2 Pipe of nominal size 6 in. (152 mm) and less shall be a minimum of Schedule 40, and all pipe fittings shall have a minimum rating of a gauge pressure of 125 psi (861 kPa).
15.4.1.10.2.3 Piping shall be pneumatically tested at 110 percent of the maximum design pressure using inert gas or air as the test medium.
15.4.1.10.2.3.1 Hydrostatic testing shall be allowed in lieu of pneumatic testing.
15.4.1.10.2.3.2 When piping is tested hydraulically, the test pressure shall be not less than 150 percent of the design pressure.

15.4.1.10.3 Piping for Pressure Exceeding a Gauge Pressure of 15 psi (103 kPa).
15.4.1.10.3.1 Piping shall be steel or wrought iron, and fittings shall be steel, malleable iron, ductile iron, or copper alloys meeting the requirements of 15.4.1.13.4.242.1.2.
15.4.1.10.3.2 Pipe of nominal size 1 in. (25 mm) and less shall be not less than Schedule 80.
15.4.1.10.3.3 All pipe of nominal sizes 1 ¼ in. (32 mm) and 1 ½ in. (38 mm) shall be not less than Schedule 160.
15.4.1.10.3.4 Pipe fittings shall have a minimum working pressure of a gauge pressure of 3,000 psi (20,684 kPa).
15.4.1.10.3.5 Bourdon tubes of pressure gauges shall be steel or copper alloys meeting the requirements of 15.4.1.13.4.242.1.2.
15.4.1.10.3.6 Pressure gauges shall be protected by a device that stops a detonation flame and limits the rise in pressure on the pressure gauge side to prevent Bourdon tube deformation.
15.4.1.10.3.7 Piping shall be hydrostatically tested at a gauge pressure of not less than 4,500 psi (31,026 kPa).
15.4.1.10.3.8 Pressure relief valves, pressure gauges, diaphragm valves, regulators, and flash arresters shall not be required to be hydrostatically tested.

15.4.1.11 Cylinder Charging Leads.
Cylinder charging leads shall have a burst pressure rating of a gauge pressure not less than 10,000 psi (68,948 kPa) and shall be constructed of metallic or nonmetallic materials compatible for use in acetylene service.

15.4.1.12 Acetylene Cylinder Charging Manifolds, Solvent Equipment, and Mobile Acetylene Trailer Systems.
15.4.1.12.1 Cylinder charging manifolds shall be provided with a shutoff valve and a blow-down valve.
15.4.12.1* The blow-down valve shall either be arranged to vent the manifold to the outdoors in accordance with 7.3.1.5 6.3.2.4.2 or the discharge shall be returned to a low or medium pressure acetylene system with the pressure rating and capacity to contain both the maximum pressure and volume released from the manifold.

15.4.12.2 A check valve shall be installed in the pipeline at each cylinder charging manifold and in each cylinder charging lead.

15.4.12.2.1 Check valves shall not be required on charging leads used to charge individual cylinders on mobile acetylene trailer systems equipped with manifold systems serving multiple containers.

15.4.12.3 Pressure gauges shall be protected by a device that stops a detonation flame and limits the rise in pressure to prevent Bourdon tube deformation.

15.4.12.4 Each cylinder charging manifold outlet shall be provided with a shutoff valve.

15.4.12.5 Cylinder charging manifolds shall be arranged so that stress in the cylinder charging leads is limited to prevent failure when connected for charging or transportation.

15.4.12.6 Cylinder Cooling Systems.

Acetylene cylinders connected to charging manifolds shall have provisions for cooling by water spray applied from a manually activated spray nozzle system, where needed for removing the heat of solution of acetylene, as determined by ambient temperature and cylinder charging rate.

15.4.12.7 Flexible transfer hoses used for charging of MATS shall have a minimum burst pressure of 10,000 psig (69,000 kPa).

15.4.13 Equipment and Piping.

15.4.13.1 Equipment and piping (generators, compressors, and manifolds) employed in acetylene operations shall be electrically continuous and bonded to any grounding electrode, in accordance with NFPA 70, National Electrical Code.

15.4.13.2 Generators, compressors, and pressure relief devices shall be marked with their capacities, pressure ratings, the manufacturer's name and address, and the model or serial numbers.

15.4.13.3 The capacity and operating pressure of this equipment shall not exceed the rating for which it is designed.

15.4.13.4 Alloys.

15.4.13.4.1 Unalloyed copper, silver, or mercury shall not be used where they are able to be exposed to acetylene or to liquids containing acetylene in solution.

15.4.13.4.2 Copper alloys containing more than 65 percent copper shall not be used where they are able to be exposed to acetylene, unless such alloys have been found to be compatible in the specific application by experience or by test.

15.4.2 Process

15.4.2.1 The charging site shall be posted with a sign with the following or equivalent wording:

ACETYLENE – FLAMMABLE GAS – NO SMOKING – NO OPEN FLAMES

55/LCP13/Inc/A2012/ROP
15.4.2.2 Electrical equipment shall be in accordance with NFPA 70
15.4.2.2.1 An electrical grounding system for the acetylene piping shall be provided in accordance with the NFPA 70
15.4.2.2.2 The trailer chassis shall be connected to the grounding system before connections are made to the piping system.

15.4.2.3 MATS Discharge Stations
15.4.2.3.1 The MATS discharge station shall be in accordance with 10.6.1 except that 10.6.1.2 shall not apply.
15.4.2.3.2 Acetylene meters, where used, shall be designed for acetylene service and shall operate at a pressure not to exceed 15 psig (103 kPa).
15.4.2.3.3 Flexible transfer hoses used for withdrawal of acetylene shall be pressure rated as follows:

(1)* For pressures greater than 15 psig hoses shall have a minimum burst pressure of 10,000 psig (69,000 kPa).

(2) For pressures of 15 psig (103 kPa) or less hoses shall be rated for a minimum working pressure of 125 psig (860 kPa) and a minimum burst pressure of 500 psig (3450 kPa).

15.4.2.3.4 Signs. Acetylene cylinder shipping and receiving docks and plant entrances shall be posted with a sign declaring the following or equivalent prohibition:

WARNING: NO OPEN FLAMES
SMOKING STRICTLY PROHIBITED

15.5 Process Operations
15.5.1 Operating Instructions.
15.5.1.1 Generator operating instructions shall be displayed in a conspicuous place near the generator or otherwise be kept convenient for ready reference by the operator.

15.5.1.2 Operating instructions shall include procedures for operation as well as shutdown procedures that are to be taken in the event of an emergency.

15.5.2 Acetylene cylinders that have provisions for caps shall not be required to have caps in place when in the acetylene cylinder charging plant.

15.5.3 Charging Procedures.
15.5.3.1 To prevent liquefaction (condensation) of acetylene, its pressure shall not exceed the values for the corresponding acetylene temperatures shown in Table 15.3.1.

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Gauge Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>°F</td>
<td>°C</td>
</tr>
<tr>
<td>-5</td>
<td>-20.5</td>
</tr>
<tr>
<td>0</td>
<td>-17.8</td>
</tr>
<tr>
<td>10</td>
<td>-12.2</td>
</tr>
<tr>
<td>20</td>
<td>-6.7</td>
</tr>
</tbody>
</table>
15.5.3.2 Valves for charging cylinders shall be operated in such a sequence that the cylinder valves are opened first at the start of charging operations and closed last at the end of charging operations.

15.5.3.3 Where process needs require removing the heat of solution of acetylene as determined by ambient temperature and cylinder charging rates, provisions shall be made for a cylinder cooling process water spray system and water run-off.

15.5.4 **Combustible Waste.** Self-closing metal waste receptacles shall be provided for greasy, oily rags and waste materials.

15.5.5 **Powered Industrial Trucks.**
Powered industrial trucks shall be in accordance with NFPA 505, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operations.*

15.6 **Maintenance (Reserved)**

15.7 **Special Problems – Raw Materials**

15.7.1 **Calcium Carbide**

15.7.1.1 **Drums and Containers.**
15.7.1.1.1 Calcium carbide shall be stored in packages meeting U.S. Department of Transportation or Transport Canada regulations or in containers approved by the authority having jurisdiction.
15.7.1.1.2 Containers for calcium carbide shall be marked using the following or equivalent wording:

   **WARNING:** **CALCIUM CARBIDE — DANGEROUS IF NOT KEPT DRY**

15.7.1.2 **Storage Areas.**
15.7.1.2.1 Calcium carbide storage areas shall not be used for the storage of flammable materials or flammable compressed gases.
15.7.1.2.2 Each area of the plant where calcium carbide is handled, stored, or used shall be posted with notices using the following or equivalent wording:

   **WARNING:** **CALCIUM CARBIDE — DANGEROUS IF NOT KEPT DRY — KEEP WATER AND FLAMES AWAY**

15.7.1.2.3 Calcium carbide storage areas shall be arranged so that defective containers are able to be removed promptly.
15.7.1.2.4 Calcium carbide containers shall be supported so that those portions of the containers containing calcium carbide will not come in contact with the ground or with groundwater.
15.7.1.2.4.1 Locations subject to flooding shall be provided with a means to protect the containers from exposure to water.
Protection from the ground shall be provided by one or more of the following:

1. Concrete or asphalt paved storage pads
2. Dry, well-drained ground protected with timbers, pallets, or gravel arranged to elevate the containers above expected surface water

Calcium carbide storage shall be located not less than 10 ft (3 m) from any line of adjoining property that is able to be built upon.

Exposed water, steam, or condensate lines shall not be permitted in rooms or buildings devoted exclusively to calcium carbide storage in drums.

Unopened bulk calcium carbide containers that have accumulations of ice and snow shall be permitted to be stored in such rooms or buildings.

Calcium carbide storage buildings shall be constructed in accordance with the building code.

Rooms or areas where the quantity of calcium carbide exceeds the maximum allowable quantity per control area shall be provided with Protection Level controls.

Handling.

Locations where calcium carbide is transferred from transport containers to generator hopper loading carts or systems shall be protected from rain.

Calcium Carbide Residue Disposal.

The discharge of calcium carbide residue from acetylene generators shall be by one or more of the following means:

1. Discharge to a public sewer when approved by the authority having jurisdiction
2. Discharge to the outdoors into an open sump or pit
3. Discharge into ventilated containment tanks

When discharging to a public sewer drain, a system shall be in place to ensure that all calcium carbide is reacted and that no free acetylene is available to create hazardous atmospheres in sewer lines. Direct connection of acetylene generators to the public sewer shall not be allowed. When discharge to the public sewer is allowed under 15.7.1.4.1(1) 6.5.1(1), connections from acetylene generators shall be constructed to provide an air gap between the point of discharge from the drain of the generator and the point of entry to the sewer.

Calcium carbide residue shall be discharged into outdoor open sump pits or other ventilated receptacles.

Such receptacles shall be permitted to have clear water connections to public sewers if such disposal means is approved by the authority having jurisdiction.

When discharging to sumps, pits, or other receptacles, the point of discharge shall be located outdoors not less than 25 ft (7.6 m) from sources of ignition and the line of adjoining property that is able to be built upon.

The minimum required distances shall not apply when fire barriers without openings or penetrations having a minimum fire resistive rating of 2 hours interrupt the line of sight between the point of discharge and the exposure. The configuration of the fire barriers shall be designed to allow natural ventilation to prevent the accumulation of hazardous gas.
15.7.1.4.1.3 Collection in containment tanks shall be allowed indoors when the tanks are equipped with an exhaust system that transports vapors to a point outside the building in which the tanks are located.

15.7.1.4.1.4 Exhaust collection systems shall be in accordance with the *Uniform Mechanical Code*, and the duct serving such systems shall be classified as product-conveying duct.

15.7.1.4.1.5 Containment tanks installed outdoors shall not be required to be equipped with an exhaust system.

15.7.1.4.2 Calcium carbide residue pits and ponds shall be within a fenced area or posted around their perimeters with signs declaring the following or equivalent warning:

**WARNING:** NO TRESPASSING — NO SMOKING — NO OPEN FLAMES

15.7.2 Solvent Equipment.

15.7.2.1 Solvent storage containers shall be constructed and installed in accordance with NFPA 30, *Flammable and Combustible Liquids Code*.

15.7.2.2 Aboveground solvent storage containers in excess of one 55 gal (208 L) drum allowed for use shall be located at least 25 ft (7.6 m) from the storage of acetylene cylinders and other flammable gas cylinders.

15.7.2.3 Solvent containers in use shall be provided with secondary containment.
At mobile acetylene charging plants a deluge fire sprinkler system in accordance with NFPA 13, extra hazard group 1 shall be installed in the areas occupied by trailers in charging or discharging stations. The deluge system shall be able to be activated automatically and also by manual actuator.

****Insert Figures 1 through 4 Here****

Substantiation: The IMG TC NFPA 51A task group has been tasked to integrate NFPA 51A into NFPA 55 and a draft Chapter 15 will be submitted by the task group. Section 15.3.9.1 has been included in a proposal under development by the IMG Chapter 15 task group. CGA has continued to study the issues surrounding the needs of fire protection for mobile acetylene trailer charging and discharging stations and new information not considered by the IMG TC has been found that has a bearing on the type of fire protection system to be installed.

Mobile acetylene trailer systems (MATS) are in use today as a means to transport or use large quantities of acetylene gas. Acetylene trailers vary in size. A trailer may contain over 200 individual cylinders of acetylene with an aggregate content that can exceed 100,000 cubic feet. Typical trailers are approximately eight feet wide and range in length from 15 to 50 feet although longer and shorter trailers may exist. The Department of Transportation (DOT) limits the maximum dimensions to 8.5 feet in width by 65 feet long.

Committee Meeting Action: Accept
Committee Statement: It is the responsibility of the committee to determine the hazard classification. The amount of water and reliability of the system is being questioned by the committee. The committee will explore whether NFPA 13, Standard for the Installation of Sprinkler Systems, or NFPA 15, Standard for Water Spray Fixed Systems for Fire Protection, is the appropriate choice. The committee intends to return at the comment phase with the resolution and seeks to achieve consensus during the NFPA 55 revision cycle.
The IMG TC NFPA 51A task group has been tasked to integrate NFPA 51A into NFPA 55 and a draft Chapter 15 will be submitted by the task group. Section 15.3.9.1 has been included in a proposal under development by the IMG Chapter 15 task group. CGA has continued to study the issues surrounding the needs of fire protection for mobile acetylene trailer charging and discharging stations and new information not considered by the IMG TC has been found that has a bearing on the type of fire protection system to be installed.

Mobile acetylene trailer systems (MATS) are in use today as a means to transport or use large quantities of acetylene gas. Acetylene trailers vary in size. A trailer may contain over 200 individual cylinders of acetylene with an aggregate content that can exceed 100,000 cubic feet. Typical trailers are approximately eight feet wide and range in length from 15 to 50 feet although longer and shorter trailers may exist. The Department of Transportation (DOT) limits the maximum dimensions to 8.5 feet in width by 65 feet long.

Recent fires involving MATS at user sites during unloading operations were the subject of a report by the National Transportation Safety Board (NTSB) that was considered by the NFPA 51A technical committee during the ROP phase. The Compressed Gas Association (CGA) brought the NTSB report to the attention of NFPA’s Industrial and Medical Gases Technical Committee along with a request to revise the provisions of the document to coordinate NTSB recommendations with CGA’s G-1.6, *Recommended Practices for Mobile Acetylene Trailer Systems* which is an informational reference published in Annex B of NFPA 51A.
Figure 2. Acetylene gas fire at Southwest facility in Dallas.¹

¹ The pictures included in Figures 2 through 4 have been extracted from a report of the National Transportation Safety Board. The report was distributed to NFPA’s Industrial and Medical Gases Technical Committee prior to the ROP meeting for NFPA 51A. Special Investigation Report; Mobile Acetylene Trailer Accidents: Fire During Unloading in Dallas, Texas, July 25, 2007; Fire During Unloading in The Woodlands, Texas, August 7, 2007; and Overturn and Fire in East New Orleans, Louisiana, October 20, 2007, National Transportation Safety Board, Washington, D.C., NTSB/SIR-09/01, PB 2009-917002, Notation 8071, Adopted January 13, 2009, p.13.
Figure 3. Final phase of fire suppression at Southwest facility in Dallas.²

² NTSB Report, NTSB/SIR-0901, p. 16
CGA submitted the sole public proposal (ROP 51A-31 Log #16) and related comment (ROC 51A-8 Log #9) to address the need for fire protection for MAT systems to address concerns expressed by NTSB and CGA G-1.6. The IMG Technical Committee accepted ROC Item 51A-8 Log #9 in principle in part, but rejected CGA’s request for a deluge sprinkler system. The IMG TC then crafted ROC Item 51A-9 Log #CC2 to require sprinkler protection designed for Extra Hazard Group 1 for MATS being charged or discharged either indoors or outdoors.

The requirements for fire protection systems under the committee comment does not follow the NTSB recommendations, Department of Transportation recommendations or those found in CGA G-1.6 all of which advise requiring the use of deluge sprinkler systems. The IMG TC deliberations did not account for the fact that previous editions of NFPA 51A, for a period of twenty years or more, had required the use of NFPA 15, Standard for Water Spray Fixed Systems for Fire Protection. The actions taken in ROC Item 51A-9 CC#2 to require the installation of an Extra Hazard sprinkler system appear to have been premature falling short of establishing a clear set of requirements for a deluge system. The committee concluded that the requirements as written did not prohibit a user from installing a deluge system, but CGA has concluded that by not specifying the use of deluge systems for this unique material capable of producing a fast moving high challenge fire was a major shortcoming. CGA cast a negative ballot on the item with mutual opposition expressed by principals from FM Global and Underwriters Laboratories in the balloting process.

The IMG TC has established an acetylene task group charged with integrating the requirements of NFPA 51A into a new Chapter 15 of NFPA 55 which is currently in the Annual 2012 Code Revision Cycle and
during the 51A ROC meeting the committee expressed an intent of withdrawing NFPA 51A from publication. The task group will be including the developments in the evolution of NFPA 51A through the ROC draft for integration into NFPA 55 as a new Chapter 15 for that document. It is hoped that the ongoing work of the IMG committee will provide requirements that will clearly establish the need for the use of a deluge system, fixed spray sprinkler system or comparable means of fire protection. Prescriptive measures are also needed to clearly state that such systems are required for charging and discharging stations whether they are located indoors or outdoors. Although the most common practice with the use of MAT systems today involves outdoor use in charging and discharging applications the applicability of the requirements in Section 10.6 of NFPA 51A are not entirely clear. Placing a requirement indicating that these requirements are intended to apply both indoors and outdoors in an informative annex is inadequate as a means to establish enforceable requirements (See ROC Item 51A-9 Log #CC2).

The special hazards attendant to acetylene trailer (MAT) system charging and discharging must recognize that acetylene is not only flammable, but it is also an unstable material where the removal of heat from any fire scenario is critical to the outcome of the event. The considerations for deluge systems indoors and outdoors raise issues to be considered regarding the use of open head or closed head systems as well as matters of density. Although the IMG TC was successful in establishing minimal requirements the divergent view between suppliers, government agencies and the fire protection community was far from what might be considered a balanced approach.
The bulk system terminates at the source valve, which is commonly the point where the gas supply, at service pressure, first enters the supply line or a piece of equipment that utilizes the gas or the liquid. The containers are either stationary or movable, and the source gas is stored as a compressed gas or cryogenic fluid. Bulk inert gas systems can be used to supply gas in either its compressed gaseous or liquefied form. Systems that may be used to supply both gaseous and liquid forms are referred to as hybrid systems. The following bulk inert gas systems are typical of those in use:

- When the primary supply of the gas as stored is from a compressed gaseous source which is used in the compressed and gaseous form, the bulk inert gas system is said to be a bulk inert compressed gas system.
- When the primary supply of the gas as stored is in a liquid form and the system is designed to transfer only liquid, the system is said to be a bulk liquefied inert gas system.
- When the primary supply of the gas as stored is in a liquid form and the system is designed to transfer or store the gas in a compressed gaseous form, with or without a feature that may also allow the subsequent transfer and use of liquid, the bulk inert gas system is said to be a hybrid bulk inert gas system.

For the purposes of the application of the code, a hybrid system is viewed as a bulk liquefied inert gas system.

Substantiation: Guidance is needed to provide more comprehensive details in an informational note that informs the user about liquid and gas systems that are commonly found in bulk inert gas systems. Bulk inert gas systems, unlike bulk hydrogen systems, are regulated under the use of a single term. Expanding the annex note to address the types of systems typically encountered will aid the user in understanding how the code is applied to any of the systems mentioned within the context of a single umbrella term that describes the three most common system designs.

Committee Meeting Action: Accept
The bulk oxygen system terminates at the source valve, which is commonly the point where oxygen, at service pressure, first enters the supply line or a piece of equipment that utilizes the oxygen gas or liquid. The containers are either stationary or movable, and the oxygen is stored as a compressed gas or cryogenic fluid.

Bulk oxygen systems can be used to supply gas in either its compressed gaseous or liquefied form. Systems that may be used to supply both gaseous and liquid forms are referred to as hybrid systems. The following bulk oxygen systems are typical of those in use:

- **When the primary supply of the gas as stored is from a compressed gaseous source which is used in the compressed and gaseous form, the bulk oxygen system is said to be a bulk inert compressed gas system.**

- **When the primary supply of the gas as stored is in a liquid form and the system is designed to transfer only liquid, the system is said to be a bulk liquefied oxygen system.**

- **When the primary supply of the gas as stored is in a liquid form and the system is designed to transfer or store the gas in a compressed gaseous form, with or without a feature that may also allow the subsequent transfer and use of liquid, the bulk oxygen system is said to be a hybrid bulk oxygen system.**

For the purposes of the application of the code, a hybrid system is viewed as a bulk liquefied oxygen system.

**Substantiation:** Guidance is needed to provide more comprehensive details in an informational note that informs the user about liquid and gas systems that are commonly found in bulk oxygen systems. Bulk oxygen systems, unlike bulk hydrogen systems, are regulated under the use of a single term. Expanding the annex note to address the types of systems typically encountered will aid the user in understanding how the code is applied to any of the systems mentioned within the context of a single umbrella term that describes the three most common system designs.

**Committee Meeting Action:** Accept in Principle

Revise text to read as follows:

- **A.3.3.15 Bulk Oxygen System.** The bulk oxygen system terminates at the source valve, which is commonly the point where oxygen, at service pressure, first enters the supply line or a piece of equipment that utilizes the oxygen gas or liquid. The containers are either stationary or movable, and the oxygen is stored as a compressed gas or cryogenic fluid.

Bulk oxygen systems can be used to supply gas in either its compressed gaseous or liquefied form. Systems that may be used to supply both gaseous and liquid forms are referred to as hybrid systems. The following bulk oxygen systems are typical of those in use:

- **When the primary supply of the gas as stored is from a compressed gaseous source which is used in the compressed and gaseous form, the bulk oxygen system is said to be a bulk inert compressed gas system.**

- **When the primary supply of the gas as stored is in a liquid form and the system is designed to transfer only liquid, the system is said to be a bulk liquefied oxygen system.**

- **When the primary supply of the gas as stored is in a liquid form and the system is designed to transfer or store the gas in a compressed gaseous form, with or without a feature that may also allow the subsequent transfer and use of liquid, the bulk oxygen system is said to be a hybrid bulk oxygen system.**

For the purposes of the application of the code, a hybrid system is viewed as a bulk liquefied oxygen system.

**Committee Statement:** The committee agreed with the proposal and made editorial corrections.
Like other cryogenic liquids, liquid hydrogen is susceptible to heat leak. Adding heat to the fluid reduces the net positive suction head (NPSH) to the pump and can reduce the level of sub-cooling or can cause the fluid to flash to vapor. Sub-cooled liquid is the ideal state for pumping liquid hydrogen. As the fluid saturates, the ability to pump decreases. The liquid suction and gas return piping to and from the pump typically is vacuum-jacketed piping. Vacuum-jacketed piping is most commonly used when liquid is to be transferred as it avoids the potential condensation of air and oxygen enrichment that can occur in piping systems that are insulated with conventional materials. In some cases the liquid may be transferred using un-insulated piping systems. Such systems must be designed in a way that condensed air does not present a contact hazard to personnel or otherwise create a potential flammability hazard due to material contact and the presence of oxygen contained in the condensate.

Substantiation: The use of insulated material for hydrogen piping systems is not desirable in some cases. Vacuum-jacketed pipe is commonly used with vacuum acting as the insulating layer in contrast with materials that may be inserted into an annulus formed by the use of a double walled piping system or by insulation placed around piping used to transport liquid. In some cases un-insulated, un-jacketed pipe may be preferable. An informational note is proposed to alert the users to the fact that vacuum jacketed piping systems will be encountered. The choice is that of the designer. The annex note adds rationale as to why the fundamental statements are made in Section 11.2.3.6 so that users are better informed and that the hazards addressed by the requirements of the subsections that follow are better understood.

Committee Meeting Action: Accept

Retain the 1st paragraph of Annex G.2 and Table G.2 (a) and G.2(b). Relocate the material in the rest of Annex G.2 to a new Annex Titles “Explanation of Methodology Utilized to Develop Separation Distances Tables 10.3.2.2.1 (a) & (b)” Renumber remaining Annexes as needed.

Substantiation: As originally intended the OSHA material was to be in a separate Annex. The material in Annex G.2 beyond the 1st paragraph does not relate to the OSHA tables but rather explains the development of the bulk GH2 separation distance tables in Chapter 10. This material is intended to assist users of the Code in understanding how the Chapter 10 separation distance tables were developed and is currently difficult to locate in Annex G. Creating two separate Annexes solves the problem.

Committee Meeting Action: Accept in Principle

Revise the proposed changes as follows:

Retain the 1st paragraph of Annex G.2 and Table G.2 (a) and G.2(b). Relocate the material in the rest of Annex G.2 to a new Annex Titles “Explanation of Methodology Utilized to Develop Separation Distances Tables 10.3.2.2.1 (a) & (b)” Renumber remaining Annexes as needed. Change the title of the Table G.2(a) to be “OSHA Table: Minimum Distance from Gaseous Hydrogen Systems to Exposure”.

Committee Statement: The committee agreed with the proposal and revised the title of Table G.2(a).