NATIONAL FIRE PROTECTION ASSOCIATION
The leading information and knowledge resource on fire, electrical and related hazards

NFPA Technical Committee on Industrial and Medical Gases (IMG-AAA)

MEETING AGENDA
NFPA 51/55 First Draft (A2022)

Web/Teleconference

NFPA 51/55 FD Meeting Dates	
Date	**Time (EST)**
Sep 28, 2020	11am – 5pm
Sep 29, 2020	11am – 5pm
Sep 30, 2020	11am – 5pm
Oct 01, 2020	11am – 5pm
Oct 06, 2020	11am – 3pm

Note: The TC Chair reserves the ability to adjust the time or add additional meeting dates as is needed or appropriate.

To join the Meeting: Contact Yiu Lee at ylee@nfpa.org

1. Call to Order. Rob Early, Chair.
2. Introductions.
3. Approval of Meeting Minutes.
   - NFPA 51 – November 17, 2015 **(Attachment A)**
   - NFPA 55 – July 24-25, 2018 **(Attachment B)**
4. Staff Updates. Heath Dehn, NFPA Staff
   - Staff Liaison Presentation
   - Committee Membership Roster (IMG-AAA) – Technical Committee on Industrial and Medical Gases **(Attachment C)**
   - Review A2022 Revision Cycle **(Attachment D)**
5. Business.
   - NFPA 51 – Public Inputs **(Attachment E)**
   - NFPA 55 – Public Inputs **(Attachment F)**
6. Other Business.
   - NFPA 2 – Public Inputs **(Attachment G)**
7. Next Meeting.
8. Adjournment.

Minutes of Meeting – NFPA 51 First Draft Meeting
Web Meeting
November 17th, 2015, 1 PM ET

Member	Attending	
Rob Early – chair	Yes	Member
John Anicello	Yes	Member
William Barlen	No	Member
Rodney Barnes	No	Member
Denise Beach	Yes	Member
Erik Christiansen	No	Member
Julie Cordero	No	Member
Ken Fegley	Yes	Member
David De Fina	No	Member
Alejandro Gonzalez	No	Member
Martin Gresho	No	Member
Gerry Hayes	No	Member
Anthony Lachawiec	No	Member
Frank Licari	No	Member
Eugene Ngai	No	Member
Robert Nii	No	Member
Diana Parks	Yes	Member
Carl Rivkin	Yes	Member
David Rohrig	No	Member
Jerry Sameth	Yes	Member
William Satterfield	No	Member
Mike St. Clair	Yes	Member
Randolph Viscomi	No	Member
Jonathan Willard	No	Member
Edgar Wolff-Klammer	Yes	Member
Joseph Balbo	No	Alternate
Richard Craig	Yes	Alternate
Dave Farese	No	Alternate
Rick Ginn	Yes	Alternate
Scott Heyworth	No	Alternate
Steward Muller	Yes	Alternate
Brian Musch	No	Alternate
Michael Pirrello	No	Alternate
Scott Swanson	No	Alternate
Robert Whittlesley	No	Alternate

Chuck Henrici	Yes	Member Emeritus
Susan Bershad		NFPA

1. The meeting was called to order by the chair, Rob Early, at 1:00 PM on November 17th

2. Susan Bershad, *NFPA staff*, gave an update on committee membership, the A2017 document schedule, and the procedures for first draft meetings.

3. Rob Early gave a summary of the status of NFPA 55. The 2016 edition of 55 has been issued and printed. The TIA developed by the CNG task group has been balloted and will be considered at the December 2015 Standards Council meeting. Another TIA on fire barrier walls is being processed and will be considered at the April Standards Council meeting.

4. Rob also provided an update on the Hydrogen Separation Distance Task Group, which is a joint task group between the NFPA 2 and the NFPA 55 committees. This group is working on revisions to the separation distance tables for gaseous and liquid hydrogen.

5. The committee reviewed and acted on public input for NFPA 51, and created first revisions to the document. The committee voted to extract the material from Chapter 15 of NFPA 55 on MATS Fire Protection into NFPA 51. It was noted that there were several changes made to this material in comparison to the original TIA from 2012.

6. The next meeting of the committee will be the first draft meeting for NFPA 55, which is an A2018 document. The Public Input closing date for NFPA 55 is June 29th, 2016. This meeting is tentatively scheduled for the week of September 12th, 2016 in the vicinity of Dulles airport in Virginia.

7. The committee discussed the new NFPA extract policy and the effect it may have on NFPA 2. NFPA 2 extracts heavily from NFPA 55. The new policy does not allow for extracts from documents in the same revision cycle. Currently NFPA 55 and NFPA 2 are both in the A2018 revision cycle. Susan is working with Standards Administration to clarify this issue so that the committees can continue to work jointly on revisions to the documents, and so that the changes can occur concurrently.

8. The meeting was adjourned at 2:30 PM ET.

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Minutes of meeting – NFPA 55 second draft meeting
Crowne Plaza Hotel, Warwick, RI
July 24-25, 2018

Member or guest	Status	Attended meeting?
Rob Early	Principal and committee chair	Yes
John Anicello	Principal	Yes
Rodney Barnes	Principal	No
Denise Beach	Principal	Yes
Erik Christiansen	Principal	No
Michael Ciotti	Principal	No
Julie Cordero	Principal	No
Mark Fasel	Principal	Yes
Kenneth Fegley	Principal	Yes
Jeff Frick	Principal	Yes
Alejandro Gonzalez	Principal	No
Bryan Gordon	Principal	No
Martin Gresho	Principal	No
Bridget Hamilton	Principal	Yes – via web conference
Gerald Hayes	Principal	Yes
Anthony Lachawiec	Principal	Yes
Frank Licari	Principal	No
Brian Musch	Principal	No
Eugene Ngai	Principal	No
Robert Nii	Principal	No
Richard Palluzi	Principal	Yes
Josh Pringle	Principal	Yes
April Richardson	Principal	Yes
Carl Rivkin	Principal	Yes
David Rohrig	Principal	Yes
William Satterfield	Principal	No
Michael St. Clair	Principal	No
Robert Sutter	Principal	Yes
Jonathan Willard	Principal	Yes
Edgar Wolff-Klammer	Principal	Yes
Joseph Bablo	Alternate	No
Jerome Bell	Alternate	Yes
Richard Craig	Alternate	No
David Farese	Alternate	Yes
Rick Ginn	Alternate	Yes
Scott Heyworth	Alternate	No
Kyle McKeown	Alternate	No
Stuart Muller	Alternate	No
Alice Muna	Alternate	Yes – via web conference

NATIONAL FIRE PROTECTION ASSOCIATION
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Minutes of meeting – NFPA 55 second draft meeting
Crowne Plaza Hotel, Warwick, RI
July 24-25, 2018

Member or guest	Status	Attended meeting?
Scott Swanson	Alternate	No
Robert Whittlesey	Alternate	No
Charles Henrici	Member emeritus	No
Robert Bogarts	Guest – ARC Specialty Products	Yes
Anthony Belvin	Guest - DOE	Yes
Chris LaFleur	Guest – Sandia National Lab	Yes
Tom Deary	Guest – Compressed Gas Association	Yes
Susan Bershad	NFPA staff	Yes
Debra Gursha	NFPA staff	Yes
Gordon Frost	NFPA staff	Yes
Heath Dehn	NFPA staff	Yes
Chris Tolentino	NFPA staff	Yes

1. Rob Early, IMG committee chair, called the meeting to order at 8:05 AM EDT on Tuesday, July 24, 2018.
2. NFPA staff facilitated roll call and self-introduction of members and guests attending the meeting.
3. Rob Early gave opening remarks about goals for the meeting.
4. NFPA staff reviewed the technical committee membership, the schedule for NFPA 55 updates, procedures for the second draft meeting, and the work process.
5. NFPA staff presented a note of appreciation from Gerald Sameth, who represented the Compressed Gas Association (CGA) on the committee before committee assignments at CGA were reorganized.
6. The committee approved the minutes of the last meeting, the joint NFPA 2/55 first draft continuation meeting on April 4-6, 2017 at Toyota Motor Sales in Torrance, CA.
7. Rob Early presented a report on the NFPA 55/99 task group. The task group is charged with creating a new chapter 17 for medical gas supply systems in NFPA 55. The next step is to act on public comments to the chapter 17 material created in the first draft phase. The task group has also submitted public input to NFPA 99 to extract the NFPA 55 chapter 17 material.
8. Tony Lachawiec gave a report on the pyrophoric gases task group. The group has submitted public comment 9, tagged to committee input 75, to provide updated language.
9. The committee resolved the 52 public inputs.
10. The committee reviewed committee input 58 about updating references to CGA G-5.5 for hydrogen vent stack locations. The committee determined that they had acted on public comments to update NFPA 55 in this area.
11. The committee reviewed committee input 75 for pyrophoric gases and determined that they had acted on a public comment to update NFPA 55 in this area.
12. The meeting ended at 11:00 AM, Wednesday, July 25.

Address List No Phone

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Heath Dehn

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Address List No Phone

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Heath Dehn 7/2/2020
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Attachment D - Revision Cycle Schedule

2022 ANNUAL REVISION CYCLE

* Public Input Closing Dates may vary according to standards and schedules for Revision Cycles may change. Please check the NFPA Website for the most up-to-date information on Public Input Closing Dates and schedules at www.nfpa.org/document # (i.e. www.nfpa.org/101) and click on Next Edition tab.

Process Stage	Process Step	Dates for TC	Dates for TC with CC
Public Input Stage (First Draft)	**Public Input Closing Date**	6/30/2020	6/30/2020
	Final date for TC First Draft Meeting	12/8/2020	9/8/2020
	Posting of First Draft and TC Ballot	1/26/2021	10/20/2020
	Final date for Receipt of TC First Draft ballot	2/16/2021	11/10/2020
	Final date for Receipt of TC First Draft ballot - recirc	2/23/2021	11/17/2020
	Posting of First Draft for CC Meeting		11/24/2020
	Final date for CC First Draft Meeting		1/5/2021
	Posting of First Draft and CC Ballot		1/26/2021
	Final date for Receipt of CC First Draft ballot		2/16/2021
	Final date for Receipt of CC First Draft ballot - recirc		2/23/2021
	Post First Draft Report for Public Comment	3/2/2021	3/2/2021
Comment Stage (Second Draft)	**Public Comment closing date**	5/11/2021	5/11/2021
	Notice published on Consent Standards (Standards that receive No Comments). Note: Date varies and determined via TC ballot.		
	Appeal Closing Date for Consent Standards (Standards That Received No Comments)		
	Final date for TC Second Draft Meeting	11/9/2021	8/3/2021
	Posting of Second Draft and TC Ballot	12/21/2021	9/14/2021
	Final date for Receipt of TC Second Draft Ballot	1/11/2022	10/5/2021
	Final date for receipt of TC Second Draft ballot - recirc	1/18/2022	10/12/2021
	Posting of Second Draft for CC Mtg		10/19/2021
	Final date for CC Second Draft Meeting		11/30/2021
	Posting of Second Draft for CC Ballot		12/21/2021
	Final date for Receipt of CC Second Draft ballot		1/11/2022
	Final date for Receipt of CC Second Draft ballot - recirc		1/18/2022
	Post Second Draft Report for NITMAM Review	1/25/2022	1/25/2022
Tech Session Preparation (& Issuance)	**Notice of Intent to Make a Motion (NITMAM) Closing Date**	2/22/2022	2/22/2022
	Posting of Certified Amending Motions (CAMs) and Consent Standards	4/5/2022	4/5/2022
	Appeal Closing Date for Consent Standards	4/20/2022	4/20/2022
	SC Issuance Date for Consent Standards	5/2/2022	5/2/2022
Tech Session	Association Meeting for Standards with CAMs	6/6-9/2022	6/6-9/2022
Appeals and Issuance	Appeal Closing Date for Standards with CAMs	6/29/2022	6/29/2022
	Council Issuance Date for Standards with CAMs*	August 2022	August 2022

Attachment E, F, and G - Public Inputs

The following schedule is the order the committee will address the NFPA 51/55 Public Inputs and other topics. This is not an all encompassing list and is subject to change per the technical committee chair's discretion.

NFPA 51/55 - First Draft Meeting Schedule

NFPA 51 Items (Meeting Day 1, Order 1–9)

Meeting Day 1		Meeting Day 2		Meeting Day 3		Meeting Day 4		Meeting Day 5	
Order	**Item**	**Order**	**Item**	**Order**	**Item**	**Order**	**Item**	**Order**	**Item**
1	Extracts	26	35	61	14	96	52	**Reserved for Overflow**	
2	Extracts	27	37	62	92	97	31		
3	Extracts	28	23	63	93	98	64		
4	7	29	21	64	94	99	63		
	8	30	57	65	82	100	62		
	6	31	13		83	101	32		
5	1	32	1	66	48	102	97		
	2		18	67	84	103	66		
	4	33	9		110	104	98		
6	References	34	74	68	58	105	99		
	3	35	75		85	106	100		
7	References	36	76	69	101	107	References		
8	References	36	90	70	102		References		
9	References	37	80	71	95		39		
1	Extracts	38	5	72	114		33		
2	Extracts	39	91	73	115		19		
3	Extracts	40	10	74	69	108	References		
4	Extracts	41	6	75	109	109	References		
5	Extracts	42	105	76	67	109	40		
6	Extracts		54	77	113	109	20		
7	Extracts	43	56	78	61	110	NFPA 2 - PI9		
8	Extracts	44	47	79	60	111	NFPA 2 - PI13		
9	Extracts	45	34	80	59	112	NFPA 2 - PI258		
10	Extracts	46	38		86	113	NFPA 2 - PI277		
11	111	47	41		96	114	NFPA 2 - PI223		
12	70		43	81	29	115	NFPA 2 - PI144		
13	87	48	16	82	30	116	NFPA 2 - PI145		
14	103		17	83	112	117	NFPA 2 - PI143		
	106	49	2	84	118	118	NFPA 2 - PI265		
15	107	50	46	85	49	119	NFPA 2 - PI270		
16	72	51	44	86	116	120	NFPA 2 - PI215		
17	104	52	12	87	65	121	NFPA 2 - PI246		
18	108	53	11	88	15	122	NFPA 2 - PI222		
19	88	54	24	89	68	123	NFPA 2 - PI232		
20	89	55	3	90	7	124	NFPA 2 - PI264		
21	71	56	77	91	45	125	NFPA 2 - PI262		
22	73	57	78	92	50	126	NFPA 2 - PI272		
23	ST-1	58	28	93	53				
24	36	59	79	94	51				
25	117	60	81	95	55				

Note: Similar colors indicate related topics and/or sections

Attachment E - NFPA 51 Public Inputs

Public Input No. 3-NFPA 51-2020 [Section No. 2.3.5]

2.3.5 UL Publications.

Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

UL 723, *Tests for Surface Burning Characteristics of Building Materials*, ~~2008, revised 2013~~ 2018 .

Statement of Problem and Substantiation for Public Input

Reason: Update of existing references.

Submitter Information Verification

Submitter Full Name:	Kelly Nicolello
Organization:	UL LLC
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Tue Jun 16 11:54:40 EDT 2020
Committee:	IMG-AAA

Attachment E - NFPA 51 Public Inputs

Public Input No. 7-NFPA 51-2020 [Section No. 3.3.15]

3.3.15 Limited-Combustible Material.

~~Refers to a building construction material not complying with the definition of *noncombustible* that, in the form in which it is used, has a potential heat value not exceeding 3500 Btu/lb (8141 kJ/kg) when tested in accordance with NFPA 259 and includes either (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, or (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 E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or UL 723, *Tests for Surface Burning Characteristics of Building Materials*.~~ [See 4.1.2]

Statement of Problem and Substantiation for Public Input

This is associated with PI6. The definition is not enforceable here and has been superseded in NFPA 101 and 5000 (and other documents).

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 6-NFPA 51-2020 [New Section after 4.1]	
Public Input No. 8-NFPA 51-2020 [Section No. 3.3.21]	

Submitter Information Verification

Submitter Full Name:	Marcelo Hirschler
Organization:	GBH International
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Thu Jun 25 19:51:53 EDT 2020
Committee:	IMG-AAA

Attachment E - NFPA 51 Public Inputs

Public Input No. 8-NFPA 51-2020 [Section No. 3.3.21]

3.3.21 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 E136 are considered noncombustible materials.~~ [See 4.1.1]

Statement of Problem and Substantiation for Public Input

Similar to limited combustible but also noting that the first and second sentence are in conflict since materials meeting ASTM E136 are allowed to ignite and burn to a limited extent.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 6-NFPA 51-2020 [New Section after 4.1]	
Public Input No. 7-NFPA 51-2020 [Section No. 3.3.15]	

Submitter Information Verification

Submitter Full Name: Marcelo Hirschler
Organization: GBH International
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 25 19:53:36 EDT 2020
Committee: IMG-AAA

Attachment E - NFPA 51 Public Inputs

Public Input No. 6-NFPA 51-2020 [New Section after 4.1]

4.1 Fire testing

4.1.1 Noncombustible material [NFPA 101]

Attachment E - NFPA 51 Public Inputs

4.1.1.1 A material that complies with any one of the following shall be considered a noncombustible material:

(1) The material, in the form in which it is used, and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat

(2) The material is reported as passing ASTM E 136, Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace

at 750 Degrees C

(3) The material is reported as complying with the pass/fail criteria of ASTM E 136 when tested in accordance with the test method and procedure in ASTM E 2652, Standard Test Method for Assesssing Combustibility of Materials Using a Tube Furnace with a Cone-shaped Airflow Stabilizer, at 750 Degrees C [NFPA 101]

4.1.2 Limited-Combustible Material. A material shall be considered a limited-combustible material where one of the following is met: [NFPA 101]

(1) The conditions of 4.1.2.1 and 4.1.2.2, and the conditions of either 4.1.2.3 or 4.1.2.4, shall be met.

(2) The conditions of 4.1.2.5 shall be met.

4.1.2.1 The material shall not comply with the requirements for noncombustible material in accordance with 4.1.1.

4.1.2. 2 The material, in the form in which it is used, shall exhibit 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* .

4.1.2.3 The material shall have the structural base of a noncombustible material with a surfacing not exceeding a thickness of ⅛ in. (3.2 mm) where the surfacing exhibits a flame spread index not greater than 50 when tested in accordance with ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials* , or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials* .

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

4.1.2.5 Materials shall be considered limited-combustible materials where tested in accordance with ASTM E2965, S *tandard Test Method for Determination of Low Levels of Heat Release Rate for Materials and Products Using an Oxygen Consumption Calorimeter* , at an incident heat flux of 75 kW/m^2 for a 20-minute exposure and both of the following conditions are met:

(1) The peak heat release rate shall not exceed 150 kW/m^2 for longer than 10 seconds.

(2) The total heat released shall not exceed 8 MJ/m^2 .

4.1.2.6 Where the term *limited-combustible* is used in this *Code* , it shall also include the term *noncombustible* .

4.1.3 Fire resistance rating

Whenever a fire resistance rating is required in this standard, it shall be determined in accordance with test procedures set forth in ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials* , or ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials* , or analytical methods approved by the authority having jurisdiction.

Also add ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials* (2014) , ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials* into Chapter 2 on referenced standards.

Attachment E - NFPA 51 Public Inputs

A.4.1.1 The provisions of 4.1 do not require inherently noncombustible materials to be tested in order to be classified as noncombustible materials. [NFPA 5000, 2015]

A.4.1.1.1(1) Examples of such materials include steel, concrete, masonry and glass. [NFPA 5000]

Also add ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials (2019),* ASTM E 2652, Standard Test Method for Assessing Combustibility of Materials Using a Tube Furnace with a Cone-shaped Airflow Stabilizer, at 750 Degrees C (2018) and ASTM E2965, *Standard Test Method for Determination of Low Levels of Heat Release Rate for Materials and Products Using an Oxygen Consumption Calorimeter* , (2017) into chapter 2 on referenced standards.

Also add: ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials,* ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials* (2001) and NFPA 259, *Standard Test Method for Potential Heat of Building Materials* into Chapter 2 on referenced standards.

Also renumber all sections in chapter 4

Statement of Problem and Substantiation for Public Input

The problem being addressed here is that the definitions of noncombustible and limited combustible are incorrect and are in a section that is not enforceable.
With regard to noncombustible, note that the first sentence of the definition says that the material cannot ignite or burn and the second sentence says that it must meet ASTM E136. However, materials can meet ASTM E136 and burn for a limited period, so the two sentences have contradictions.
With regard to limited combustible, a new test method has been added which is easier to use because it requires a much smaller sample than the one needed for ASTM E84.
The information in 4.1.1 and 4.1.2 has all been extracted from NFPA 101 for both of them. In conjunction with this PI the definitions in chapter 3 are proposed to be deleted and to reference this section, in associated PIs.
With regard to fire resistance rating it is important to clarify the test method to be used to assess the time for the fire resistance rating and the codes and the NFPA system all use ASTM E119 or UL 263.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 7-NFPA 51-2020 [Section No. 3.3.15]	
Public Input No. 8-NFPA 51-2020 [Section No. 3.3.21]	

Submitter Information Verification

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Committee:	IMG-AAA

Attachment E - NFPA 51 Public Inputs

Public Input No. 1-NFPA 51-2019 [Section No. 6.2.1]

6.2.1

Joints in steel piping shall be welded, threaded, ~~or~~ press-connected or flanged. Fittings, such as ells, tees, couplings, and unions, shall be permitted to be rolled, forged, or cast steel, malleable iron, or nodular iron. Gray or white cast-iron fittings shall be prohibited.

Statement of Problem and Substantiation for Public Input

Currently NFPA 51 does not incorporate press-connect fittings. Press-connect fittings are a reliable permanent joining method
incorporating an elastomeric seal or an elastomeric seal and corrosion-resistant grip or bite ring. The permanent joint is made with a pressing tool and jaw or ring approved by the fitting manufacturer.

Press-connect fittings are designed for use in water, gas and chemical piping systems and many other applications that have been in use for over 20 years in the United States and Canada and over 30 years in Europe. Press-connect fittings are used in a variety of applications and are specifically referenced in NFPA 31, 54, 55, 58 and are also included by reference in international plumbing, mechanical and fuel gas codes.

The addition of press-connect fittings to NFPA 51 will provide the installer with a safe installation method that does not require the use of open flame, reduces the risk of injury to the installer and reduces the risk of property damage associated with other piping joining methods.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 2-NFPA 51-2019 [Section No. 6.2.2]	Copper Pipe joint proposal
Public Input No. 2-NFPA 51-2019 [Section No. 6.2.2]	
Public Input No. 4-NFPA 51-2020 [Section No. 6.2.3]	

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Attachment E - NFPA 51 Public Inputs

Public Input No. 2-NFPA 51-2019 [Section No. 6.2.2]

6.2.2

Joints in brass or copper pipe shall be welded, brazed, threaded, ~~or~~ press-connected or flanged. If of the socket type, they shall be brazed with silver-brazing alloy or similar high-melting-point filler metal.

Statement of Problem and Substantiation for Public Input

Currently NFPA 51 does not incorporate press-connect fittings. Press-connect fittings are a reliable permanent joining method
incorporating an elastomeric seal or an elastomeric seal and corrosion-resistant grip or bite ring. The permanent joint is made with a pressing tool and jaw or ring approved by the fitting manufacturer.

Press-connect fittings are designed for use in water, gas and chemical piping systems and many other applications that have been in use for over 20 years in the United States and Canada and over 30 years in Europe. Press-connect fittings are used in a variety of applications and are specifically referenced in NFPA 31, 54, 55, 58 and are also included by reference in international plumbing, mechanical and fuel gas codes.

The addition of press-connect fittings to NFPA 51 will provide the installer with a safe installation method that does not require the use of open flame, reduces the risk of injury to the installer and reduces the risk of property damage associated with other piping joining methods.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 1-NFPA 51-2019 [Section No. 6.2.1]	Steel Pipe Joint section revision
Public Input No. 1-NFPA 51-2019 [Section No. 6.2.1]	
Public Input No. 4-NFPA 51-2020 [Section No. 6.2.3]	

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Attachment E - NFPA 51 Public Inputs

Public Input No. 4-NFPA 51-2020 [Section No. 6.2.3]

6.2.3

Joints in seamless copper, brass, or stainless steel tubing shall be listed or approved gas tubing fittings, press-connect joints, or the joints shall be brazed. If of the socket type, they shall be brazed with silver-brazing alloy or similar high-melting-point filler metal. Press-connect joints shall be installed in accordance with the manufacturer's specifications and installation instructions.

Statement of Problem and Substantiation for Public Input

Currently press-connect fittings are not included as a joining method for copper or stainless steel tubing. Due to the fact that the listing language in this section does not specifically list the a standard the product must be listed to, i wanted to be sure to include press-connect fittings as a joining method to ensure there are no confusion regarding the installation of the products in these applications. Press-connect fittings are a common joining method for these type of applications and are specifically called out in NFPA 31, NFPA 54, NFPA 55 and NFPA 58 just to name a few. The revision of this section will allow this technology to be included along with the other common joining methods currently recognized by the code.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 1-NFPA 51-2019 [Section No. 6.2.1]	
Public Input No. 2-NFPA 51-2019 [Section No. 6.2.2]	

Submitter Information Verification

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Committee: IMG-AAA

Attachment F - NFPA 55 Public Inputs

Public Input No. 111-NFPA 55-2020 [Section No. 1.1]

1.1 _ Scope .

This code shall provide fundamental safeguards for the installation, storage, use, and handling of compressed gases and cryogenic fluids in portable and stationary cylinders, containers, and tanks.

1. 2 Purpose .

The purpose of this code shall be to provide a reasonable degree of protection of life and property from fire through standardization of practices for the installation, storage, use, and handling of compressed gases and cryogenic fluids.

1. 3 Application .

1

~~* – Applicability.~~

~~This **.3.1*** This code shall apply to the installation, storage, use, and handling of compressed gases and cryogenic fluids in portable and stationary cylinders, containers, equipment, and tanks in all occupancies.~~

Attachment F - NFPA 55 Public Inputs

1.~~1~~ 3 .2* Specific Applications. ~~This code shall not apply to the following:~~

Attachment F - NFPA 55 Public Inputs

(1) * Off-site transportation of materials covered by this code

(2) Storage, use, and handling of radioactive gases in accordance with NFPA 801

(3) * Use and handling of medical compressed gases at health care facilities in accordance with NFPA 99, except as specified in Chapter 17

(4) Systems consisting of cylinders of oxygen and cylinders of fuel gas used for welding and cutting in accordance with NFPA 51

(5) * Flammable gases used as a vehicle fuel when stored on a vehicle

(6) * Storage, use, and handling of liquefied and nonliquefied compressed gases in laboratory work areas in accordance with NFPA 45

(7) Storage, use, and handling of liquefied petroleum gases in accordance with NFPA 58

(8) Storage, use, and handling of compressed gases within closed-cycle refrigeration systems complying with the mechanical code

(9) Liquefied natural gas (LNG) storage at utility plants under NFPA 59A

(10) Compressed natural gas (CNG) and LNG utilized as a vehicle fuel in accordance with NFPA 52

(11) * Compressed hydrogen gas (GH_2), or liquefied hydrogen gas (LH_2) generated, installed, stored, piped, used, or handled in accordance with NFPA 2 when there are no specific or applicable requirements in NFPA 55

(12) Nonflammable mixtures of ethylene oxide with other chemicals

(13) Ethylene oxide in chambers 10 scf (0.283 Nm^3) or less in volume or for containers holding 7.05 oz (200 g) of ethylene oxide or less

Renumber Annex material as follows:

A.1.3.1 The term "portable" points out the application of this code to systems other than those considered to be permanent; i.e., systems where the equipment is installed on foundations and meant to stay in place for a considerable period of time. This code applies to portable and temporary systems, including the two types listed below:

(1) Equipment that is ordinarily used for the transportation and delivery of compressed gases or cryogenic fluids but that is located at a customer (end user) location and used for storage of compressed gases or cryogenic fluids. One example is a compressed gas tube trailer that is dropped at a customer location and left in place to supply the compressed gas to the customer use point. Another example is a cryogenic liquid trailer that is left at a customer location to supply cryogenic liquids to the customer use point (or vaporized into gas before going to the use point).

(2) Equipment used for the temporary supply of compressed gases or cryogenic fluids at a customer location. An example is a portable cryogenic tank that is mounted on a trailer and dropped at the customer location and not always connected to foundations by anchor bolts. Such a supply system may be in place for a matter of weeks as opposed to a more permanent system that is left in place for years.

Some of the requirements of this code are not applicable to this type of equipment. For example, some sections of this code mandate that the equipment be anchored to permanent foundations. Equipment with wheels for transportation do not need to be anchored. However, auxiliary equipment, such as pressure reducing stations, would need to be anchored to a foundation. The user must determine which sections of the code apply to equipment and which sections do not apply.

It is not the intent of this code to regulate transportation and delivery equipment when that equipment is used only to deliver product to a storage system at a customer location. For example, a cryogenic liquid trailer that delivers product into a storage system (and does not stay on site after delivering product) does not have to meet the requirements of this code. The trailer is governed by DOT/TC requirements. Another example is a compressed gas tube trailer that delivers product to a permanent storage system and does not stay on site to supply product to the end user.

Portable equipment is sometimes transported with product loaded in the storage vessel or may be shipped with the vessel empty, to be filled at the customer location. Equipment that is designed to be transported with product in it is governed by DOT/TC regulations. Nothing in this code is intended to overrule the DOT/TC regulations governing the use of such equipment.

A.1.3.2(1) For regulations on the transportation of gases, see 49 CFR 100–185, "Transportation," and *Transportation of Dangerous Goods Regulations* .

A.1.3.2(3) Cryogenic fluid central supply system installations are intended to be covered by the requirements of this

Attachment F - NFPA 55 Public Inputs

code. Instrumentation and alarms that are attendant to the system and designed to interface with the application in a health care facility are to be retained within the purview of NFPA 99. See Section 17.1.2.

A.1.3.2(5) For information, see NFPA 52, or NFPA 58.

A.1.3.2(6) The storage and use of compressed gases and cryogenic fluids outside the boundaries of laboratory work areas are covered by this code.

A.1.3.2(11) NFPA 55 is used as the source document for the fundamental requirements for compressed hydrogen gas (GH2), or liquefied hydrogen gas (LH2) system installations. Correlation between NFPA 55 and NFPA 2 is the responsibility of the two technical committees involved. The installation requirements for bulk GH2 or LH2 are viewed as fundamental provisions. On the other hand, use-specific requirements for designated applications such as vehicular fueling are not resident in NFPA 55 and are under the purview of the NFPA 2 Technical Committee. Where there are specific provisions or controls included in NFPA 55, the specific controls of NFPA 55 will govern except that modifications made to provisions that have been extracted can be followed when the modifications have been made within NFPA's extract procedure as indicated in the *Manual of Style for NFPA Technical Committee Documents* .

Additional Proposed Changes

File Name	Description	Approved
NFPA_55_document_scope_Submit.docx	Word Doc of changes	

Statement of Problem and Substantiation for Public Input

To correct the scope, purpose and application of the document to match the manual of style. This was submitted by the NFPA 55 scope review task group.

Submitter Information Verification

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Submittal Date: Mon Jun 29 08:45:57 EDT 2020

Committee: IMG-AAA

Attachment F - PI111 Attachment

NFPA 55 document scope update 2020

Chapter 1 Administration

1.1 Scope. This code shall provide fundamental safeguards for the installation, storage, use, and handling of compressed gases and cryogenic fluids in portable and stationary cylinders, containers, and tanks.

1.2 Purpose The purpose of this standard shall be to provide a reasonable degree of protection of life and property from fire through standardization of practices for the installation, storage, use, and handling of compressed gases and cryogenic fluids.

1.3 Application

1.3.1* This code shall apply to the installation, storage, use, and handling of compressed gases and cryogenic fluids in portable and stationary cylinders, containers, equipment, and tanks in all occupancies.

A.1.3.1 The term "portable" points out the application of this code to systems other than those considered to be permanent; i.e., systems where the equipment is installed on foundations and meant to stay in place for a considerable period of time. This code applies to portable and temporary systems, including the two types listed below:

(1) Equipment that is ordinarily used for the transportation and delivery of compressed gases or cryogenic fluids but that is located at a customer (end user) location and used for storage of compressed gases or cryogenic fluids. One example is a compressed gas tube trailer that is dropped at a customer location and left in place to supply the compressed gas to the customer use point. Another example is a cryogenic liquid trailer that is left at a customer location to supply cryogenic liquids to the customer use point (or vaporized into gas before going to the use point).

(2) Equipment used for the temporary supply of compressed gases or cryogenic fluids at a customer location. An example is a portable cryogenic tank that is mounted on a trailer and dropped at the customer location and not always connected to foundations by anchor bolts. Such a supply system may be in place for a matter of weeks as opposed to a more permanent system that is left in place for years.

Some of the requirements of this code are not applicable to this type of equipment. For example, some sections of this code mandate that the equipment be anchored to permanent foundations. Equipment with wheels for transportation do not need to be anchored. However, auxiliary equipment, such as pressure reducing stations, would need to be anchored to a foundation. The user must determine which sections of the code apply to equipment and which sections do not apply.

It is not the intent of this code to regulate transportation and delivery equipment when that equipment is used only to deliver product to a storage system at a customer location. For example, a cryogenic liquid trailer that delivers product into a storage system (and does not stay on site after delivering product) does not have to meet the requirements of this code. The trailer is governed by DOT/TC requirements. Another example is a compressed gas tube trailer that delivers product to a permanent storage system and does not stay on site to supply product to the end user.

Portable equipment is sometimes transported with product loaded in the storage vessel or may be shipped with the vessel empty, to be filled at the customer location. Equipment that is designed to be transported with product in it is governed by DOT/TC regulations. Nothing in this code is intended to overrule the DOT/TC regulations governing the use of such equipment.

1.3.2 This code shall not apply to the following:

(1)***** Off-site transportation of materials covered by this code

A.1.3.2(1) For regulations on the transportation of gases, see 49 CFR 100–185, "Transportation," and *Transportation of Dangerous Goods Regulations*.

(2) Storage, use, and handling of radioactive gases in accordance with NFPA 801

(3)***** Use and handling of medical compressed gases at health care facilities in accordance with NFPA 99, except as specified in Chapter 17
A.1.3.2(3) Cryogenic fluid central supply system installations are intended to be covered by the requirements of this code. Instrumentation and alarms that are attendant to the system and designed to interface with the application in a health care facility are to be retained within the purview of NFPA 99. See Section 17.1.2.
(4) Systems consisting of cylinders of oxygen and cylinders of fuel gas used for welding and cutting in accordance with NFPA 51
(5)***** Flammable gases used as a vehicle fuel when stored on a vehicle
A.1.3.2(5) For information, see NFPA 52, or NFPA 58.
(6)***** Storage, use, and handling of liquefied and nonliquefied compressed gases in laboratory work areas in accordance with NFPA 45
A.1.3.2(6) The storage and use of compressed gases and cryogenic fluids outside the boundaries of laboratory work areas are covered by this code.
(7) Storage, use, and handling of liquefied petroleum gases in accordance with NFPA 58
(8) Storage, use, and handling of compressed gases within closed-cycle refrigeration systems complying with the mechanical code
(9) Liquefied natural gas (LNG) storage at utility plants under NFPA 59A
(10) Compressed natural gas (CNG) and LNG utilized as a vehicle fuel in accordance with NFPA 52
(11)***** Compressed hydrogen gas (GH2), or liquefied hydrogen gas (LH2) generated, installed, stored, piped, used, or handled in accordance with NFPA 2 when there are no specific or applicable requirements in NFPA 55
A.1.3.2(11) NFPA 55 is used as the source document for the fundamental requirements for compressed hydrogen gas (GH2), or liquefied hydrogen gas (LH2) system installations. Correlation between NFPA 55 and NFPA 2 is the responsibility of the two technical committees involved. The installation requirements for bulk GH2 or LH2 are viewed as fundamental provisions. On the other hand, use-specific requirements for designated applications such as vehicular fueling are not resident in NFPA 55 and are under the purview of the NFPA 2 Technical Committee. Where there are specific provisions or controls included in NFPA 55, the specific controls of NFPA 55 will govern except that modifications made to provisions that have been extracted can be followed when the modifications have been made within NFPA's extract procedure as indicated in the *Manual of Style for NFPA Technical Committee Documents*.
(12) Nonflammable mixtures of ethylene oxide with other chemicals
(13) Ethylene oxide in chambers 10 scf (0.283 Nm3) or less in volume or for containers holding 7.05 oz (200 g) of ethylene oxide or less.

Attachment F - NFPA 55 Public Inputs

Public Input No. 70-NFPA 55-2020 [Section No. 1.1.2]

1.1.2 Specific Applications.

This code shall not apply to the following:

(1) * Off-site transportation of materials covered by this code

(2) Storage, use, and handling of radioactive gases in accordance with NFPA 801

(3) * Use and handling of medical compressed gases at health care facilities in accordance with NFPA 99, except as specified in Chapter 17

(4) Systems consisting of cylinders of oxygen and cylinders of fuel gas used for welding and cutting in accordance with NFPA 51

(5) * Flammable gases used as a vehicle fuel when stored on a vehicle

(6) * Storage, use, and handling of liquefied and nonliquefied compressed gases in laboratory work areas in accordance with NFPA 45

(7) Storage, use, and handling of liquefied petroleum gases in accordance with NFPA 58

(8) Storage, use, and handling of compressed gases within closed-cycle refrigeration systems complying with the mechanical code

(9) Liquefied natural gas (LNG) storage at utility plants under NFPA 59A

(10) Compressed natural gas (CNG) and LNG utilized as a vehicle fuel in accordance with NFPA 52

(11) * Compressed hydrogen gas (GH_2), or liquefied hydrogen gas (LH_2) generated, installed, stored, piped, used, or handled in accordance with NFPA 2 ~~when there are no specific or applicable requirements in NFPA 55~~ ;

(12) Nonflammable mixtures of ethylene oxide with other chemicals

(13) Ethylene oxide in chambers 10 scf (0.283 Nm^3) or less in volume or for containers holding 7.05 oz (200 g) of ethylene oxide or less

Statement of Problem and Substantiation for Public Input

According to the Committee Scopes the HYD Committee has "primary responsibility for documents on the storage, transfer, production, and use hydrogen" and the IMG "Committee shall coordinate the material on gaseous and liquid hydrogen storage and use with the Hydrogen Technology Committee." The present text of 1.1.2 (11) is not consistent with these scopes. Removing the conditional phrase at the end of the sentence puts in agreement with the scope statements.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 87-NFPA 55-2020 [Section No. A.1.1.2(11)]	

Submitter Information Verification

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Committee: IMG-AAA

Attachment F - NFPA 55 Public Inputs

Public Input No. 39-NFPA 55-2020 [Section No. 2.3.3]

2.3.3 ASTM Publications.

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

ASTM B88, *Standard Specification for Seamless Copper Water Tube*, 2016.

ASTM B819, *Standard Specification for Seamless Copper Tube for Medical Gas Systems*, ~~2018~~ 2019 .

ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, ~~2018~~ 2020 .

ASTM E136, *Standard Test Method for ~~Behavior~~ Assessing Combustibility of Materials ~~in a~~ Using a Vertical Tube Furnace at 750°C*, ~~2016~~ 2019a .

ASTM E681, *Standard Test Method for Concentration Limits of Flammability of Chemicals (Vapors and Gases)*, 2009 (2015) .

ASTM E1529, *Standard Test Methods for Determining Effects of Large Hydrocarbon Pool Fires on Structural Members and Assemblies*, 2016 e1 .

ASTM E2652, *Standard Test Method for ~~Behavior of Materials in a~~ Assessing Combustibility of Materials Using a Tube Furnace with a Cone-Shaped Airflow Stabilizer, at 750 Degrees C*, ~~2016~~ 2018 .

ASTM E2965, *Standard Test Method for Determination of Low Levels of Heat Release Rate for Materials and Products Using an Oxygen Consumption Calorimeter*, 2017.

Statement of Problem and Substantiation for Public Input

updates

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Committee:	IMG-AAA

Attachment F - NFPA 55 Public Inputs

Public Input No. 33-NFPA 55-2020 [Section No. 2.3.8]

2.3.8 ISO Publications.

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

ISO 10156, *Gases and gas mixtures — Determination of fire potential and oxidizing ability for the selection of cylinder valve outlets,*2017.

ISO 10298, *Gas cylinders - Gases and gas mixtures - Determination of toxicity ~~of a gas or gas mixture~~ for the selection of cylinder valve outlets* , 2018.

Statement of Problem and Substantiation for Public Input

Revise to correct title. Title cited in NFPA 55 2020 for ISO 10298:2018 is in error.

Submitter Information Verification

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Committee: IMG-AAA

Attachment F - NFPA 55 Public Inputs

Public Input No. 19-NFPA 55-2020 [Section No. 2.3.9]

2.3.9 UL Publications.

Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062.

~~ANSI/~~ UL 723, ~~*Standard for Test*~~ *Test of Surface Burning Characteristics of Building Materials*, ~~2008, revised~~ 2018.

Statement of Problem and Substantiation for Public Input

Reason: Many years ago, UL preferred the ANSI/UL reference because there was a transition of traditional UL standards towards an ANSI standards development process.

Now, years later, a large majority of UL Standards are ANSI approved and follow the ANSI development and maintenance process. However, sometimes readers are confused because they don't understand the standards are actually UL standards, not developed by ANSI. There are many other references to standards promulgated by other standards development organizations where they are considered ANSI approved but do not include ANSI in the reference.
The terms "Standard for" or "Subject" are redundant and unnecessary. All references to UL are standards.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 20-NFPA 55-2020 [Section No. I.1.2.9]	

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Committee: IMG-AAA

Attachment F - NFPA 55 Public Inputs

Public Input No. 62-NFPA 55-2020 [Section No. 3.3.28]

3.3.28 Court.

An open, uncovered, unoccupied space, unobstructed to the sky, bounded on three or more sides by exterior building or fire barrier walls. ~~[*101,* 2018]~~

3.3.28.1 Enclosed Court.

A court bounded on all sides by ~~the~~ exterior ~~walls of a~~ building or ~~by the exterior walls and lot lines on which walls are permitted. [**5000,** 2018]~~ fire barrier walls.

Statement of Problem and Substantiation for Public Input

Many courts consisting of a combination of exterior building walls and fire barrier walls are currently used for hydrogen systems. The current definitions do not include fire barrier walls. Both of the paragraphs with modified text are extract and it's proposed to drop the extract tags in lieu of a definition that is more applicable to NFPA 55.

Submitter Information Verification

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Submittal Date:	Thu Jun 25 21:02:57 EDT 2020
Committee:	IMG-AAA

Attachment F - NFPA 55 Public Inputs

Public Input No. 21-NFPA 55-2020 [New Section after 3.3.51.1]

3.3.51.1 (new) Chemically Unstable Gas (Category A)

A flammable gas which is chemically unstable at 68F (20C) and a standard pressure of 14.7 psi (101.3 kPa).

3.3.51.2 (new) Chemically Unstable Gas (Category B)

A flammable gas which is chemically unstable at a temperature greater than 68F (20C) and/or a pressure greater than 14.7 psi (101.3 kPa).

Statement of Problem and Substantiation for Public Input

The term "chemically unstable gas" is defined in the GHS Purple Book, 7th Ed, Flammable Gas Classification Criteria. It will be used in the proposed categories of flammable gas which is also from the GHS Purple Book.

It is recognized that there is an 8th Edition of the GHS Purple Book. However, the proposed definitions remain the same and I referenced the 7th Edition since that is what is being considered for adoption by OSHA.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 23-NFPA 55-2020 [New Section after 5.1.4.2]	Term is used in language proposed in PI 23.

Submitter Information Verification

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Submittal Date: Wed Jun 17 12:46:52 EDT 2020

Committee: IMG-AAA

Attachment F - NFPA 55 Public Inputs

Public Input No. 71-NFPA 55-2020 [Section No. 3.3.56]

~~**3.3.56** Gasifier.~~

~~An assembly of equipment that converts carbonaceous materials, such as coal or petroleum, into carbon monoxide and hydrogen by reacting the raw material at high temperatures with a controlled amount of oxygen.~~

Statement of Problem and Substantiation for Public Input

"Gasifier" is only used in 3.3.95.9.2 as one example of a hydrogen generator. Hydrogen generators including gasifiers are in the scope of NFPA 2 and are addressed by that code and neither is addressed by NFPA 55. There is no need for this definition in NFPA 55 and its presence causes confusion regarding whether NFPA 2 or NFPA 55 applies.

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Attachment F - NFPA 55 Public Inputs

Public Input No. 101-NFPA 55-2020 [Section No. 3.3.69]

~~**3.3.69** Metal Hydride.~~

~~A generic name for compounds composed of metallic element(s) and hydrogen.~~

Statement of Problem and Substantiation for Public Input

The storage, use, handling, and many other aspects of hydrogen including metal hydride are addressed by NFPA 2. The simplest, least error prone way for NFPA 55 to coordinate with NFPA 2 regarding hydrogen gas is to just refer the user to NFPA 2. This is best accomplished in in 7.6.1.2 and 8.1.4. This nullifies the need for Chapter 10 and thus for this definition.

Note: Per the committee scope statements the HYD Committee has "primary responsibility for documents on the storage, transfer, production, and use hydrogen" and the IMG "Committee shall coordinate the material on gaseous and liquid hydrogen storage and use with the Hydrogen Technology Committee."

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 85-NFPA 55-2020 [Chapter 10]	This definition is only used in Chapter 10.
Public Input No. 102-NFPA 55-2020 [Section No. 3.3.70]	

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Attachment F - NFPA 55 Public Inputs

Public Input No. 102-NFPA 55-2020 [Section No. 3.3.70]

~~**3.3.70** – Metal Hydride Storage System.~~

~~A closed system consisting of a group of components assembled as a package to contain metal–hydrogen compounds for which there exists an equilibrium condition where the hydrogen-absorbing metal alloy(s), hydrogen gas, and the metal–hydrogen compound(s) coexist and where only hydrogen gas is released from the system in normal use.~~

Statement of Problem and Substantiation for Public Input

The storage, use, handling, and many other aspects of hydrogen including metal hydride are addressed by NFPA 2. The simplest, least error prone way for NFPA 55 to coordinate with NFPA 2 regarding hydrogen gas is to just refer the user to NFPA 2. This is best accomplished in in 7.6.1.2 and 8.1.4. This nullifies the need for Chapter 10 and thus for this definition.

Note: Per the committee scope statements the HYD Committee has "primary responsibility for documents on the storage, transfer, production, and use hydrogen" and the IMG "Committee shall coordinate the material on gaseous and liquid hydrogen storage and use with the Hydrogen Technology Committee."

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 85-NFPA 55-2020 [Chapter 10]	This definition is only used in Chapter 10.
Public Input No. 101-NFPA 55-2020 [Section No. 3.3.69]	Related definitions.

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Attachment F - NFPA 55 Public Inputs

Public Input No. 73-NFPA 55-2020 [Section No. 3.3.84]

~~**3.3.84** Reformer.~~

~~An assembly of equipment that can be used to produce hydrogen gas from hydrocarbons or other hydrogen-containing fuel, usually at high temperature and usually in the presence of a catalyst. The gaseous stream consists principally of a mixture of hydrogen and carbon monoxide.~~

Statement of Problem and Substantiation for Public Input

"Reformer" is only used in 3.3.95.9.2 as one example of a hydrogen generator. Hydrogen generators including reformers are in the scope of NFPA 2 and are addressed by that code and neither is addressed by NFPA 55. There is no need for this definition in NFPA 55 and its presence causes confusion regarding whether NFPA 2 or NFPA 55 applies.

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Attachment F - NFPA 55 Public Inputs

Public Input No. 36-NFPA 55-2020 [New Section after 3.3.85]

3.3.X Risk Management Terminology.

3.3.X.1 Harm.

Injury or damage to the health of people, or damage to property or the environment.

3.3.X.2 Hazard.

Potential source of harm.

3.3.X.3 Likelihood.

Chance of something happening.

3.3.X.4 Risk.

The combination of the probability of occurrence of harm and the severity of that harm.

3.3.X.5 Risk Analysis.

Process to comprehend the nature of risk and to determine the level of risk.

3.3.X.6 Risk Assessment.

Overall process of risk identification, risk analysis, and risk evaluation.

3.3.X.7 Risk Identification.

Process of finding, recognizing and describing risks.

3.3.X.8 Risk Evaluation.

Process of comparing the results of risk analysis with risk criteria to determine whether the risk and/or its magnitude is acceptable or tolerable.

3.3.X.9 Level of Risk.

Magnitude of a risk or combination of risks, expressed in terms of the combination of consequences and their likelihood.

Statement of Problem and Substantiation for Public Input

The term risk and other risk related terms are used extensively in NFPA 55, but are not defined. For example A.16.9.1 states that thermal mass flow controllers should not be used (for liquid nitrous oxide systems) due to the internal heater element, unless a "risk assessment" is carried out to ensure that there is no risk of thermal decomposition. Adding the risk terminology definitions will help readers of NFPA 55, not versed in risk management, better understand these terms when they are cited in NFPA 55.

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Attachment F - NFPA 55 Public Inputs

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Attachment F - NFPA 55 Public Inputs

Public Input No. 34-NFPA 55-2020 [New Section after 3.3.94]

3.3.X Subatmospheric Gas Source (SAGS)

3.3.x.1 Subatmospheric Gas Storage and Delivery Source (Type 1 SAGS)

A gas source package that stores and delivers gas at subatmospheric pressure and includes a container (e.g.,gas cylinder and outlet valve) that stores and delivers gas at a pressure of less than absolute pressure of 14.7 psi at NTP. [318, 2018]

3.3.X.2 Subatmospheric Gas Delivery Source (Type 2 SAGS)

A gas source package that stores compressed gas and delivers gas at subatmospheric pressure and includes a container (e.g., gas cylinder and outlet valve) that stores gas at a pressure greater than absolute pressure of 14.7 psi at NTP and delivers gas at a pressure of less than absolute pressure of 14.7 psi at NTP. [318,2018]

Statement of Problem and Substantiation for Public Input

By extracting the definitions for SAGS from NFPA 318 (Standard for the Protection of Semiconductor Fabrication Facilities), requirements for these gas sources can be extended to facilities of producers of SAGS and facilities other than semiconductor fabrication facilities that use SAGS. The scope of NFPA 318 applies only to semiconductor fabrication facilities. The scope of NFPA includes producers and non-semicondutors users.

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Attachment F - NFPA 55 Public Inputs

Public Input No. 35-NFPA 55-2020 [Section No. 3.3.95.2]

3.3.95.2* Bulk Inert Gas System.

An assembly of equipment that consists of, but is not limited to, storage containers, pressure regulators, pressure relief devices, vaporizers, manifolds, and piping, with a storage capacity of more than 20,000 scf (566 Nm^3) of inert gas, ~~including unconnected reserves on hand at the site, and~~ and that terminates at the source valve.

Statement of Problem and Substantiation for Public Input

CGA P-18 does not include unconnected reserves in the bulk system definition. The term "including unconnected reserves on hand at the site" has been removed from definitions for other bulk gas systems in NFPA 55 in previous revision cycles, but section 3.3.95.2 was missed.

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Attachment F - NFPA 55 Public Inputs

Public Input No. 103-NFPA 55-2020 [Section No. 3.3.95.9]

~~**3.3.95.9** * – Gaseous Hydrogen (GH_2) System.~~

~~An assembly of equipment that consists of, but is not limited to, storage containers, pressure regulators, pressure relief devices, compressors, manifolds, and piping and that terminates at the source valve.~~

~~**3.3.95.9.1** * – Bulk Hydrogen Compressed Gas System.~~

~~A gaseous hydrogen (GH_2) system with a storage capacity of more than 5000 scf (141.6 Nm^3) of compressed hydrogen gas.~~

~~**3.3.95.9.2** – Hydrogen Generation System.~~

~~A packaged, factory matched, or site constructed hydrogen gas generation appliance or system such as (a) an electrolyzer that uses electrochemical reactions to electrolyze water to produce hydrogen and oxygen gas; (b) a reformer that converts hydrocarbon fuel to a hydrogen-rich stream of composition and conditions suitable for the type of device using the hydrogen; or (c) a gasifier that converts coal to a hydrogen-rich stream of composition and conditions suitable for a type of device using the hydrogen. It does not include hydrogen generated as a by-product of a waste treatment process.~~

Statement of Problem and Substantiation for Public Input

The storage, use, handling, and many other aspects of hydrogen are addressed by NFPA 2. The simplest, least error prone way for NFPA 55 to coordinate with NFPA 2 regarding hydrogen gas is to just refer the user to NFPA 2. This is best accomplished in in 7.6.1.2 and 8.1.4. This nullifies the need for Chapter 10 and thus for these definitions.

Note: Per the committee scope statements the HYD Committee has "primary responsibility for documents on the storage, transfer, production, and use hydrogen" and the IMG "Committee shall coordinate the material on gaseous and liquid hydrogen storage and use with the Hydrogen Technology Committee."

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 85-NFPA 55-2020 [Chapter 10]	These definitions are used in Chapter 10.
Public Input No. 106-NFPA 55-2020 [Section No. A.3.3.95.9]	
Public Input No. 107-NFPA 55-2020 [Section No. A.3.3.95.9.1]	

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Attachment F - NFPA 55 Public Inputs

Public Input No. 72-NFPA 55-2020 [Section No. 3.3.95.9.2]

~~**3.3.95.9.2** – Hydrogen Generation System.~~

~~A packaged, factory matched, or site constructed hydrogen gas generation appliance or system such as (a) an electrolyzer that uses electrochemical reactions to electrolyze water to produce hydrogen and oxygen gas; (b) a reformer that converts hydrocarbon fuel to a hydrogen-rich stream of composition and conditions suitable for the type of device using the hydrogen; or (c) a gasifier that converts coal to a hydrogen-rich stream of composition and conditions suitable for a type of device using the hydrogen. It does not include hydrogen generated as a by-product of a waste treatment process.~~

Statement of Problem and Substantiation for Public Input

Hydrogen generators are in the scope of NFPA 2 and are addressed by that code and are not addressed by NFPA 55. There is no need for this definition in NFPA 55.

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Attachment F - NFPA 55 Public Inputs

Public Input No. 104-NFPA 55-2020 [Section No. 3.3.95.10]

~~**3.3.95.10** – Liquefied Hydrogen (LH $_2$) System.~~

~~An assembly of equipment that consists of, but is not limited to, storage containers, pressure regulators, pressure relief devices, compressors, manifolds, and piping and that terminates at the source valve.~~

~~**3.3.95.10.1** * – Bulk Liquefied Hydrogen System.~~

~~A liquefied hydrogen (LH $_2$) system with a storage capacity of more than 39.7 gal (150 L) of liquefied hydrogen.~~

Statement of Problem and Substantiation for Public Input

The storage, use, handling, and many other aspects of hydrogen including metal hydride are addressed by NFPA 2. The simplest, least error prone way for NFPA 55 to coordinate with NFPA 2 regarding hydrogen gas is to just refer the user to NFPA 2. This is best accomplished in in 7.6.1.2 and 8.1.4. This nullifies the need for Chapter 11 and thus for these definitions.

Note: Per the committee scope statements the HYD Committee has "primary responsibility for documents on the storage, transfer, production, and use hydrogen" and the IMG "Committee shall coordinate the material on gaseous and liquid hydrogen storage and use with the Hydrogen Technology Committee."

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 86-NFPA 55-2020 [Chapter 11]	These definitions are used in Chapter 11.
Public Input No. 108-NFPA 55-2020 [Section No. A.3.3.95.10.1]	

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Attachment F - NFPA 55 Public Inputs

Public Input No. 37-NFPA 55-2020 [Section No. 5.1.4.1]

5.1.4.1 Toxicity of Gas Mixtures .

The toxicity of gas mixtures shall be classified in accordance with CGA P-20, *Standard for the Classification of Toxic Gas Mixtures,* ~~or by testing in accordance with~~ or with the requirements of 29 CFR 1910.~~1000~~ 1200 , ~~DOT~~ 49 CFR 173.115 , or ISO 10298, *Gas cylinders - Gases and gas mixtures - Determination of toxicity* ~~*of a gas or gas mixture*~~ *for the selection of cylinder valve outlets* .

Statement of Problem and Substantiation for Public Input

Changing the heading of 5.1.4.1 to include "of Gas Mixtures" makes it consistent with 5.1.4.2 which has the heading “Classification of Flammable Gas Mixtures” and because this paragraph only discusses toxic gas mixtures.

29 CFR 1910.1000 does not provide requirements for classification of gases or gas mixtures. 29 CFR 1910.1000 provides requirements for employee exposure limits to certain chemical substances.

29 CFR 1910.1200 is the OSHA Hazard Communication Standard which requires that the hazards of all chemicals produced or imported are classified and that information concerning the classified hazards is transmitted to employers and employees. The requirements of 29 CFR 1910.1200 intends to be consistent with the provisions of the United Nations Globally Harmonized System of Classification and Labeling of Chemicals (GHS), Revision 3.

OSHA defines a health hazard to mean a chemical which is classified as posing one of the following hazardous effects: acute toxicity (any route of exposure); skin corrosion or irritation; serious eye damage or eye irritation; respiratory or skin sensitization; germ cell mutagenicity; carcinogenicity; reproductive toxicity; specific target organ toxicity (single or repeated exposure); or aspiration hazard.

The criteria for determining whether a chemical is classified as a health hazard are detailed in Appendix A to 29 CFR §1910.1200—Health Hazard Criteria.

Section A.1.3 of Appendix A to 29 CFR §1910.1200 provides the requirements for classifying the acute toxicity of mixtures. Figure A.1.1 in Appendix A shows the process that must be followed.

Therefore 29 CFR 1910.1200 is the appropriate reference to insert in NFPA 55 5.1.4.1, if the intent is to include an OSHA reference for the classification of toxic gas mixtures.

Note: Classification in accordance with 29 CFR 1910.1200 results in the classification required for the workplace environment, whereas classification in accordance with P-20, 49 CFR 173.115 and ISO 10298 result in the classification requirements for transport. This is not stated in NFPA 55 and it may be advisable to address this ambiguity.

Testing is not the only method gas mixtures can be classified by in accordance with 29 CFR 1910.1200, 49 CFR 173.115, or ISO 10298. For example, 49 CFR 173.115 (c)(2) allows the LC50 values for mixtures to be determined using the formula in §173.133(b)(1)(i). Additionally, sub-section A.0.2.1 of 29 CFR 1910.1200 Appendix A states there is no requirement for testing chemicals when classifying chemicals. A.1.3.6 of 29 CFR 1910.1200 allows for an estimate of toxicity when test data is not available for the complete mixture or the bridging principles cannot be applied and test data is available for each ingredient of the mixture. This method uses the additivity formula to calculate the toxicity of the mixture to provide an acute toxicity estimate (ATE). For gas mixtures this approach is often used as test data for gas mixtures are rare precluding the use of the bridging principle method of classification. In this case a formula is used to classify the toxicity of a gas mixture and not a test.

The title of ISO 10298:2018 is incorrect in NFPA 55 2020 and has been corrected.

The DOT citation has been revised to better identify the location in 49 CFR where the requirements for classification of toxic gas mixtures is located.

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Attachment F - NFPA 55 Public Inputs

Public Input No. 23-NFPA 55-2020 [New Section after 5.1.4.2]

5.2 Flammable Gas Categories.

Flammable gases shall be classified in accordance with the following criteria.

5.2.1 Category 1A . Flammable gases that does is not classified as Category 1B or Category 2, a pyrophoric gases, and chemically unstable gases shall be identified as a Category 1A Flammable Gas.

5.2.2 Category 1B. Flammable gases that are not pyrophoric or chemically unstable and which have at least either:

(1) A lower flammability limit of more than 6% by volume in air; or

(2) A fundamental burning velocity of less than 10 cm/s

5.2.3 Category 2. Gases, other than those of Category 1A or 1B, which, at 68F (20C) and a standard pressure of 14. psi (101.3 kPa), have a flammable range while mixed in air.

Statement of Problem and Substantiation for Public Input

The intent of the Public Input is to create consistency with the GHS Purple Book, 7th Ed. Flammable Gas Classification Criteria. It is recognized that there is an 8th Edition but the proposed classifications are the same between the two editions and OSHA is considering adopting the 7th Edition of the GHS Purple Book.

It is recognized that this is not a complete submission in that other changes will need to be made throughout the document if the Committee indicates that they will at least consider the GHS classifications. The complete package will be submitted during the Public Comment period if that is the case. We would recommend that a Committee Input be created based upon this Public Input, if the Committee will consider changing the definitions.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 21-NFPA 55-2020 [New Section after 3.3.51.1]	

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Attachment F - NFPA 55 Public Inputs

Public Input No. 57-NFPA 55-2020 [Chapter 6]

~~**Chapter 6** – Building-Related Controls~~

~~**6.1** – General.~~

~~**6.1.1** – Occupancy.~~

~~**6.1.1.1** – Occupancy Requirements.~~

~~Occupancies that contain compressed gases or cryogenic fluids shall comply with this chapter in addition to other applicable requirements of this code.~~

~~**6.1.1.2** – Occupancy Classification.~~

~~The occupancy of a building or structure, or portion of a building or structure, shall be classified in accordance with the building code.~~

~~**6.2** – Control Areas.~~

~~**6.2.1** – Construction Requirements.~~

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

~~Table 6.2.1 Design and Number of Control Areas~~

~~Floor Level Maximum Allowable~~

~~Quantity per Control~~

~~Area (%)* Number of Control~~

~~Areas per Floor Fire Resistance~~

~~Rating for~~

~~Fire Barriers† (hr) Above grade - - - >9 5 1 2 7–9 5 2 2 4–6 12.5 2 2 3 50 2 1 2 75 3 1 1 100 4 1 Below grade - - - 1 75 3 1 2 50 2 1 Lower than 2 NP NP N/A~~

~~NP: Not Permitted.~~

~~N/A: Not Applicable.~~

~~*Percentages represent the MAQ per control area shown in Table 6.3.1.1, with all of the increases permitted in the footnotes of that table.~~

~~†Fire barriers are required to include floors and walls, as necessary, to provide a complete separation from other control areas.~~

~~[**400:** Table 5.2.2.1]~~

~~**6.2.2** – Number of Control Areas.~~

~~The maximum number of control areas within a building shall be in accordance with Table 6.2.1 . [**400:** 5.2.2.1]~~

~~**6.2.3** –~~

~~Where only one control area is present in a building, no special construction provisions shall be required. [**400:** 5.2.2.2]~~

~~**6.2.4** – Quantities Less Than or Equal to the MAQ.~~

~~Indoor control areas with compressed gases or cryogenic fluids stored or used in quantities less than or equal to those shown in Table 6.3.1.1 shall be in accordance with 6.3.1.6 and 6.3.1.7 and Sections 6.1 , 6.8 , 6.9 , 6.13 , 6.16 , and 6.17 , and the applicable provisions of Chapters 1 through 5 and Chapters 7 through 16 .~~

~~**6.3** – Occupancy Protection Levels.~~

~~**6.3.1** – Quantity Thresholds for Compressed Gases and Cryogenic Fluids Requiring Special Provisions.~~

Attachment F - NFPA 55 Public Inputs

~~**6.3.1.1** Threshold Exceedances.~~

~~Where the quantities of compressed gases or cryogenic fluids stored or used within an indoor control area exceed those shown in Table 6.3.1.1 , the area shall meet the requirements for Protection Levels 1 through 5 in accordance with the building code, based on the requirements of 6.3.2 .~~

~~Table 6.3.1.1 Maximum Allowable Quantity (MAQ) of Hazardous Materials per Control Area~~

~~- - - Storage - Use — Closed Systems - Use — Open Systems Material Class High Hazard Protection~~
~~Level Solid Pounds Liquid Gallons Gas [a] scf (lb) - Solid Pounds Liquid Gallons Gas [a] scf (lb) - Solid~~
~~Pounds Liquid Gallons Cryogenic fluid Flammable 2 NA 45 [b,~~
~~c] NA - NA 45 [b,c] NA - NA 45 [b,c] - Oxidizing 3 NA 45 [d,~~
~~e] NA - NA 45 [d,e] NA - NA 45 [d,e] - Inert NA NA NL NA - NA NL NA - NA NL Flammable,~~
~~gas [f] Gaseous 2 NA NA 1000 [d,e] - NA NA 1000 [d,e] - NA NA - Liquefied 2 NA NA (150) [d,e] - NA NA (150) [d,e] - N~~
~~gas Gaseous NA NA NA NL - NA NA NL - NA NA - Liquefied NA NA NA NL - NA NA NL - NA NA Oxidizing~~
~~gas Gaseous 3 NA NA 1500 [d,e] - NA NA 1500 [d,e] - NA NA - Liquefied 3 NA NA (150) [d,e] - NA NA (150) [d,e] - NA~~
~~gas Gaseous 2 NA NA 50 [d,j] - NA NA 50 [d,j] - NA NA - Liquefied 2 NA NA (4) [d,j] - NA NA (4) [d,j] - NA NA Unstable~~
~~(reactive) gas Gaseous - - - - - - - - - - - - 4 or 3 detonable 1 NA NA 10 [d,j] - NA NA 10 [d,j] - NA NA - 3~~
~~nondetonable 2 NA NA 50 [d,e] - NA NA 50 [d,e] - NA NA - 2 3 NA NA 750 [d,e] - NA NA 750 [d,e] - NA NA - 1 NA NA N~~
~~(reactive) gas Liquefied - - - - - - - - - - - - 4 or 3~~
~~detonable 1 NA NA (1) [d,j] - NA NA (1) [d,j] - NA NA - 3~~
~~nondetonable 2 NA NA (2) [d,e] - NA NA (2) [d,e] - NA NA - 2 3 NA NA (150) [d,e] - NA NA (150) [d,e] - NA NA - 1 NA N~~
~~gas Gaseous 4 NA NA 810 [d,e] - NA NA 810 [d,e] - NA NA - Liquefied - NA NA (150) [d,e] - NA NA (150) [d,e] - NA NA~~
~~toxic~~
~~gas Gaseous 4 NA NA 20 [e,k] - NA NA 20 [e,k] - NA NA - Liquefied - NA NA (4) [e,k] - NA NA (4) [e,k] - NA NA Toxic~~
~~gas Gaseous 4 NA NA 810 [d,e] - NA NA 810 [d,e] - NA NA - Liquefied - NA NA (150) [d,e] - NA NA (150) [d,e] - NA NA~~

~~NA: Not applicable within the context of NFPA 55 (refer to the applicable building or fire code for additional information on these materials).~~

~~NL: Not limited in quantity.~~

~~Notes:~~

~~(1) For use of control areas, see Section 6.2.~~

~~(2) Table values in parentheses or brackets correspond to the unit name in parentheses or brackets at the top of the column.~~

~~(3) 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 the building code.~~

~~[a] Measured at NTP [70°F (20°C) and 14.7 psi (101.3 kPa)].~~

~~[b] 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.~~

~~[c] With pressure-relief devices for stationary or portable containers vented directly outdoors or to an exhaust hood.~~

~~[d] Quantities are permitted to be increased 100 percent where stored or used in approved cabinets, gas cabinets, exhausted enclosures, gas rooms, as appropriate for the material stored. Where Footnote e also applies, the increase for the quantities in both footnotes is permitted to be applied accumulatively.~~

~~[e] Maximum quantities are permitted to be increased 100 percent in buildings equipped throughout with an automatic sprinkler system in accordance with NFPA 13. Where Footnote d also applies, the increase for the quantities in both footnotes is permitted to be applied accumulatively.~~

~~[f] Flammable gases in the fuel tanks of mobile equipment or vehicles are permitted to exceed the MAQ where the equipment is stored and operated in accordance with the applicable fire code.~~

~~[g] See NFPA 58 for requirements for liquefied petroleum gas (LP-Gas). LP-Gas is not within the scope of NFPA 55.~~

~~[h] Additional storage locations are required to be separated by a minimum of 300 ft (92 m).~~

~~[i] 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.~~

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~~j Permitted only in buildings equipped throughout with an automatic sprinkler system in accordance with NFPA 13.~~

~~k Allowed only where stored or used in gas rooms or in approved gas cabinets or exhausted enclosures, as specified in this code.~~

~~**6.3.1.2** – Quantities Greater Than the MAQ.~~

~~Building-related controls in areas with compressed gases or cryogenic fluids stored or used within an indoor area in quantities greater than those shown in Table 6.3.1.1 shall be in accordance with the requirements of Chapter 6 .~~

~~**6.3.1.3** – Aggregate Allowable Quantities.~~

~~The aggregate quantity in use and storage shall not exceed the quantity listed for storage.~~

~~**6.3.1.4** – Incompatible Materials.~~

~~When the classification of materials in individual containers requires the area to be placed in more than one protection level, the separation of protection levels shall not be required, provided the area is constructed to meet the requirements of the most restrictive protection level and that the incompatible materials are separated as required by 7.1.10.2 .~~

~~**6.3.1.5** – Multiple Hazards.~~

~~When a compressed gas or cryogenic fluid has multiple hazards, all hazards shall be addressed and controlled in accordance with the provisions for the protection level for which the threshold quantity is exceeded.~~

~~**6.3.1.6** – Flammable and Oxidizing Gases.~~

~~**6.3.1.6.1**~~ –

~~Flammable and oxidizing gases shall not be stored or used in other than industrial or storage occupancies.~~

~~**6.3.1.6.2**~~ –

~~Cylinders, containers, or tanks not exceeding 250 scf (7.1 Nm^3) content at normal temperature and pressure (NTP) and used for maintenance purposes, patient care, or operation of equipment shall be permitted.~~

~~**6.3.1.6.3**~~ –

~~Hydrogen gas systems located in a hydrogen gas room that meet the requirements of Section 6.5 shall be permissible in quantities up to those allowed by Table 6.3.1.1 in assembly, educational, institutional, residential, or business occupancies.~~

~~**6.3.1.7** – Toxic and Highly Toxic Compressed Gases.~~

~~Except for containers or cylinders not exceeding 20 scf (0.6 Nm^3) content at NTP stored or used within gas cabinets or exhausted enclosures of educational occupancies, toxic or highly toxic compressed gases shall not be stored or used in other than industrial and storage occupancies.~~

~~**6.3.2** – Classification of Protection Levels.~~

~~The protection level required shall be based on the hazard class of the material involved as indicated in 6.3.2.1 through 6.3.2.5 .~~

~~**6.3.2.1** – Protection Level 1.~~

~~Occupancies used for the storage or use of unstable reactive Class 4 and unstable reactive Class 3 detonable compressed gases in quantities that exceed the quantity thresholds for gases requiring special provisions shall be classified Protection Level 1.~~

~~**6.3.2.2** – Protection Level 2.~~

~~Occupancies used for the storage or use of flammable, pyrophoric, and nondetonable, unstable reactive Class 3 compressed gases or cryogenic fluids in quantities that exceed the quantity thresholds for gases requiring special provisions shall be classified as Protection Level 2.~~

~~**6.3.2.3** – Protection Level 3.~~

~~Occupancies used for the storage or use of oxidizing and unstable reactive Class 2 compressed gases or cryogenic fluids in quantities that exceed the quantity thresholds for gases requiring special provisions shall be classified as Protection Level 3.~~

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~~**6.3.2.4** – Protection Level 4.~~

~~Occupancies used for the storage or use of toxic, highly toxic, and corrosive compressed gases in quantities that exceed the quantity thresholds for gases requiring special provisions shall be classified as Protection Level 4.~~

~~**6.3.2.5** – Protection Level 5.~~

~~Buildings and portions thereof used for fabrication of semiconductors or semiconductor research and development and containing quantities of hazardous materials exceeding the maximum allowable quantities of high hazard level 5 contents permitted in control areas shall be classified as Protection Level 5.~~

~~**6.4** – Gas Rooms.~~

~~Where a gas room is used to increase the threshold quantity for a gas requiring special provisions or where otherwise required by the material or application specific requirements of Chapters 7 through 16 , the room shall meet the requirements of 6.4.1 through 6.4.5 .~~

~~**6.4.1** – Pressure Control.~~

~~Gas rooms shall operate at a negative pressure in relationship to the surrounding area.~~

~~**6.4.2** – Exhaust Ventilation.~~

~~Gas rooms shall be provided with an exhaust ventilation system.~~

~~**6.4.3** – Construction.~~

~~Gas rooms shall be constructed in accordance with the building code.~~

~~**6.4.4** – Separation.~~

~~Gas rooms shall be separated from other occupancies by a minimum of 1-hour fire resistance.~~

~~**6.4.5** – Limitation on Contents.~~

~~The function of compressed gas rooms shall be limited to storage and use of compressed gases and associated equipment and supplies.~~

~~**6.5** – Hydrogen Gas Rooms.~~

~~**6.5.1** –~~

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

~~**6.5.1.1** –~~

~~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.~~

~~**6.5.1.2** –~~

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

~~**6.5.1.3** –~~

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

~~**6.5.1.4** –~~

~~Windows and doors shall be in exterior walls only.~~

~~**6.5.2** –~~

~~Ventilation shall be as provided in Section 6.17 .~~

~~**6.5.3** –~~

~~Explosion control shall be provided in accordance with the requirements of Section 6.10 .~~

~~**6.5.4** –~~

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

~~**6.5.5** –~~

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

~~**6.5.6** –~~

~~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 6.5.5 .~~

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~~**6.6** * – Detached Buildings.~~

~~Occupancies used for the storage or use of compressed gases, including individual bulk hydrogen compressed gas systems in quantities exceeding those specified in Table 6.6 , shall be in detached buildings constructed in accordance with the provisions of the building code.~~

~~Table 6.6 Detached Buildings Required Where Quantity of Material Exceeds Amount Shown~~

~~- - Quantity of Material Gas Hazard Class scf Nm 3 Individual bulk hydrogen compressed gas systems N/A 15,000 425 Unstable reactive (detonable) 4 or 3 Quantity thresholds for gases requiring special provisions* Unstable reactive (nondetonable) 3 2,000 57 Unstable reactive (nondetonable) 2 10,000 283 Pyrophoric gas ‡ N/A 2,000 57~~

~~N/A: Not applicable.~~

~~*See Table 6.3.1.1.~~

~~‡ Detached buildings are not required for gases in high-hazard gas rooms that support Protection Level 5 fabrication facilities separated from other areas by a fire barrier with a fire resistance rating of not less than 2 hours, where the gas is located in internally sprinklered gas cabinets equipped with continuous leak detection and automatic shutdown, where the supply is from cylinders that do not exceed 125 lb (57 kg) water capacity per 49 CFR 173.192 for Hazard Zone A toxic gases, and where the gas cabinets are not manifolded upstream of pressure control devices.~~

~~**6.7** – Weather Protection.~~

~~**6.7.1** –~~

~~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.~~

~~**6.7.2** –~~

~~Weather protected areas constructed in accordance with 6.7.3 shall be regulated as outdoor storage or use.~~

~~**6.7.2.1** –~~

~~Weather protected areas that are not constructed in accordance with 6.7.3 shall be regulated as indoor storage or use.~~

~~**6.7.3** –~~

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

(1) ~~The building or structure shall be constructed of noncombustible materials.~~

(2) ~~Walls shall not obstruct more than one side of the structure.~~

(3) ~~Walls shall be permitted to obstruct portions of multiple sides of the structure, provided that the obstructed area does not exceed 25 percent of the structure's perimeter area.~~

(4) ~~The building or structure shall be limited to a maximum area of 1500 ft ^{2} (140 m ^{2}), with increases in area allowed by the building code based on occupancy and type of construction.~~

(5) ~~The distance from the structure constructed as weather protection 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.~~

(6) ~~Reductions in 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 .~~

~~**6.8** * – Electrical Equipment.~~

~~Electrical wiring and equipment shall be in accordance with Section 6.8 and *NFPA 70* .~~

~~**6.8.1** – Standby Power.~~

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~~**6.8.1.1**~~ –

~~Where the following systems are required by this code for the storage or use of compressed gases or cryogenic fluids that exceed the quantity thresholds for gases requiring special provisions, such systems shall be connected to a standby power system in accordance with *NFPA 70* :~~

(1) ~~Mechanical ventilation~~

(2) ~~Treatment systems~~

(3) ~~Temperature controls~~

(4) ~~Alarms~~

(5) ~~Detection systems~~

(6) ~~Other electrically operated systems~~

~~**6.8.1.2**~~ –

~~The requirements of 6.8.1.1 shall not apply where emergency power is provided in accordance with 6.8.2 and *NFPA 70* .~~

~~**6.8.1.3**~~ –

~~When standby power is required, the system shall meet the requirements for a Level 2 system in accordance with NFPA 111.~~

~~**6.8.2**~~ – ~~Emergency Power.~~

~~When emergency power is required, the system shall meet the requirements for a Level 2 system in accordance with NFPA 110 or NFPA 111.~~

~~**6.9** *~~ – ~~Employee Alarm System.~~

~~Where required by government regulations, an employee alarm system shall be provided to allow warning for necessary emergency action as called for in the emergency action plan required by 4.2.1.1 , or for reaction time for safe egress of employees from the workplace or the immediate work area, or both.~~

~~**6.10**~~ – ~~Explosion Control.~~

~~Explosion control shall be provided as required by Table 6.10 in accordance with NFPA 68, or NFPA 69, where amounts of compressed gases in storage or use exceed the quantity thresholds requiring special provisions.~~

~~Table 6.10 Explosion Control Requirements~~

~~- - Explosion Control Methods Material Class Barricade~~

~~Construction Explosion Venting or Prevention Systems Flammable cryogenic fluid —~~
~~Not required Required Flammable gas Nonliquefied Not~~
~~required Required - Liquefied Not required Required Pyrophoric gas — Not~~
~~required Required Unstable reactive gas 4 Required Not required - 3~~
~~(detonable) Required Not required - 3 (nondetonable) Not required Required~~

~~**6.11** *~~ – ~~Fire Protection Systems.~~

~~Except as provided in 6.11.1 , buildings or portions thereof required to comply with Protection Levels 1 through 5 shall be protected by an approved automatic fire sprinkler system complying with NFPA 13.~~

~~**6.11.1**~~ –

~~Rooms or areas that are of noncombustible construction with wholly noncombustible contents shall not be required to be protected by an automatic fire sprinkler system.~~

~~**6.11.2**~~ – ~~Sprinkler System Design.~~

~~**6.11.2.1**~~ –

~~Where sprinkler protection is required, the area in which compressed gases or cryogenic fluids are stored or used shall be protected with a sprinkler system designed to be not less than that required by 11.2.3.1.1 of NFPA 13 for the Ordinary Hazard Group 2 density/area curve.~~

~~**6.11.2.2**~~ –

~~Where sprinkler protection is required, the area in which the flammable or pyrophoric compressed gases or cryogenic fluids are stored or used shall be protected with a sprinkler system designed to be not less than that required by 11.2.3.1.1 of NFPA 13 for the Extra Hazard Group 1 density/area curve.~~

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~~**6.12** – Lighting.~~

~~Approved lighting by natural or artificial means shall be provided for areas of storage or use.~~

~~**6.13** – Hazard Identification Signs.~~

~~**6.13.1** – Location.~~

~~Hazard identification signs shall be placed at all entrances to locations where compressed gases are produced, stored, used, or handled in accordance with NFPA 704.~~

~~**6.13.1.1** –~~

~~Ratings shall be assigned in accordance with NFPA 704.~~

~~**6.13.1.2** –~~

~~The authority having jurisdiction shall be permitted to waive 6.13.1 where consistent with safety.~~

~~**6.13.2** – Application.~~

~~Signage shall be provided as specified in 6.13.2.1 and 6.13.2.2 .~~

~~**6.13.2.1** – Signs.~~

~~Signs shall not be obscured or removed.~~

~~**6.13.2.2** – No Smoking.~~

~~Signs prohibiting smoking or open flames within 25 ft (7.6 m) of area perimeters shall be provided in areas where toxic, highly toxic, corrosive, unstable reactive, flammable, oxidizing, or pyrophoric gases are produced, stored, or used.~~

~~**6.14** – Spill Control, Drainage, and Secondary Containment.~~

~~Spill control, drainage, and secondary containment shall not be required for compressed gases.~~

~~**6.15** – Shelving.~~

~~**6.15.1** –~~

~~Shelves used for the storage of cylinders, containers, and tanks shall be of noncombustible construction and designed to support the weight of the materials stored.~~

~~**6.15.2** –~~

~~Shelves and containers shall be secured from overturning.~~

~~**6.16** – Vent Pipe Termination.~~

~~The termination point for piped vent systems serving cylinders, containers, tanks, and gas systems used for the purpose of operational or emergency venting shall be located to prevent impingement exposure on the system served and to minimize the effects of high temperature thermal radiation or the effects of contact with the gas from the escaping plume to the supply system, personnel, adjacent structures, and ignition sources.~~

~~**6.17** – 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 is shown to be acceptable for the material as stored.~~

~~**6.17.1** – Compressed Air.~~

~~The requirements of Section 6.17 shall not apply to cylinders, containers, and tanks containing compressed air.~~

~~**6.17.2** – Ventilation Systems.~~

~~In addition to the requirements of Section 6.17 , ventilation systems shall be designed and installed in accordance with the requirements of the mechanical code.~~

~~**6.17.3** – Mechanical Exhaust Ventilation.~~

~~Where mechanical exhaust ventilation is provided, the system shall be operational during the time the building or space is occupied.~~

~~**6.17.3.1** – Continuous Operation.~~

~~When operation of ventilation systems is required, systems shall operate continuously unless an alternative design is approved by the AHJ.~~

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~~**6.17.3.2** – Ventilation Rate.~~

~~Mechanical exhaust or fixed natural ventilation shall be provided at a rate of not less than 1 scf/min/ft ^{2} (0.0051 m ^{3} /sec/m ^{2}) of floor area over the area of storage or use.~~

~~**6.17.3.3** – 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.~~

~~**6.17.3.3.1** – Manual Shutoff Switch.~~

~~The switch shall be the breakglass or equivalent type and shall be labeled as follows:~~

~~WARNING:~~

~~VENTILATION SYSTEM EMERGENCY SHUTOFF~~

~~**6.17.4** – Inlets to the Exhaust System.~~

~~**6.17.4.1** –~~

~~The exhaust ventilation system design shall take into account the density of the potential gases released.~~

~~**6.17.4.2** * –~~

~~For gases that are heavier than air, exhaust shall be taken from a point within 12 in. (305 mm) of the floor. The use of supplemental inlets shall be allowed to be installed at points above the 12 in. (305 mm) threshold level.~~

~~**6.17.4.3** * –~~

~~For gases that are lighter than air, exhaust shall be taken from a point within 12 in. (305 mm) of the ceiling. The use of supplemental inlets shall be allowed to be installed at points below the 12 in. (305 mm) threshold level.~~

~~**6.17.4.4** –~~

~~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.~~

~~**6.17.5** – Recirculation of Exhaust.~~

~~Exhaust ventilation shall not be recirculated.~~

~~**6.17.6** – Ventilation Discharge.~~

~~Ventilation discharge systems shall terminate at a point not less than 50 ft (15 m) from intakes of air-handling systems, air-conditioning equipment, and air compressors.~~

~~**6.17.7** – Air Intakes.~~

~~Storage and use of compressed gases shall be located not less than 20 ft (6 m) from air intakes. *(See Sections 7.4 through 7.10 for material-specific requirements.)*~~

~~**6.18** – Gas Cabinets.~~

~~Where a gas cabinet is required, is used to provide separation of gas hazards, or is used to increase the threshold quantity for a gas requiring special provisions, the gas cabinet shall be in accordance with the requirements of 6.18.1 through 6.18.5 .~~

~~**6.18.1** – Construction.~~

~~**6.18.1.1** – Materials of Construction.~~

~~The gas cabinet shall be constructed of not less than 0.097 in. (2.46 mm) (12 gauge) steel.~~

~~**6.18.1.2** – Access to Controls.~~

~~The gas cabinet shall be provided with self-closing limited access ports or noncombustible windows to give access to equipment controls.~~

~~**6.18.1.3** – Self-Closing Doors.~~

~~The gas cabinet shall be provided with self-closing doors.~~

~~**6.18.2** – Ventilation Requirements.~~

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~~**6.18.2.1** –~~

~~The gas cabinet shall be provided with an exhaust ventilation system designed to operate at a negative pressure relative to the surrounding area.~~

~~**6.18.2.2** –~~

~~Where toxic, highly toxic, pyrophoric, unstable reactive Class 3 or Class 4, or corrosive gases are contained, the velocity at the face of access ports or windows, with the access port or window open, shall not be less than 200 ft/min (61 m/min) average, with not less than 150 ft/min (46 m/min) at any single point.~~

~~**6.18.3** – Fire Protection.~~

~~Gas cabinets used to contain toxic, highly toxic, or pyrophoric gases shall be internally sprinklered.~~

~~**6.18.4** – Quantity Limits.~~

~~Gas cabinets shall contain not more than three cylinders, containers, or tanks.~~

~~**6.18.5** – Separation of Incompatibles.~~

~~Incompatible gases, as defined by Table 7.1.10.2 , shall be stored or used within separate gas cabinets.~~

~~**6.19** – Exhausted Enclosures.~~

~~**6.19.1** – Ventilation Requirements.~~

~~Where an exhausted enclosure is required or used to increase the threshold quantity for a gas requiring special provisions, the exhausted enclosure shall be provided with an exhaust ventilation system designed to operate at a negative pressure in relationship to the surrounding area.~~

~~**6.19.1.1** – Control Velocity at Access Openings.~~

~~Where toxic, highly toxic, pyrophoric, unstable reactive Class 3 or Class 4, or corrosive gases are contained, the velocity at the face openings providing access shall be not less than 200 ft/min (61 m/min) average, with not less than 150 ft/min (46 m/min) at any single point.~~

~~**6.19.1.2** – Separation of Incompatible Gases Within Enclosures.~~

~~Cylinders, containers, and tanks within enclosures shall be separated in accordance with Table 7.1.10.2 .~~

~~**6.19.1.3** – Fire Protection.~~

~~Exhausted enclosures shall be internally sprinklered.~~

~~**6.19.2** – Separation.~~

~~Incompatible gases, as defined by Table 7.1.10.2 , shall be stored or used within separate exhausted enclosures.~~

~~**6.20** * – Source Valve.~~

~~Bulk gas systems shall be provided with a source valve.~~

~~**6.20.1** –~~

~~The source valve shall be marked.~~

~~**6.20.2** –~~

~~The source valve shall be designated on the design drawings for the installation.~~

~~Harmonize NFPA 55 Chapter 6 and 7 with NFPA 2 Chapter 6~~

Statement of Problem and Substantiation for Public Input

This public input is proposing to re-align NFPA 2 with the requirements in NFPA 55. It is a placeholder comment to allow work to be done by a task group in the future to better align the documents based upon feedback from the NFPA2/55 Scope Joint Working Group. A Public Comment will be submitted with exact language changes.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 56-NFPA 55-2020 [Chapter 7]	Related PI
Public Input No. 58-NFPA 55-2020 [Chapter 10]	Related PI
Public Input No. 59-NFPA 55-2020 [Chapter 11]	Related PI

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Public Input No. 56-NFPA 55-2020 [Chapter 7]
Public Input No. 58-NFPA 55-2020 [Chapter 10]
Public Input No. 59-NFPA 55-2020 [Chapter 11]

Submitter Information Verification

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Submittal Date:	Thu Jun 25 11:13:54 EDT 2020
Committee:	IMG-AAA

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Public Input No. 1-NFPA 55-2019 [New Section after 6.2.4]

6.2.5 Outdoor Control Areas

6.2.5.1 General.

6.2.5.1.1 Hazardous materials shall be permitted to be stored or used in outdoor control areas in accordance with 6.2.5.2 and 6.2.5.3.

6.2.5.1.2 Where storage or use is in an outdoor control area, compliance with the outdoor storage and use requirements in Chapters 7 through 16 shall not be required.

6.2.5.2 Maximum Allowable Quantity per Outdoor Control Area. Maximum allowable quantities of hazardous materials in an outdoor control area shall be as specified in Table 6.2.5.2.

6.2.5.3 Number of Outdoor Control Areas.

6.2.5.3.1 A single outdoor control area shall be permitted on any property.

6.2.5.3.2 Where a property exceeds 10,000 ft2 (929 m2), a group of two outdoor control areas shall be permitted where approved and where each control area is separated by a minimum distance of 50 ft (15 m).

6.2.5.3.3 Where a property exceeds 35,000 ft2 (3252 m2), additional groups of outdoor control areas shall be permitted where approved, provided that each group is separated by a minimum distance of 300 ft (91 m).

6.2.5 Outdoor Storage and Use Areas. Where the quantity of hazardous materials in outdoor storage or use exceeds the MAQ for outdoor control areas as set forth in Table 6.2.5.2, the outdoor area shall comply with the applicable outdoor requirements of Chapter 6 and Chapters 7 through 16.

Table 6.2.5.2 Maximum Allowabl

Material	Class	Solid Pounds	Storage Liquid Gallons	Gas [a]
Cryogenic fluid	Flammable	NA	135	NA

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Material	Class	Solid Pounds	Storage Liquid Gallons	Gas [a]
	Oxidizing	NA	135	NA
	Inert	NA	NL	NA
Flammable, gas [f]	Gaseous	NA	NA	3000
	Liquified	NA	NA	(300)
Inert gas	Gaseous	NA	NA	NL
	Liquified	NA	NA	NL
Oxidizing gas	Gaseous	NA	NA	6000
	Liquified	NA	NA	(600)
Pyrophoric gas	Gaseous	NA	NA	100
	Liquified	NA	NA	(8)
Unstable (reactive) gas	Gaseous			
	4 or 3 detonable	NA	NA	20
	3 nondetonable	NA	NA	200
	2	NA	NA	1000
	1	NA	NA	1500
Unstable (reactive) gas	Liquified			
	4 or 3 detonable	NA	NA	(2)
	3 nondetonable	NA	NA	(20)
	2	NA	NA	(200)
	1	NA	NA	NL
Corrosive gas	Gaseous	NA	NA	1620
	Liquified	NA	NA	(300)
Highly toxic gas	Gaseous	NA	NA	40*
	Liquified	NA	NA	(8)*
Toxic gas	Gaseous	NA	NA	1620
	Liquified	NA	NA	(300)

For SI units, 1 lb = 0.454 kg; 1 gal = 3.785 L; 1 scf3 = 0.0283 Nm3.

N/A: Not applicable. NL: Not limited.

Notes:

(1) Table values in parentheses correspond to the unit name in parentheses at the top of the column.

(2) For gallons of liquids, divide the amount in pounds by 10.

(3) The aggregate quantities in storage and use cannot exceed the quantity listed for storage.

(4) The aggregate quantity of nonflammable solid and nonflammable or noncombustible liquid hazardous

materials allowed in outdoor storage per single property under the same ownership or control used for retail

or wholesale sales is permitted to exceed the MAQ where such storage is in accordance with 5.2.1.13.3.

*Permitted only where stored or used in approved exhausted gas cabinets, exhausted enclosures, or fume hoods.

Statement of Problem and Substantiation for Public Input

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There is a need to correlate NFPA 400 outside control area maximum allowable quantities for gases with NFPA 55, and to clarify to gas users that there are outdoor quantities limits for some compressed, liquefied, and cryogenic gases. The suggested change is taken from NFPA 400 Section 5.4 Outdoor Areas. The table is formatted to match that in NFPA 55 (2016) for maximum allowable quantities. This may require additional work to calrify requirements between outdoor and indoor control areas in NFPA 55 as is done in NFPA 400.

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Public Input No. 18-NFPA 55-2020 [New Section after 6.2.4]

Outdoor Control Areas

6.2.5 Quantities Less than or Equal to the MAQ (Outdoor). Outdoor control areas with compressed gases or cryogenic fluids stored in quantities less than or equal to those shown in Table 6.2.5 shall be in accordance with Sections 6.8, 6.9, 6.13, and 6.16, and the applicable provisions of Chapters 1 through 5 and Chapters 7 through 17.

6.2.5.1 A single outdoor control area shall be permitted on any property.

6.2.5.2 Where a property exceeds 10,000 ft2 (929 m2), a group of two outdoor control areas shall be permitted where approved and where each control area is separated by a minimum distance of 50 ft (15 m).

6.2.5.3 Where a property exceeds 35,000 ft2 (3252 m2), additional groups of outdoor control areas shall be permitted where approved, provided that each group is separated by a minimum distance of 300 ft (91 m).

6.2.6 Outdoor Storage and Use Areas. Where the quantity of hazardous materials in outdoor storage or use exceeds the MAQ for outdoor control areas as set forth in Table 6.2.5, the outdoor area shall comply with the applicable outdoor requirements of Chapter 6 and the applicable requirements of Chapter 7 through 17.

Table 6.2.5 Maximum Allowable Quantity (MAQ) of Hazardous Materials per Outdoor Control Area - See Attachment

Additional Proposed Changes

File Name	Description	Approved
NFPA_55_Table_6.2.5_Proposed_Outdoor_Control_area_MAQ.docx	New Table to go with public input	

Statement of Problem and Substantiation for Public Input

NFPA 55 does not address outdoor control areas, whereas NFPA 400 does address outdoor control areas. This information has been copied from NFPA 400.

The table values have been copied from NFPA 400 with the following exceptions:
-The limit for oxidizing gas closed systems was lowered to 1500 SCF to be consistent with other fire codes (International Fire Code).
-Unstable Reactive Gas (Liquefied) category does not exist in the NFPA 400 table and is proposed as part of this public comment (double the indoor MAQ).
-Footnotes "b" (fuel tanks) and "c" (NFPA 58) were added.

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(PROPOSED NEW)

Table 6.2.5 Maximum Allowable Quantity (MAQ) of Hazardous Materials per Outdoor Control Area

		Storage			Use — Closed Systems			Use — Open Systems	
Material	**Class**	**Solid Pounds**	**Liquid Gallons**	**Gas[a] scf (lb)**	**Solid Pounds**	**Liquid Gallons**	**Gas[a] scf (lb)**	**Solid Pounds**	**Liquid Gallons**
Cryogenic fluid	Inert	NA	NL	NA	NA	NL	NA	NA	NL
Flammable, gas[b]	Gaseous	NA	NA	3000	NA	NA	1500	NA	NA
	Liquefied	NA	NA	(300)	NA	NA	(150)	NA	NA
	LP[c]								
Inert gas	Gaseous	NA	NA	NL	NA	NA	NL	NA	NA
	Liquefied	NA	NA	NL	NA	NA	NL	NA	NA
Oxidizing gas	Gaseous	NA	NA	6000	NA	NA	1500	NA	NA
	Liquefied	NA	NA	(600)	NA	NA	(300)	NA	NA
Pyrophoric gas	Gaseous	NA	NA	100	NA	NA	10	NA	NA
	Liquefied	NA	NA	(4)	NA	NA	(4)	NA	NA
Unstable (reactive) gas	Gaseous								
	4 or 3 detonable	NA	NA	20	NA	NA	2	NA	NA
	3 nondetonable	NA	NA	200	NA	NA	10	NA	NA
	2	NA	NA	1000	NA	NA	250	NA	NA
	1	NA	NA	NL	NA	NA	NL	NA	NA
Unstable (reactive) gas	Liquefied								
	4 or 3 detonable	NA	NA	(2)	NA	NA	(1)	NA	NA
	3 nondetonable	NA	NA	(4)	NA	NA	(2)	NA	NA
	2	NA	NA	(300)	NA	NA	(150)	NA	NA
	1	NA	NA	NL	NA	NA	NL	NA	NA
Corrosive gas	Gaseous	NA	NA	1620	NA	NA	810	NA	NA
	Liquefied	NA	NA	(300)	NA	NA	(150)	NA	NA
Highly toxic gas	Gaseous	NA	NA	40[d]	NA	NA	20[d]	NA	NA
	Liquefied	NA	NA	(8)[d]	NA	NA	(4)[d]	NA	NA
Toxic gas	Gaseous	NA	NA	1620	NA	NA	810	NA	NA
	Liquefied	NA	NA	(300)	NA	NA	(150)	NA	NA

NA: Not applicable within the context of NFPA 55 (refer to the applicable building or fire code for additional information on these materials).
NL: Not limited in quantity.
Notes:
(1) For use of control areas, see Section 6.2.
(2) Table values in parentheses or brackets correspond to the unit name in parentheses or brackets at the top of the column.
(3) The aggregate quantity in use and storage is not permitted to exceed the quantity listed for storage.
[a]Measured at NTP [70°F (20°C) and 14.7 psi (101.3 kPa)].
[b]Flammable gases in the fuel tanks of mobile equipment or vehicles are permitted to exceed the MAQ where the equipment is stored and operated in accordance with the applicable fire code.
[c]See NFPA 58 for outdoor storage requirements for liquefied petroleum gas (LP-Gas). LP-Gas is not within the scope of NFPA 55.
[d]Allowed only where stored or used in approved exhausted gas cabinets, exhausted enclosures, or fume hoods.

Attachment F - NFPA 55 Public Inputs

Public Input No. 13-NFPA 55-2020 [Section No. 6.2.4]

6.2.4 Quantities Less Than or Equal to the MAQ.

Indoor control areas with compressed gases or cryogenic fluids stored or used in quantities less than or equal to those shown in Table 6.3.1.1 shall be in accordance with 6.3.1.6 and 6.3.1.7 and Sections 6.1, 6.8, 6.9, 6. 11, 6. 13, 6.16, and 6.17, and the applicable provisions of Chapters 1 through 5 and Chapters 7 through 16.

Statement of Problem and Substantiation for Public Input

Currently as written the standard does not require fire protection (6.11) if you are below the MAQ. This seems like something that is not what the committee intended. As the wording of 6.11 says "where sprinkler protection is required" I think this covers applications where it is not required.

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Attachment F - NFPA 55 Public Inputs

Public Input No. 74-NFPA 55-2020 [Section No. 6.3.1.6.3]

~~**6.3.1.6.3**~~ –

~~Hydrogen gas systems located in a hydrogen gas room that meet the requirements of Section 6.5 shall be permissible in quantities up to those allowed by Table 6.3.1.1 in assembly, educational, institutional, residential, or business occupancies.~~

Statement of Problem and Substantiation for Public Input

Hydrogen gas rooms are in the scope of NFPA 2 and are addressed by that code. There is no need for this clause in NFPA 55 and its presence causes confusion regarding whether NFPA 2 or NFPA 55 applies.

Submitter Information Verification

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Attachment F - NFPA 55 Public Inputs

Public Input No. 75-NFPA 55-2020 [Section No. 6.5]

~~**6.5** Hydrogen Gas Rooms.~~

~~**6.5.1**~~

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

~~**6.5.1.1**~~

~~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.~~

~~**6.5.1.2**~~

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

~~**6.5.1.3**~~

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

~~**6.5.1.4**~~

~~Windows and doors shall be in exterior walls only.~~

~~**6.5.2**~~

~~Ventilation shall be as provided in Section 6.17 .~~

~~**6.5.3**~~

~~Explosion control shall be provided in accordance with the requirements of Section 6.10 .~~

~~**6.5.4**~~

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

~~**6.5.5**~~

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

~~**6.5.6**~~

~~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 6.5.5 .~~

Statement of Problem and Substantiation for Public Input

Hydrogen gas rooms are in the scope of NFPA 2 and are addressed by that code. There is no need for this clause in NFPA 55 and its presence causes confusion regarding whether NFPA 2 or NFPA 55 applies.

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Attachment F - NFPA 55 Public Inputs

Public Input No. 76-NFPA 55-2020 [Section No. 6.6]

6.6* Detached Buildings.

Occupancies used for the storage or use of compressed gases, ~~including individual bulk hydrogen compressed gas systems~~ _ in quantities exceeding those specified in Table 6.6, shall be in detached buildings constructed in accordance with the provisions of the building code.

Table 6.6 Detached Buildings Required Where Quantity of Material Exceeds Amount Shown

		Quantity of Material	
Gas Hazard	Class	scf	Nm^3
~~Individual bulk hydrogen compressed gas systems~~	~~N/A~~	~~15,000~~	~~425~~
Unstable reactive (detonable)	4 or 3	Quantity thresholds for gases requiring special provisions*	
Unstable reactive (nondetonable)	3	2,000	57
Unstable reactive (nondetonable)	2	10,000	283
Pyrophoric gas†	N/A	2,000	57

N/A: Not applicable.

*See Table 6.3.1.1.

†Detached buildings are not required for gases in high-hazard gas rooms that support Protection Level 5 fabrication facilities separated from other areas by a fire barrier with a fire resistance rating of not less than 2 hours, where the gas is located in internally sprinklered gas cabinets equipped with continuous leak detection and automatic shutdown, where the supply is from cylinders that do not exceed 125 lb (57 kg) water capacity per 49 CFR 173.192 for Hazard Zone A toxic gases, and where the gas cabinets are not manifolded upstream of pressure control devices.

Statement of Problem and Substantiation for Public Input

Hydrogen storage and use in detached buildings are in the scope of NFPA 2 and are addressed by that code. There is no need to include hydrogen in this clause and its presence is not consistent with the committee scope statements.

Note: Per the committee scope statements the HYD Committee has "primary responsibility for documents on the storage, transfer, production, and use hydrogen" and the IMG "Committee shall coordinate the material on gaseous and liquid hydrogen storage and use with the Hydrogen Technology Committee."

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 90-NFPA 55-2020 [Section No. A.6.6]	

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Attachment F - NFPA 55 Public Inputs

Committee:	IMG-AAA

Attachment F - NFPA 55 Public Inputs

Public Input No. 5-NFPA 55-2020 [Section No. 6.17.4]

6.17.4 ~~Inlets to the~~ _ Exhaust System.

6.17.4.1

The exhaust ventilation system design shall take into account the density of the potential gases released.

6.17.4.2*

For gases that are heavier than air, exhaust shall be taken from a point within 12 in. (305 mm) of the floor. The use of supplemental inlets shall be allowed to be installed at points above the 12 in. (305 mm) threshold level.

6.17.4.3*

For gases that are lighter than air, exhaust shall be taken from a point within 12 in. (305 mm) of the ceiling. The use of supplemental inlets shall be allowed to be installed at points below the 12 in. (305 mm) threshold level.

6.17.4.4

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.

Additional Proposed Changes

File Name	Description	Approved
55_PC_22.pdf	NFPA 55 Public Comment No. 22	

Statement of Problem and Substantiation for Public Input

NOTE: This Public Input appeared as "Reject but Hold" in the Public Comment No. 22 of the A2019 Second Draft Report for NFPA 55 and per REGs. at 4.4.8.3.1.

Subject of this section is the whole Exhaust System not just the Inlets; title should reflect the whole scope of the section.

Ref. NFPA 2 FR 105.

Submitter Information Verification

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Submittal Date: Thu Feb 06 11:18:44 EST 2020
Committee: IMG-AAA

Attachment F - PI5 (PC-22)

Public Comment No. 22-NFPA 55-2018 [Section No. 6.17.4]

6.17.4 ~~Inlets to the~~ Exhaust System.

6.17.4.1

The exhaust ventilation system design shall take into account the density of the potential gases released.

6.17.4.2 *

For gases that are heavier than air, exhaust shall be taken from a point within 12 in. (305 mm) of the floor. The use of supplemental inlets shall be allowed to be installed at points above the 12 in. (305 mm) threshold level.

6.17.4.3 *

For gases that are lighter than air, exhaust shall be taken from a point within 12 in. (305 mm) of the ceiling. The use of supplemental inlets shall be allowed to be installed at points below the 12 in. (305 mm) threshold level.

6.17.4.4

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.

Statement of Problem and Substantiation for Public Comment

Subject of this section is the whole Exhaust System not just the Inlets; title should reflect the whole scope of the section.

Ref. NFPA 2 FR105.

Related Item

• First Draft

Submitter Information Verification

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Submittal Date: Fri Apr 13 13:53:14 EDT 2018
Committee:

Committee Statement

Committee Action: Rejected but held

Resolution: This PC does not have a valid first revision associated with it. It is being held until the next revision cycle.

Attachment F - NFPA 55 Public Inputs

Copyright Assignment

I, Stephen Goyette, hereby irrevocably grant and assign to the National Fire Protection Association (NFPA) all and full rights in copyright in this Public Comment (including both the Proposed Change and the Statement of Problem and Substantiation). I understand and intend that I acquire no rights, including rights as a joint author, in any publication of the NFPA in which this Public Comment in this or another similar or derivative form is used. I hereby warrant that I am the author of this Public Comment and that I have full power and authority to enter into this copyright assignment.

☑ By checking this box I affirm that I am Stephen Goyette, and I agree to be legally bound by the above Copyright Assignment and the terms and conditions contained therein. I understand and intend that, by checking this box, I am creating an electronic signature that will, upon my submission of this form, have the same legal force and effect as a handwritten signature

Attachment F - NFPA 55 Public Inputs

Public Input No. 10-NFPA 55-2020 [Section No. 6.18.4]

6.18.4 Quantity Limits.

~~Gas~~ Except as provided in 6.18.4.1, gas cabinets shall contain not more than three cylinders, containers, or tanks.

6.18.4.1 Cylinders, containers or tanks containing less than 10 scf, gas cabinets shall contain not more than 90 cylinders, containers or tanks.

Statement of Problem and Substantiation for Public Input

Gas cabinets are one of the safest locations to store compressed gas cylinders. Small cylinders like lecture bottles represent a significantly smaller hazard than full size cylinders. This change will provide increased operational flexibility for facilities like laboratories.

The 10 scf limit allows for standard lecture bottles, including those filled with liquefied gas. The IFC has similar exemption for toxic gases that is based on the mass of the gas contained in the container (1-pound). The volumetric limit is more consistent with other sections of NFPA 55. It also is more restrictive for gases with a low molecular weight.

The 90-cylinder limit (900 scf total) is consistent with 3 full size cylinders in the current rule.

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Attachment F - NFPA 55 Public Inputs

Public Input No. 6-NFPA 55-2020 [New Section after 6.18.5]

TITLE OF NEW CONTENT

6.18.6* The interior of gas cabinets handling flammable gases or flammable liquified gases shall be electrically classified as determined by a qualified person in accordance with the requirements and recommendations of NFPA 70 The National Electric Code and 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.

Annex A Information:

A6.18.6 The committee believes it is prudent for all electrical equipment inside a gas cabinet to meet at least a Class I Division 2 classification unless a hazard analysis and risk assessment indicates another classification is more prudent. The area outside the gas cabinet should be classified based on the situation and activities occurring in that area independent of the gas cabinet itself.

Statement of Problem and Substantiation for Public Input

This is the result of a subgroup of NFPA 55 that met to determine how to clarify the requirements for the electrical classification of gas cabinets. The group decided that classifying the interior was prudent but that it required a qualified individual as some areas might need interpretation for compliance with NFPA 497 recommendations and that some situations might, after a detailed hazard analysis and risk assessment, even justify an unclassified interior due to other mitigative measures. The annex information tries to address this as well.

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Attachment F - NFPA 55 Public Inputs

Public Input No. 56-NFPA 55-2020 [Chapter 7]

~~**Chapter 7** – Compressed Gases~~

~~**7.1** – General.~~

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

~~**7.1.1** –~~

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

~~**7.1.2** – Compressed Gas Systems.~~

~~**7.1.2.1** – Design.~~

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

~~**7.1.2.2** – Installation.~~

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

~~**7.1.3** – Insulated Liquid Carbon Dioxide Systems.~~

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

~~**7.1.4** – Insulated Liquid Nitrous Oxide Systems.~~

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

~~**7.1.5** – Cylinders, Containers, and Tanks.~~

~~**7.1.5.1** – Design and Construction.~~

~~Cylinders, containers, and tanks shall be designed, fabricated, tested, and marked (i.e., stamped) in accordance with Department of Transportation (DOT) regulations, Transport Canada's (TC) *Transportation of Dangerous Goods Regulations* , or the ASME *Boiler and Pressure Vessel Code* .~~

~~**7.1.5.2** – Defective Cylinders, Containers, and Tanks.~~

~~**7.1.5.2.1** –~~

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

~~**7.1.5.2.2** –~~

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

~~**7.1.5.2.3** –~~

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

~~**7.1.5.3** – Supports.~~

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

~~**7.1.5.4** – Cylinders, Containers, and Tanks Containing Residual Gas.~~

~~Compressed gas cylinders, containers, and tanks containing residual product shall be treated as full except when being examined, serviced, or refilled by a gas manufacturer, authorized cylinder requalifier, or distributor.~~

~~**7.1.5.5** – Pressure Relief Devices.~~

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~~**7.1.5.5.1** –~~

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

~~**7.1.5.5.2** –~~

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

~~**7.1.5.5.3** –~~

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

~~**7.1.5.5.4** –~~

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

~~**7.1.5.5.5** –~~

~~Pressure relief devices shall be arranged to discharge unobstructed to the open air in such a manner as to prevent any impingement of escaping gas upon the container, adjacent structures, or personnel. This requirement shall not apply to DOT specification containers having an internal volume of 2.0 scf (0.057 Nm ^{3}) or less.~~

~~**7.1.5.5.6** –~~

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

~~**7.1.5.5.7** – Shutoffs Between Pressure Relief Devices and Containers.~~

~~**7.1.5.5.7.1** – General.~~

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

~~**7.1.5.5.7.2** – Location.~~

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

~~**7.1.5.5.7.3** * – Security.~~

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

~~**7.1.5.5.7.4** – Multiple Pressure Relief Devices.~~

~~Shutoff valves controlling multiple pressure relief devices on a container shall be installed so that either the type of valve installed or the arrangement provides the full required flow through the relief devices at all times.~~

~~**7.1.6** – Cathodic Protection.~~

~~Where required, cathodic protection shall be in accordance with 7.1.6 .~~

~~**7.1.6.1** – Operation.~~

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

~~**7.1.6.2** – Inspection.~~

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

~~**7.1.6.2.1** –~~

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

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~~**7.1.6.3** – Impressed Current Systems.~~

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

~~**7.1.6.3.1** –~~

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

~~**7.1.6.3.2** –~~

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

(1) ~~The results of inspections of the system~~

(2) ~~The results of testing that has been completed~~

~~**7.1.6.4** –~~

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

~~**7.1.6.4.1** –~~

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

~~**7.1.7** – Labeling Requirements.~~

~~**7.1.7.1** – Containers.~~

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

~~**7.1.7.2** – Label Maintenance.~~

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

~~**7.1.7.3** – Stationary Compressed Gas Cylinders, Containers, and Tanks.~~

~~**7.1.7.3.1** –~~

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

~~**7.1.7.3.2** –~~

~~Markings shall be visible from any direction of approach.~~

~~**7.1.7.4** – Piping Systems.~~

~~**7.1.7.4.1** –~~

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

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

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

(3) ~~Markings for piping systems shall be provided at the following locations:~~

  (4) ~~At each critical process control valve~~

  (5) ~~At wall, floor, or ceiling penetrations~~

  (6) ~~At each change of direction~~

  (7) ~~At a minimum of every 20 ft (6.1 m) or fraction thereof throughout the piping run~~

~~**7.1.7.4.2** –~~

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

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~~**7.1.8** – Security.~~

~~**7.1.8.1** – General.~~

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

~~**7.1.8.2** * – Security of Areas.~~

~~Storage, use, and handling areas shall be secured against unauthorized entry.~~

~~**7.1.8.2.1** –~~

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

~~**7.1.8.3** – Physical Protection.~~

~~**7.1.8.3.1** –~~

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

~~**7.1.8.3.2** –~~

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

~~**7.1.8.4** – Securing Compressed Gas Cylinders, Containers, and Tanks.~~

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

~~**7.1.8.4.1** –~~

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

~~**7.1.8.4.2** –~~

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

~~**7.1.9** – Valve Protection.~~

~~**7.1.9.1** – General.~~

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

~~**7.1.9.1.1** –~~

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

~~**7.1.9.1.1.1** –~~

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

~~**7.1.9.2** – Valve-Protective Caps.~~

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

~~**7.1.9.3** – Valve Outlet Caps or Plugs.~~

~~**7.1.9.3.1** –~~

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

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~~**7.1.9.3.2**~~ –

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

~~**7.1.10** – Separation from Hazardous Conditions.~~

~~**7.1.10.1** – General.~~

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

~~**7.1.10.2** * – Incompatible Materials.~~

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

~~Table 7.1.10.2 Separation of Gas Cylinders, Containers, and Tanks by Hazard Class~~

~~Gas Category Other Gas Unstable Reactive Class 2, Class 3, or~~
~~Class 4 - Corrosive - Oxidizing - Flammable - Pyrophoric - Toxic or Highly~~
~~Toxic ft m - ft m - ft m - ft m - ft m - ft m Toxic or highly~~
~~toxic NR 20 6.1 - 20 6.1 - 20 6.1 - 20 6.1 - 20 6.1 - — — Pyrophoric NR 20 6.1 - 20 6.1 - 20 6.1 - 20 6.1 - — — - 20 6.~~
~~reactive Class 2, Class 3, or Class 4 NR — — - 20 6.1 - 20 6.1 - 20 6.1 - 20 6.1 - 20 6.1 Other gas —~~
~~NR - NR - NR - NR - NR - NR~~

~~NR: No separation required.~~

~~**7.1.10.2.1**~~ –

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

~~**7.1.10.2.2**~~ –

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

~~**7.1.10.2.3**~~ –

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

~~**7.1.10.2.4**~~ –

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

~~**7.1.10.2.5** *~~ –

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

~~**7.1.10.3** * – Clearance from Combustibles and Vegetation.~~

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

~~**7.1.10.3.1**~~ –

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

~~**7.1.10.3.2**~~ –

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

~~**7.1.10.4** – Ledges, Platforms, and Elevators.~~

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

~~**7.1.10.5** – Temperature Extremes.~~

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

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~~**7.1.10.5.1**~~ –

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

~~**7.1.10.6**~~ – ~~Falling Objects.~~

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

~~**7.1.10.7**~~ – ~~Heating.~~

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

~~**7.1.10.7.1**~~ – ~~Electrically Powered Heating Devices.~~

~~Electrical heating devices shall be in accordance with *NFPA 70* .~~

~~**7.1.10.7.2**~~ – ~~Fail-Safe Design.~~

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

~~**7.1.10.8**~~ – ~~Sources of Ignition.~~

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

~~**7.1.10.9**~~ – ~~Exposure to Chemicals.~~

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

~~**7.1.10.10**~~ – ~~Exposure to Electrical Circuits.~~

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

~~**7.1.10.10.1** *~~ –

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

~~**7.1.11**~~ – ~~Service and Repair.~~

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

~~**7.1.12**~~ – ~~Unauthorized Use.~~

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

~~**7.1.13**~~ – ~~Cylinders, Containers, and Tanks Exposed to Fire.~~

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

~~**7.1.14**~~ – ~~Leaks, Damage, or Corrosion.~~

~~**7.1.14.1**~~ – ~~Removal from Service.~~

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

~~**7.1.14.2**~~ – ~~Replacement and Repair.~~

~~Leaking, damaged, or corroded compressed gas systems shall be replaced or repaired.~~

~~**7.1.14.3** *~~ – ~~Handling of Cylinders, Containers, and Tanks Removed from Service.~~

~~Compressed gas cylinders, containers, and tanks that have been removed from service shall be handled in an approved manner.~~

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~~**7.1.14.4** – Leaking Systems.~~

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

~~**7.1.15** – Surfaces.~~

~~**7.1.15.1** –~~

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

~~**7.1.15.2** –~~

~~Surfaces shall be graded to prevent accumulation of water.~~

~~**7.1.16** – Storage Area Temperature.~~

~~**7.1.16.1** – Compressed Gas Containers.~~

~~Storage area temperatures shall not exceed 125°F (52°C).~~

~~**7.1.17** – Underground Piping.~~

~~**7.1.17.1** –~~

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

~~**7.1.17.1.1** –~~

~~Valves or connections located in boxes or enclosures shall be permitted to be installed underground where such boxes or enclosures are accessible from above ground and where the valves or connections contained are isolated from direct contact with earth or fill.~~

~~**7.1.17.1.1.1** –~~

~~Valve boxes or enclosures installed in areas subject to vehicular traffic shall be constructed to resist uniformly distributed and concentrated live loads in accordance with the building code for areas designated as vehicular driveways and yards, subject to trucking.~~

~~**7.1.17.1.2** * –~~

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

~~**7.1.17.2** –~~

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

~~**7.1.17.2.1** –~~

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

~~**7.1.17.3** –~~

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

~~**7.1.17.4** –~~

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

~~**7.1.17.5** –~~

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

~~**7.1.17.6** –~~

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

~~**7.1.17.7** –~~

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

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~~**7.1.17.8**~~ –

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

~~**7.1.17.9**~~ –

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

~~**7.1.17.10**~~ –

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

~~**7.1.18**~~ – ~~Cleaning and Purging of Gas Piping Systems.~~

~~**7.1.18.1**~~ – ~~General.~~

~~**7.1.18.1.1**~~ –

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

(1) ~~The system is installed and prior to being placed into service~~

(2) ~~There is a change in service~~

(3)* ~~There are alterations or repair of the system involving the replacement of parts or addition to the piping system and prior to returning the system to service~~

(4)* ~~The design standards or written procedures specify cleaning and purging~~

~~**7.1.18.1.2**~~ –

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

~~**7.1.18.1.3**~~ * –

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

~~**7.1.18.1.3.1**~~ * –

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

(1) ~~Evaluate hazards, errors, and malfunctions related to each step in the procedure~~

(2) ~~Review the measures prescribed in the procedure for applicability~~

(3) ~~Make recommendations for additional hazard mitigation measures if deemed necessary~~

~~**7.1.18.1.3.2**~~ –

~~The completed written procedure shall be as follows:~~

(1) ~~Maintained on site by the facility owner/operator~~

(2) ~~Provided to operating personnel engaged in cleaning or purging operations~~

(3) ~~Made available to the AHJ upon request~~

~~**7.1.18.1.3.3**~~ –

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

~~**7.1.18.1.3.4**~~ –

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

~~**7.1.18.1.4**~~ –

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

~~**7.1.18.1.4.1**~~ –

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

(1) ~~The technical basis for the proposed change~~

(2) ~~The safety and health implications~~

(3) ~~Whether the change is permanent or temporary~~

(4) ~~Whether modifications to the cleaning and purging procedures are required as a result of the identified changes~~

~~**7.1.18.1.4.2**~~ –

~~When modifications to the cleaning and purging procedures are required, the written procedure shall be updated to incorporate any elements identified by the management-of-change procedures.~~

~~**7.1.18.1.5**~~ –

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

~~**7.1.18.1.5.1**~~ –

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

~~**7.1.18.1.5.2**~~ –

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

~~**7.1.18.1.5.3** *~~ –

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

~~**7.1.18.2** *~~ – ~~Cleaning.~~

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

~~**7.1.18.2.1**~~ –

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

~~**7.1.18.2.2** *~~ –

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

~~**7.1.18.3** *~~ – ~~Purging.~~

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

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~~**7.1.18.3.1**~~ –

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

(1) ~~Activating or placing a piping system into service~~

(2) ~~Deactivating or removing a piping system from service~~

(3) ~~Changing the service of a piping system from one gas to another, except when such gas is supplied to a manifold or piping system designed for the purpose of filling or otherwise processing cylinders, containers, or tanks in a process with established procedures~~

(4) ~~Performing service, maintenance, or modifications on a system where personnel or designated areas will potentially be exposed to the internal contents of the piping system~~

(5) ~~Performing hot work, including but not limited to, welding, cutting, or brazing on the piping system~~

~~**7.1.18.3.2**~~ –

~~The termination point for the release of purged gases shall be in accordance with Section 6.16 .~~

~~**7.1.18.3.2.1**~~ –

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

~~**7.1.18.3.2.2**~~ –

~~The termination point for the release of purged gases resultant from the purging of piping systems out of service, other than those in accordance with 7.1.18.3.2.1 , shall not be required to be in accordance with Section 6.16 where the contained volume of the piping system (when released to indoor areas) does not result in a concentration in the room or area that will reduce the oxygen concentration in the room or area below a level of 19.5 percent or that exceeds any of the following limits:~~

(1) ~~Ceiling limit~~

(2) ~~Permissible exposure limit~~

(3) ~~Short-term exposure limit~~

(4) ~~Twenty-five percent of the lower flammable limit~~

~~**7.2**~~ – ~~Storage.~~

~~**7.2.1**~~ – ~~General.~~

~~**7.2.1.1**~~ – ~~Applicability.~~

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

~~**7.2.1.2**~~ – ~~Upright Storage Flammable Gas in Solution and Liquefied Flammable Gas.~~

~~Cylinders, containers, and tanks containing liquefied flammable gases and flammable gases in solution shall be positioned in the upright position.~~

~~**7.2.1.2.1**~~ – ~~Cylinders and Containers of 1.3 Gal (5 L) or Less.~~

~~Containers with a capacity of 1.3 gal (5 L) or less shall be permitted to be stored in a horizontal position.~~

~~**7.2.1.2.2**~~ – ~~Cylinders, Containers, and Tanks Designed for Horizontal Use.~~

~~Cylinders, containers, and tanks designed for use in a horizontal position shall be permitted to be stored in a horizontal position.~~

~~**7.2.1.2.3**~~ – ~~Palletized Cylinders, Containers, and Tanks.~~

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

~~**7.2.1.3**~~ – ~~Classification of Weather Protection as an Indoor Versus an Outdoor Area.~~

~~For other than explosive materials and hazardous materials presenting a detonation hazard, a weather protection structure shall be permitted to be used for sheltering outdoor storage or use areas without requiring such areas to be classified as indoor storage.~~

~~**7.2.2**~~ – ~~Material-Specific Regulations.~~

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~~**7.2.2.1** – Indoor Storage.~~

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

~~**7.2.2.2** – Exterior Storage.~~

~~**7.2.2.2.1** – General.~~

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

~~**7.2.2.2.2** – Separation.~~

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

~~**7.3** – Use and Handling.~~

~~**7.3.1** – General.~~

~~**7.3.1.1** – Applicability.~~

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

~~**7.3.1.2** – Controls.~~

~~**7.3.1.2.1** –~~

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

~~**7.3.1.2.2** –~~

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

~~**7.3.1.3** – Piping Systems.~~

~~Piping, tubing, fittings, and related components shall be designed, fabricated, and tested in accordance with the requirements of the applicable parts in ASME B31.3, *Process Piping* .~~

~~**7.3.1.3.1** – Integrity.~~

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

~~**7.3.1.3.2** – Backflow Prevention.~~

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

~~**7.3.1.4** – Valves.~~

~~**7.3.1.4.1** –~~

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

~~**7.3.1.4.2** –~~

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

~~**7.3.1.5** – Vent Pipe Termination.~~

~~**7.3.1.5.1** –~~

~~Venting of gases shall be directed to an approved location.~~

~~**7.3.1.5.2** –~~

~~The termination point for piped vent systems serving cylinders, containers, tanks, and gas systems used for the purpose of operational or emergency venting shall be in accordance with Section 6.16 .~~

~~**7.3.1.6** – Upright Use.~~

~~**7.3.1.6.1** –~~

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

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~~**7.3.1.6.2**~~ –

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

~~**7.3.1.7** – Inverted Use.~~

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

~~**7.3.1.7.1**~~ –

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

~~**7.3.1.7.2**~~ –

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

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

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

~~**7.3.1.9** – Transfer.~~

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

~~**7.3.1.10** – Use of Compressed Gases for Inflation.~~

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

~~**7.3.1.11** – Emergency Shutoff Valves.~~

~~**7.3.1.11.1**~~ –

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

~~**7.3.1.11.1.1 ***~~ –

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

~~**7.3.1.11.2**~~ –

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

~~**7.3.1.12** – Emergency Isolation.~~

~~**7.3.1.12.1**~~ –

~~Where compressed gases from sources in excess of the quantity thresholds in Table 6.3.1.1 having a hazard ranking in one or more of the following hazard classes in accordance with NFPA 704 are carried in pressurized piping above a gauge pressure of 15 psi (103 kPa), an approved method of emergency isolation shall be provided:~~

(1) ~~Health hazard Class 3 or Class 4~~

(2) ~~Flammability Class 4~~

(3) ~~Instability Class 3 or Class 4~~

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~~**7.3.1.12.2**~~ –

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

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

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

(3) ~~A constantly monitored control station with an alarm and remote shutoff of the gas supply system~~

(4) ~~Excess flow valves at the bulk source~~

~~**7.3.1.12.3**~~ –

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

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

(2) ~~Piping for pressure relief devices~~

~~**7.3.1.12.4**~~ – ~~Location Exemptions.~~

~~The requirements of 7.3.1.12 shall not apply to the following:~~

(1) ~~Piping for inlet connections designed to prevent backflow~~

(2) ~~Piping for pressure relief devices~~

(3) ~~Systems containing 430 scf (12.7 Nm ^{3}) or less of flammable gas~~

~~**7.3.2**~~ – ~~Material-Specific Regulations.~~

~~**7.3.2.1**~~ – ~~Indoor Use.~~

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

~~**7.3.2.2**~~ – ~~Exterior Use.~~

~~**7.3.2.2.1**~~ – ~~General.~~

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

~~**7.3.2.2.2**~~ – ~~Separation.~~

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

~~**7.3.3**~~ – ~~Handling.~~

~~**7.3.3.1**~~ – ~~Applicability.~~

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

~~**7.3.3.2**~~ – ~~Carts and Trucks.~~

~~**7.3.3.2.1**~~ –

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

~~**7.3.3.2.2**~~ –

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

~~**7.3.3.3**~~ – ~~Lifting Devices.~~

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

~~**7.4**~~ – ~~Medical Gas Systems.~~

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

~~**7.5**~~ – ~~Corrosive Gases.~~

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~~**7.5.1** – General.~~

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

~~**7.5.2** – Distance to Exposures.~~

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

~~**7.5.2.1** –~~

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

~~**7.5.2.1.1** * –~~

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

~~**7.5.2.1.2** –~~

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

~~**7.5.2.1.3** –~~

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

~~**7.5.2.1.4** –~~

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

~~**7.5.3** – Indoor Use.~~

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

~~**7.5.3.1** – Gas Cabinets.~~

~~Gas cabinets shall be in accordance with Section 6.18 .~~

~~**7.5.3.2** – Exhausted Enclosures.~~

~~Exhausted enclosures shall be in accordance with Section 6.19 .~~

~~**7.5.3.3** – Gas Rooms.~~

~~Gas rooms shall be in accordance with Section 6.4 .~~

~~**7.5.3.4** – Treatment Systems.~~

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

~~**7.5.3.4.1** –~~

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

(1) ~~Gas detection in accordance with 7.9.3.2.1.1~~

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

~~**7.5.3.4.2** –~~

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

~~**7.5.3.4.3** –~~

~~Treatment system sizing shall be in accordance with 7.9.3.4 .~~

~~**7.6** – Flammable Gases.~~

~~**7.6.1** – Storage, Use, and Handling.~~

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~~**7.6.1.1** * –~~

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

~~**7.6.1.2** –~~

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

~~**7.6.1.3** –~~

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

~~**7.6.2** – Distance to Exposures.~~

~~The outdoor storage or use of non-bulk flammable compressed gas shall be located from lot lines, public streets, public alleys, public ways, or buildings not associated with the manufacture or distribution of such gases in accordance with Table 7.6.2 .~~

~~Table 7.6.2 Distance to Exposures for Non-Bulk Flammable Gases~~

~~Maximum Amount per Storage Area~~

~~(scf) Minimum Distance Between Storage Areas~~

~~(ft) Minimum Distance to Lot Lines of Property That Can Be Built Upon~~

~~(ft) Minimum Distance to Public Streets, Public Alleys or Public Ways~~

~~(ft) Minimum Distance to Buildings on the Same Property Less Than~~

~~2-Hour Construction 2-Hour Construction 4-Hour~~
~~Construction 0–4225 5 5 5 5 0 0 4226–21,125 10 10 10 10 5 0 21,126–50,700 10 15 15 20 5 0 50,701–84,500 10 2~~

~~For SI units, 1 ft = 304.8 mm; 1 scf = 0.02832 Nm 3 .~~

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

~~**7.6.2.1** –~~

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

~~**7.6.2.1.1** * –~~

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

~~**7.6.2.1.2** –~~

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

~~**7.6.2.2** –~~

~~Bulk gas systems for flammable gases other than hydrogen shall be in accordance with Table 10.4.2.2.1(a) , Table 10.4.2.2.1(b) , or Table 10.4.2.2.1(c) where the quantity of flammable compressed gas exceeds 5000 scf (141.6 Nm 3).~~

~~**7.6.2.2.1** –~~

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

~~**7.6.2.2.2** –~~

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

~~**7.6.2.3** –~~

~~The configuration of the protective structure shall be designed to allow natural ventilation to prevent the accumulation of hazardous gas concentrations.~~

~~**7.6.2.4** –~~

~~Storage and use of flammable compressed gases shall not be located within 50 ft (15.2 m) of air intakes.~~

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~~**7.6.2.5** –~~

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

~~**7.6.2.6** –~~

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

~~**7.6.3** – Ignition Source Control.~~

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

~~**7.6.3.1** – Static Producing Equipment.~~

~~Static producing equipment located in flammable gas areas shall be grounded.~~

~~**7.6.3.2** – No Smoking or Open Flame.~~

~~Signs shall be posted in areas containing flammable gases stating that smoking or the use of open flame, or both, is prohibited within 25 ft (7.6 m) of the storage or use area perimeter.~~

~~**7.6.3.3** – Heating.~~

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

~~**7.6.4** – Electrical.~~

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

~~**7.6.5** – Maintenance of Piping Systems.~~

~~**7.6.5.1** –~~

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

~~**7.6.5.2** –~~

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

~~**7.6.5.3** –~~

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

~~**7.7** – Oxidizing Gases.~~

~~**7.7.1** – General.~~

~~The storage or use of oxidizing compressed gases exceeding the quantity thresholds for gases requiring special provisions as specified in Table 6.3.1.1 shall be in accordance with Chapters 1 through 6 and Sections 7.1 through 7.3 and 7.7 .~~

~~**7.7.2** – Distance to Exposures.~~

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

~~Table 7.7.2 Distance to Exposures for Oxidizing Gases~~

~~Quantity of Gas Stored (at NTP) - Distance to a Building Not Associated~~

~~with the Manufacture or Distribution of Oxidizing Gases or to a Public Way or Property Line - Minimum Distance Between Storage~~

~~Areas scf Nm ^{3} - ft m - ft m 0–50,000 0–1416 - 5 1.5 - 5 1.5 50,001–100,000 1417–2832 - 10 3.0 - 10 3.0 ≥100,001~~

~~**7.7.2.1** –~~

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

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~~**7.7.2.1.1** *~~ –

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

~~**7.7.2.1.2**~~ –

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

~~**7.7.2.2**~~ –

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

~~**7.7.2.3**~~ –

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

~~**7.8** – Pyrophoric Gases.~~

~~**7.8.1** – General.~~

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

~~**7.8.2** – Silane and Silane Mixtures.~~

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

~~**7.8.3** – Distance to Exposures.~~

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

~~Table 7.8.3 Distance to Exposures for Pyrophoric Gases~~

~~Maximum Amount per~~

~~Storage Area - Minimum Distance Between Storage Areas - Minimum Distance to Property Lines - Minimum Distance to Public Ways - Minimum Distance to Buildings on~~

~~the Same Property Less Than~~

~~2-Hour Construction - 2-Hour Construction - 4-Hour~~

~~Construction scf Nm 3 - ft m - ft m - ft m - ft m - ft m - ft m 250 7.1 - 5 1.5 - 25 7.6 - 5 1.5 - 5 1.5 - 0 0 - 0 0 >250 to 2500 >7.1 to 71.0 - 10 3.0 - 50 15.2 - 10 3.0 - 10 3.0 - 5 1.5 - 0 0 >2500 to 7500 >71.0 to 212.4 - 20 6.0 - 100 30.5 - 20 6.0 - 20 6.0 - 10 3.0 - 0 0~~

~~**7.8.3.1**~~ –

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

~~**7.8.3.1.1** *~~ –

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

~~**7.8.3.1.2**~~ –

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

~~**7.8.3.1.3**~~ –

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

~~**7.8.3.1.4**~~ –

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

~~**7.8.3.2**~~ –

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

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~~**7.8.3.2.1**~~ –

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

~~**7.9** – Toxic and Highly Toxic Gases.~~

~~**7.9.1** – General.~~

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

~~**7.9.2** – Ventilation and Arrangement.~~

~~**7.9.2.1** – Indoors.~~

~~The indoor storage or use of highly toxic gases or toxic gases shall be provided with a gas cabinet, exhausted enclosure, or gas room.~~

~~**7.9.2.1.1**~~ –

~~Gas cabinets shall be in accordance with Section 6.18 .~~

~~**7.9.2.1.2**~~ –

~~Exhausted enclosures shall be in accordance with Section 6.19 .~~

~~**7.9.2.1.3**~~ –

~~Gas rooms shall be in accordance with Section 6.4 .~~

~~**7.9.2.2** – Distance to Exposures.~~

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

~~**7.9.2.2.1**~~ –

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

~~**7.9.2.2.1.1***~~ –

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

~~**7.9.2.2.1.2**~~ –

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

~~**7.9.2.2.1.3**~~ –

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

~~**7.9.2.2.1.4**~~ –

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

~~**7.9.2.2.2**~~ –

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

~~**7.9.2.3** – Air Intakes.~~

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

~~**7.9.3** – Treatment Systems.~~

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

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~~**7.9.3.1** – Storage of Toxic or Highly Toxic Gases.~~

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

~~**7.9.3.1.1** – Valve Outlets Protected.~~

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

~~**7.9.3.1.2** – Handwheels Secured.~~

~~Where provided, handwheel-operated valves shall be secured to prevent movement.~~

~~**7.9.3.1.3** – Containment Devices Provided.~~

~~Approved cylinder containment vessels or cylinder containment systems shall be provided at an approved location.~~

~~**7.9.3.2** – Use of Toxic Gases.~~

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

~~**7.9.3.2.1** – Gas Detection.~~

~~**7.9.3.2.1.1** –~~

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

~~**7.9.3.2.1.2** –~~

~~The gas detection system shall monitor the exhaust system at the point of discharge from the gas cabinet, exhausted enclosure, or gas room.~~

~~**7.9.3.2.2** – Fail-Safe Automatic Closing Valve.~~

~~An approved automatic-closing fail-safe valve shall be located on or immediately adjacent to and downstream of active cylinder, container, or tank valves.~~

~~**7.9.3.2.2.1** –~~

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

~~**7.9.3.2.2.2** –~~

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

~~**7.9.3.2.2.3** –~~

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

~~**7.9.3.2.2.4** –~~

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

~~**7.9.3.3** – Treatment System Design and Performance.~~

~~Treatment systems shall be capable of diluting, adsorbing, absorbing, containing, neutralizing, burning, or otherwise processing stored or used toxic or highly toxic gas, or both.~~

~~**7.9.3.3.1** –~~

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

~~**7.9.3.3.2** –~~

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

~~**7.9.3.4** – Treatment System Sizing.~~

~~**7.9.3.4.1** – Worst-Case Release of Gas.~~

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

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~~**7.9.3.4.2** – Largest Compressed Gas Vessel.~~

~~The entire contents of the single largest compressed gas vessel shall be considered.~~

~~**7.9.3.4.3** – Attended Operations — Alternative Method of System Sizing.~~

~~**7.9.3.4.3.1** –~~

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

~~**7.9.3.4.3.2** –~~

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

~~**(A)** – Local Exhaust.~~

~~All gas transfer operations shall be conducted within a zone of local exhaust that is connected to a treatment system.~~

~~**(B)** – Gas Detection.~~

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

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

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

~~**(C)** – Process Shutdown.~~

~~Operations involving the gas detected shall be shut down and leaks repaired.~~

~~**(D)** – Piping System Construction.~~

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

~~**(E)** – Piping System Accessibility.~~

~~Piping systems shall be designed to provide for readily accessible manual shutdown controls.~~

~~**7.9.3.5** – Rate of Release.~~

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

~~Table 7.9.3.5 Rate of Release~~

~~- Time Release Container Type Nonliquefied Gases Liquefied~~

~~Gases Cylinders without restrictive flow orifices 5 minutes 30 minutes Portable tanks without restrictive flow orifices 40 minutes 240 minutes All others Based on peak flow from maximum valve orifice Based on peak flow from maximum valve orifice~~

~~**7.9.3.6 *** – Maximum Flow Rate of Release.~~

~~**7.9.3.6.1** –~~

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

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~~**7.9.3.6.2** *~~ –

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

$$CFM = (767 \times A \times P)\frac{(28.96 / MW)^{1/2}}{60} \quad \text{[7.9.3.6.2]}$$

~~where:~~

~~*CFM* = standard cubic feet per minute of gas of concern under flow conditions~~

~~*A* = area of orifice in square inches (See Table A.7.9.3.6 for areas of typical restricted flow orifices.)~~

~~*P* = supply pressure of gas at NTP in pounds per square inch absolute~~

~~*MW* = molecular weight~~

~~**7.9.3.6.3**~~ –

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

~~**7.9.4**~~ – ~~Leaking Cylinders, Containers, and Tanks.~~

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

~~**7.9.4.1**~~ – ~~Gas Cabinets or Exhausted Enclosures.~~

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

~~**7.9.4.2**~~ – ~~Containment Vessels or Systems.~~

~~Where containment vessels or containment systems are provided, they shall comply with the requirements of 7.9.4.2.1 through 7.9.4.2.3 .~~

~~**7.9.4.2.1**~~ – ~~Performance.~~

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

~~**7.9.4.2.2**~~ – ~~Personnel.~~

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

~~**7.9.4.2.3**~~ – ~~Location.~~

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

~~**7.9.5**~~ – ~~Emergency Power.~~

~~**7.9.5.1**~~ – ~~General.~~

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

~~**7.9.5.2**~~ – ~~Alternative to Emergency Power.~~

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

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~~**7.9.5.3** – Where Required.~~

~~Emergency power shall be provided for the following systems:~~

(1) ~~Exhaust ventilation~~

(2) ~~Treatment system~~

(3) ~~Gas detection system~~

(4) ~~Temperature control system~~

(5) ~~Required alarm systems~~

~~**7.9.5.4** – Level.~~

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

~~**7.9.6** – Gas Detection.~~

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

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

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

~~**7.9.6.2** – Local Alarm.~~

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

~~**7.9.6.3** – Alarm Monitored.~~

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

~~**7.9.6.4** – Automatic Shutdown.~~

~~**7.9.6.4.1** –~~

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

~~**7.9.6.4.2** –~~

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

~~**7.9.6.5** – Detection Points.~~

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

~~**7.9.6.5.1** – Treatment System Discharge.~~

~~Detection shall be provided at the discharge from the treatment system.~~

~~**7.9.6.5.2** – Point of Use.~~

~~Detection shall be provided in the room or area in which the gas is used.~~

~~**7.9.6.5.3** – Source.~~

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

~~**7.9.6.5.4** – Storage.~~

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

~~**7.9.6.6** – Level of Detection.~~

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

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~~**7.9.7** – Automatic Smoke Detection System.~~

~~An automatic smoke detection system shall be provided for the indoor storage or use of highly toxic compressed gases in accordance with *NFPA 72* .~~

~~**7.10** – Unstable Reactive Gases (Nondetonable).~~

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

~~**7.10.1** – Distances to Exposures for Class 2.~~

~~**7.10.1.1** –~~

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

~~**7.10.1.2** –~~

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

~~**7.10.1.2.1** * –~~

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

~~**7.10.1.2.2** –~~

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

~~**7.10.1.2.3** –~~

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

~~**7.10.1.2.4** –~~

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

~~**7.10.2** – Distances to Exposures for Class 3.~~

~~**7.10.2.1** –~~

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

~~**7.10.2.2** –~~

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

~~**7.10.2.2.1** * –~~

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

~~**7.10.2.2.2** –~~

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

~~**7.10.2.2.3** –~~

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

~~**7.10.2.2.4** –~~

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

~~**7.10.3** – Storage Configuration.~~

~~**7.10.3.1** –~~

~~Unstable reactive Class 3 compressed gases stored in cylinders, containers, or tanks shall be arranged to limit individual groups of cylinders, containers, or tanks to areas not exceeding 100 ft ^{2} (9.3 m ^{2}).~~

~~**7.10.3.2** –~~

~~Multiple areas shall be separated by aisles.~~

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~~**7.10.3.3** –~~

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

~~**7.10.4** – Basements.~~

~~Unstable reactive compressed gases shall not be stored in basements.~~

~~**7.10.5** – Unstable Reactive Gases (Detonable).~~

~~**7.10.5.1** – Storage or Use.~~

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

~~**7.10.5.2** – Location.~~

~~The location of storage areas shall be determined based on the requirements of the building code for explosive materials.~~

~~Harmonize NFPA 55 Chapter 6 and 7 with NFPA 2 Chapter 6~~

Statement of Problem and Substantiation for Public Input

This public input is proposing to re-align NFPA 2 with the requirements in NFPA 55. It is a placeholder comment to allow work to be done by a task group in the future to better align the documents based upon feedback from the NFPA2/55 Scope Joint Working Group. A Public Comment will be submitted with exact language changes.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 57-NFPA 55-2020 [Chapter 6]	Related PI
Public Input No. 58-NFPA 55-2020 [Chapter 10]	Related PI
Public Input No. 59-NFPA 55-2020 [Chapter 11]	Related PI
Public Input No. 57-NFPA 55-2020 [Chapter 6]	
Public Input No. 58-NFPA 55-2020 [Chapter 10]	
Public Input No. 59-NFPA 55-2020 [Chapter 11]	

Submitter Information Verification

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Committee: IMG-AAA

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Public Input No. 47-NFPA 55-2020 [New Section after 7.1]

7.XX Subatmospheric Gas Sources

The storage and use of subatmopheric gas (type 1 or type 2) sources shall meet all requirements of this standard based on the the assigned hazard categories listed in 5.1, except as provided for in 7.14.2.1 -7.14.2.6. of NFPA 318.

Statement of Problem and Substantiation for Public Input

These terms need to be included so they can be listed in the definitions section.

Submitter Information Verification

Submitter Full Name:	Thomas Deary
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Attachment F - NFPA 55 Public Inputs

Public Input No. 38-NFPA 55-2020 [New Section after 7.1.2.2]

7.1.2.3

Tube trailers used as gas supply systems shall comply with CGA P-74, Standard for Tube Trailer Supply Systems at Customer Sites.

Statement of Problem and Substantiation for Public Input

NFPA 55 section 1.1.1 (applicability) and annex note A.1.1.1 clarify the point that NFPA 55 does apply to portable supply systems, including tube trailers. P-74 provides specific requirements and methodology for tube trailers used as customer supply systems, including references to applicable sections of NFPA 55, and so enhances the requirements in section 1.1.1.

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Attachment F - NFPA 55 Public Inputs

Public Input No. 2-NFPA 55-2019 [Section No. 7.1.10.2]

7.1.10.2* Incompatible Materials.

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

Table 7.1.10.2 Separation of Gas Cylinders, Containers, and Tanks by Hazard Class

Gas Category	Other Gas	Unstable Reactive Class 2, Class 3, or Class 4		-	Corrosive		-	Oxidizing		-	Flammable		-	Pyrophoric		-	Toxic or Highly Toxic	
		ft	m	-	ft	m	-	ft	m	-	ft	m	-	ft	m	-	ft	m
Toxic or highly toxic	NR	20	6.1	-	20	6.1	-	20	6.1	-	20	6.1	-	20	6.1	-	—	—
Pyrophoric	NR	20	6.1	-	20	6.1	-	20	6.1	-	20	6.1	-	—	—	-	20	6.1
Flammable	NR	20	6.1	-	20	6.1	-	20	6.1	-	—	—	-	20	6.1	-	20	6.1
Oxidizing	NR	20	6.1	-	20	6.1	-	—	—	-	20	6.1	-	20	6.1	-	20	6.1
Corrosive	NR	20	6.1	-	—	—	-	20	6.1	-	20	6.1	-	20	6.1	-	20	6.1
Unstable reactive Class 2, Class 3, or Class 4	NR	—	—	-	20	6.1	-	20	6.1	-	20	6.1	-	20	6.1	-	20	6.1
Other gas	—	NR		-	NR		-	NR		-	NR		-	NR		-	NR	

NR: No separation required.

7.1.10.2.1

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

7.1.10.2.2

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

7.1.10.2.3

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

7.1.10.2.4

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

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7.1.10.2.5*

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

7.1.10.2.6

Gas cylinders, containers, and tanks containing oxidizing gases in storage shall be separated from tanks and containers of flammable and combustible liquids by one of the following methods:

(1) Segregating by a distance of not less than 25 ft (6.1 m)

(2) Storing the combustible and flammable liquids in an approved storage cabinet complying with NFPA 30 Section 9.5 for flammable liquids storage cabinets.

(3) Storing compressed gases in gas cabinets or exhausted enclosures complying with 6.17 or 6.18, respectively.

Statement of Problem and Substantiation for Public Input

This is to correlate with NFPA 30 Section 9.17.3, but also provide additional options for compliance as 25 feet separation is difficult to acheive in many laboratories that may use both oxidizing gases, and combustible and flammable liquids.

NFPA 400 Section 6.1.12 was also considered for a basis and at least partial correlation with this code is also desired.

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Attachment F - NFPA 55 Public Inputs

Public Input No. 41-NFPA 55-2020 [Section No. 7.1.10.2]

7.1.10.2* Incompatible Materials.

Gas cylinders, containers, and tanks containing incompatible materials shall be separated ~~in accordance with Table 7.1.10.2 .~~

~~Table 7.1.10.2 Separation of Gas Cylinders, Containers, and Tanks by Hazard Class~~

~~Gas Category Other Gas Unstable Reactive Class 2, Class 3, or Class 4 - Corrosive - Oxidizing - Flammable - Pyrophoric - Toxic or Highly Toxic ft m - ft m - ft m - ft m - ft m - ft m Toxic or highly toxic NR 20 6.1 - 20 6.1 - 20 6.1 - 20 6.1 - 20 6.1 - — — Pyrophoric NR 20 6.1 - 20 6.1 - 20 6.1 - 20 6.1 - — — - 20 6 reactive Class 2, Class 3, or Class 4 NR — — - 20 6.1 - 20 6.1 - 20 6.1 - 20 6.1 - 20 6.1 Other gas — NR - NR - NR - NR - NR - NR~~

~~NR: No separation required.~~

from each other by a distance of not less than 20 ft (6.1 m). See definition of incompatible materials in 3.3.66.1.

7.1.10.2.1

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

7.1.10.2.2

The

~~distances shown in Table 7.1.10.2~~

20 ft. (6.1 m) distances shall be permitted to be reduced without limit where compressed gas cylinders, containers, and tanks are separated by a barrier of noncombustible construction that has a fire resistance rating of at least 0.5 hour and interrupts the line of sight between the containers.

7.1.10.2.3

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

7.1.10.2.4

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

7.1.10.2.5*

Spatial separation shall not be required between gas cylinders

~~deemed to be~~

containing incompatible materials in gas production facilities where gas cylinders are connected to manifolds for the purposes of filling, analysis of compressed gases, or manufacturing procedures, assuming the prescribed controls for the manufacture of gas mixtures are in place.

Statement of Problem and Substantiation for Public Input

The Table in this paragraph requiring separation by hazard class sweeps so broadly that it forces the separation of materials that would otherwise be chemically compatible, or would be no more dangerous if mixed. This PC would provide for material separation based on the technical definition of incompatible materials as defined in NFPA-55. An example illustrates the need for this change: Suppose there are two cylinders in storage: oxygen and chlorine. Both are oxidizing gases, but chlorine is also a toxic gas. If mixed, these materials would not create a new hazard not already inherent in either gas by itself. Simply stated: oxygen and chlorine cannot be said to be incompatible materials. But because chlorine is toxic and oxygen is not, separation would be required between these cylinders. There is no technical basis for forcing this separation. And the economic harm this section does outweighs any argument to keep it for its ease of adminstration. The impact of forcing container separation when it is otherwise unjustified by sound engineering judgement is significant for both gas manufacturers and end users. Many companies who handle cylinder gases deal in both a high volume of cylinders and a wide variety of gas types. And compliance with separation requirements comes at a cost of capital, space, engineering time, and future flexibility

Attachment F - NFPA 55 Public Inputs

of the facility. The economic cost of compliance with this section—requiring separate storage areas or canopies, fire walls, and supporting systems (e.g., fire protection, electrical distribution)—could range from thousands to millions of dollars depending upon the size of the facility. The cost of compliance with rules such as these is only justified when it create a safer environment. But those valuable resources are wasted where there is no technical justification for separation, and doing so is just to meet the letter of the code. Making this change will not affect the ability of the Authorities Having Jurisdiction to enforce the separation of legitimately incompatible materials. In fact, this PC will address and correct the incompatiblities allowed to exist under the present code, while also eliminating the wasteful use of resources of segregating by general classification.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 43-NFPA 55-2020 [New Section after 7.1.10.2.5]	

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Attachment F - NFPA 55 Public Inputs

Public Input No. 16-NFPA 55-2020 [New Section after 7.1.10.2.2]

Separation of compatible gases

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

Statement of Problem and Substantiation for Public Input

The basic requirement should be that incompatible gases are separated by the distance specified by the code. The use of these generic categories presents unnecessary difficulties when storing gases that are assigned multiple gas categories but are actually chemically compatible. For example, per the current 7.1.10.2, a cylinder of chlorine gas (typically classified as a corrosive, oxidizer, and a toxic gas) cannot be stored with a cylinder of oxygen gas (classified as an oxidizing gas). The "491" section of the NFPA Fire Protection Guide to Hazardous Materials does not indicate an incompatibility for these two gases. An allowance to store compatible gases should be allowed when compatibility information is available.

This approach is consistent with the NFPA 400 Hazardous Material Management Plan/Hazardous Material Inventory Statements in Appendix C. NFPA 400 Figure C.3.1 Part A and section C.3.2.5 which include a section for the determination of compatibility. The NFPA Fire Protection Guide to Hazardous Materials should be used for guidance on compatibility. Additionally, the Safety Data Sheets and other sources such as HMEX (TM) provide information about the compatibility of chemicals.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 17-NFPA 55-2020 [New Section after A.7.1.10.2]	

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Attachment F - NFPA 55 Public Inputs

Public Input No. 43-NFPA 55-2020 [New Section after 7.1.10.2.5]

TITLE OF NEW CONTENT

Add following sections:

7.1.10.2.6 Gas cylinders, containers, and tanks containing materials incompatible with each other shall be separated into groups of compatible materials and segregated by distance or barrier.

7.1.10.2.7 Incompatibility/Compatibility shall be established based on information extracted from the material's SDS or other chemical property reference(s).

7.1.10.2.8 Incompatible examples include but are not limited to: oxidizers and flammables, strong acids and strong bases, and hydrides and halogen compounds

Statement of Problem and Substantiation for Public Input

The Table in this paragraph requiring separation by hazard class sweeps so broadly that it forces the separation of materials that would otherwise be chemically compatible, or would be no more dangerous if mixed. This PC would provide for material separation based on the technical definition of incompatible materials as defined in NFPA-55. An example illustrates the need for this change: Suppose there are two cylinders in storage: oxygen and chlorine. Both are oxidizing gases, but chlorine is also a toxic gas. If mixed, these materials would not create a new hazard not already inherent in either gas by itself. Simply stated: oxygen and chlorine cannot be said to be incompatible materials. But because chlorine is toxic and oxygen is not, separation would be required between these cylinders. There is no technical basis for forcing this separation. And the economic harm this section does outweighs any argument to keep it for its ease of adminstration. The impact of forcing container separation when it is otherwise unjustified by sound engineering judgement is significant for both gas manufacturers and end users. Many companies who handle cylinder gases deal in both a high volume of cylinders and a wide variety of gas types. And compliance with separation requirements comes at a cost of capital, space, engineering time, and future flexibility of the facility. The economic cost of compliance with this section—requiring separate storage areas or canopies, fire walls, and supporting systems (e.g., fire protection, electrical distribution)—could range from thousands to millions of dollars depending upon the size of the facility. The cost of compliance with rules such as these is only justified when it create a safer environment. But those valuable resources are wasted where there is no technical justification for separation, and doing so is just to meet the letter of the code. Making this change will not affect the ability of the Authorities Having Jurisdiction to enforce the separation of legitimately incompatible materials. In fact, this PC will address and correct the incompatiblities allowed to exist under the present code, while also eliminating the wasteful use of resources of segregating by general classification.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 41-NFPA 55-2020 [Section No. 7.1.10.2]	

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Attachment F - NFPA 55 Public Inputs

Public Input No. 46-NFPA 55-2020 [Section No. 7.1.10.5]

7.1.10.5 Temperature Extremes.

Compressed gas cylinders, containers, and tanks, whether full or partially full, shall not be exposed to temperatures exceeding 125°F (52°C) or subambient (low) temperatures unless:

(1) The compressed gas cylinders, containers, and tanks are designed for use under such exposure; or

(2) At compressed gas manufacturing facilities where temperatures above 125°F (52°C) and below subambient (low) temperatures are permitted for the purposes of filling, analysis, and other related procedures, provided engineering controls are employed to prevent any hazard and the temperature extremes will not degrade the original mechanical properties of the container, cylinder, or tank .

7.1.10.5.1

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

Statement of Problem and Substantiation for Public Input

Cylinders at compressed gas manufacturing facilities may require exposure to temperatures beyond the extremes listed in 7.1.10.5. Cylinders may be exposed to subambient temperatures during a filling processes. A compressed gas cylinder filler may not be able to prove the cylinder was designed for such operation, but could provide evidence that the mechanical properties of the cylinder are not degraded after processing under such conditions.

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Attachment F - NFPA 55 Public Inputs

Public Input No. 44-NFPA 55-2020 [Section No. 7.1.10.7 [Excluding any Sub-Sections]]

Compressed gas cylinders, containers, and tanks, whether full or partially full, shall not be heated by devices that could raise the surface temperature of the container, cylinder, or tank to above 125°F (52°C), except for at compressed gas manufacturing facilities, where temperatures above 125°F (52°C) are permitted for the purposes of filling, analysis, and other related procedures, provided engineering controls are employed to prevent any hazard and the elevated temperatures will not degrade the original mechanical properties of the container, cylinder, or tank ..

Statement of Problem and Substantiation for Public Input

Compressed gas cylinder processing often requires the surface temperature of the cylinders to be raised in excess of 125°F (52°C). For example, pre-fill cylinder conditioning procedure may involve the addition of a small amount of the fill gas followed by heating to a temperature > 125°F (52°C) to render the interior cylinder surface unreactive.

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Attachment F - NFPA 55 Public Inputs

Public Input No. 12-NFPA 55-2020 [New Section after 7.1.10.9]

TITLE OF NEW CONTENT

7.1.10.9.2 Compressed gas cylinders shall ne separated from flammable or combustible liquid storage by suitable means or 25 ft. to prevent ignition of a leak of such flammable liquids from over heating the cylinder. Dikes, trenches, sloping floors, and spill containment are typical mitigative measures.

Statement of Problem and Substantiation for Public Input

I have seen numerous installations where the current wording fails to address the concern of nearby flammable storage near compressed gas cylinders. In the event of a spill and potential fire, these can cause the compressed gas cylinders to relieve and feed the fire. It seems only prudent to include some wording to highlight the hazard and some guidance as to potential mitigative measures. The 25 ft distance was chosen to match the incompatible gas spacing in this standard.

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Attachment F - NFPA 55 Public Inputs

Public Input No. 11-NFPA 55-2020 [Section No. 7.1.10.9]

7.1.10.9 Exposure to Chemicals.

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

<u>Compressed gas cylinders shall not be located such that they may be exposed to spills of flammable liquids.</u>

Statement of Problem and Substantiation for Public Input

Right now the code allows compressed gas cylinders to be stored right next to flammable materials. A drum of a flammable materials, in the event of a spill, could create a fire hazard which could cause the cylinders to relieve and feed the fire.

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Attachment F - NFPA 55 Public Inputs

Public Input No. 24-NFPA 55-2020 [Section No. 7.1.17.1 [Excluding any Sub-Sections]]

Underground ~~piping~~ piping joints shall be ~~of welded construction without~~ welded or press-connected without valves, unwelded mechanical joints, or connections installed underground. Press-Connect joints shall be installed in accordance with the manufacturer's specifications and installation instructions.

Statement of Problem and Substantiation for Public Input

Currently press-connect fittings are not a recognized pipe joining method for underground piping. Press-Connect fittings are listed for use underground with multiple gasses and the physical properties of this joining technology differ from traditional mechanical joints due to the fact they are a permanent connect that cannot be removed without cutting the pipe and or tubing. Press-connect technology provides an alternative to open flame welding, increasing safety on the job for the installed and building owners. Press Connect fittings are included in multiple NFPA standards 31, 54 and 58 just to name a few and are suitable for underground use due to their construction and they are widely used in these applications. This proposed revision will provide the designer and installer with another option for joining pipe without the use of open flame and fire permits.

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Attachment F - NFPA 55 Public Inputs

Public Input No. 3-NFPA 55-2019 [Section No. 7.3.1.10]

7.3.1.

~~10 Use~~

10 Use of Compressed Gases for Inflation.

~~Inflatable equipment, devices,~~

~~or balloons~~

and small unregulated elastic balloons, such as party balloons, shall only be pressurized or filled with compressed air or inert gases. Balloons intended for launch into the atmosphere for scientific or meteorological purposes and manned balloons are exempt from the provisions of this section.

Statement of Problem and Substantiation for Public Input

Prior to a flight, gas balloon and hot air balloon pilots routinely launch non-instrumented small elastic party-size balloons - containing either helium or hydrogen - to get a reading of the wind direction and speed in the vicinity of, and downwind of, the launch site. Helium has become difficult to source and purchase, even in small quantities. These meteorological balloon soundings are an important factor in understanding local micrometeorological conditions which are often not forecast and, as such, are an essential component to the safety of manned balloon flight.

Gas balloons have been in continuous use for many centuries, and have carried people aloft since 1783. Gas balloons have been inflated with both helium and hydrogen as the lighter than air gas. Globally, the current gas predominantly used is hydrogen. The largest manned gas balloon event is held in Europe and is called the Gordon Bennett Cup (or Coupe Aéronautique Gordon Bennett) - this is the most famous and longest running aviation event in the world. (http://www.gordonbennett.org/index.php/en/the-gordon-bennett) In the US, Albuquerque NM hosts a manned hydrogen gas balloon race annually called the Americas Challenge Gas Balloon Race (https://balloonfiesta.com/Americas-Challenge).

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Attachment F - NFPA 55 Public Inputs

Public Input No. 77-NFPA 55-2020 [Section No. 7.6.1.2]

7.6.1.2

Storage, use, and handling of gaseous hydrogen shall be in accordance with ~~7.6.1 and Chapter 10~~ . NFPA 2.

Statement of Problem and Substantiation for Public Input

The storage, use, handling, and many other aspects of hydrogen are addressed by NFPA 2. Per the committee scope statements the HYD Committee has "primary responsibility for documents on the storage, transfer, production, and use hydrogen" and the IMG "Committee shall coordinate the material on gaseous and liquid hydrogen storage and use with the Hydrogen Technology Committee." The simplest, least error prone way for NFPA 55 to coordinate with NFPA 2 regarding hydrogen gas is to just refer the user to NFPA 2.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 78-NFPA 55-2020 [Section No. 7.6.2.1]	
Public Input No. 79-NFPA 55-2020 [Section No. 7.6.2.6]	
Public Input No. 85-NFPA 55-2020 [Chapter 10]	
Public Input No. 86-NFPA 55-2020 [Chapter 11]	

Submitter Information Verification

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Attachment F - NFPA 55 Public Inputs

Public Input No. 78-NFPA 55-2020 [Section No. 7.6.2.1]

~~**7.6.2.1**~~ –

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

~~**7.6.2.1.1 ***~~ –

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

~~**7.6.2.1.2**~~ –

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

Statement of Problem and Substantiation for Public Input

The distances to exposures from all types of hydrogen systems are addressed by NFPA 2. Per the committee scope statements the HYD Committee has "primary responsibility for documents on the storage, transfer, production, and use hydrogen" and the IMG "Committee shall coordinate the material on gaseous and liquid hydrogen storage and use with the Hydrogen Technology Committee." The simplest, least error prone way for NFPA 55 to coordinate with NFPA 2 regarding hydrogen gas is to just refer the user to NFPA 2. This is best accomplished in 7.6.1.2.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 77-NFPA 55-2020 [Section No. 7.6.1.2]	Refers user to NFPA 2 for requirements re: hydrogen.

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Attachment F - NFPA 55 Public Inputs

Public Input No. 28-NFPA 55-2020 [Section No. 7.6.2.2 [Excluding any Sub-Sections]]

Bulk gas systems for flammable gases ~~other than~~ including hydrogen shall be in accordance with Table 10.4.2.2.1(a), Table 10.4.2.2.1(b), or Table 10.4.2.2.1(c) where the quantity of flammable compressed gas exceeds 5000 scf (141.6 Nm^3).

Statement of Problem and Substantiation for Public Input

The tables 10.4.2.2.1 (a-c) are for bulk hydrogen, but the current language in this clause state exempts hydrogen. A better way to do this might be to move tables 10.4.2.2.1 (a-c) to this section and have Chapter 10 reference Chapter 7. This may cause conflicts with NFPA2.

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Attachment F - NFPA 55 Public Inputs

Public Input No. 118-NFPA 55-2020 [Sections 7.6.2.4, 7.6.2.5]

Sections 7.6.2.4, 7.6.2.5

7.6.2.4

Storage and use of flammable compressed gases shall not be located within 50 ft (15.2 m) of air intakes or the minimum distance from a bulk storage system (Table 10 .4.2.2.1(a), (b) and (c)).

7.6.2.5

Storage and use of flammable gases outside of buildings shall also be separated from building openings by 25 ft (7.6 m) or the minimum distance from a bulk storage system (Table 10 .4.2.2.1(a), (b) and (c)). Fire barriers shall be permitted to be used as a means to separate storage areas from openings or a means of egress used to access the public way.

Statement of Problem and Substantiation for Public Input

For hydrogen, there is a possible situation in which you could have a non-bulk system that has a larger setback than a bulk system, suggesting that to reduce your setbacks you can just make the system larger.

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Attachment F - NFPA 55 Public Inputs

Public Input No. 79-NFPA 55-2020 [Section No. 7.6.2.6]

7.6.2.6

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

Statement of Problem and Substantiation for Public Input

The venting of all types of hydrogen systems are addressed by NFPA 2. The simplest, least error prone way for NFPA 55 to coordinate with NFPA 2 regarding hydrogen gas is to just refer the user to NFPA 2. This is best accomplished in 7.6.1.2.

Note: Per the committee scope statements the HYD Committee has "primary responsibility for documents on the storage, transfer, production, and use hydrogen" and the IMG "Committee shall coordinate the material on gaseous and liquid hydrogen storage and use with the Hydrogen Technology Committee."

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 77-NFPA 55-2020 [Section No. 7.6.1.2]	Refers user to NFPA 2 for requirements re: hydrogen.

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Attachment F - NFPA 55 Public Inputs

Public Input No. 81-NFPA 55-2020 [New Section after 8.1.3]

8.1.4

Storage, use, and handling of liquid hydrogen shall be in accordance with NFPA 2.

Statement of Problem and Substantiation for Public Input

Chapter 8 is missing the general reference for liquid hydrogen that 7.6 includes for gaseous hydrogen.

The storage, use, handling, and many other aspects of liquid hydrogen are addressed by NFPA 2. The simplest, least error prone way for NFPA 55 to coordinate with NFPA 2 regarding hydrogen gas is to just refer the user to NFPA 2.

Note: Per the committee scope statements the HYD Committee has "primary responsibility for documents on the storage, transfer, production, and use hydrogen" and the IMG "Committee shall coordinate the material on gaseous and liquid hydrogen storage and use with the Hydrogen Technology Committee."

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 80-NFPA 55-2020 [Section No. 8.6.3.1]	
Public Input No. 85-NFPA 55-2020 [Chapter 10]	
Public Input No. 86-NFPA 55-2020 [Chapter 11]	

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Submittal Date:	Sun Jun 28 16:56:43 EDT 2020
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Attachment F - NFPA 55 Public Inputs

Public Input No. 14-NFPA 55-2020 [Section No. 8.6.2 [Excluding any Sub-Sections]]

Stationary containers located outdoors shall be separated from exposure hazards in accordance with the minimum separation distances indicated in Table 8.6.2.

Table 8.6.2 does not apply to stationary containers located indoors. However, the distance requirements apply to the fill connection location and the vent line discharge location(s) outside the building of a cryogenic container installed indoors.

Table 8.6.2 Minimum Separation Distance Between Stationary Cryogenic Containers and Exposures

	-	Minimum Distance
Exposure	ft	m
(1) Buildings, regardless of construction type	1	0.3
(2) Wall openings	1	0.3
(3) Air intakes	10	3.1
(4) Property lines	5	1.5
(5) Places of public assembly (assembly occupancies)	50	15
(6) Nonambulatory patient areas	50	15
(7) Combustible materials, (e.g., paper, leaves, weeds, dry grass, debris)	15	4.5
(8) Incompatible hazardous materials	20	6.1
(9) Building exits	10	3.1

Statement of Problem and Substantiation for Public Input

To ensure that NFPA 55 code covers requirements of indoor installations of cryogenic systems. Due to the fact that NFPA 55 is the code that supersedes any other references/ standards such as CGA P-18, the clarifications or detailed information should be included in the NFPA 55 code first. In addition, specifying that these distance requirements apply to the vent line discharge and fill connection will clarify their location during construction and ensure safety.

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Attachment F - NFPA 55 Public Inputs

Public Input No. 80-NFPA 55-2020 [Section No. 8.6.3.1]

~~**8.6.3.1**~~ –

~~Non-bulk portable containers of liquefied hydrogen shall be separated from exposure hazards in accordance with Table 8.6.3.1 .~~

~~Table 8.6.3.1 Distance to Exposures for Non-Bulk Liquefied Hydrogen (LH 2)~~

~~Maximum Amount per Storage Area (gal) Minimum Distance Between Storage Areas (ft) Minimum Distance to Lot Lines of Property That Can Be Built Upon (ft) Minimum Distance to Public Streets, Public Alleys, or Public Ways (ft) Minimum Distance to Buildings on~~

~~the Same Property Less than 2-Hour Construction 2-Hour Construction 4-Hour Construction 0–39.7 5 5 5 5 0 0 39.8–186.9 10 10 10 10 5 0 187–448.7 10 15 15 20 5 0 448.8–747.8 10 20 20 20 5~~

~~For SI units: 1 ft = 305 mm.~~

~~Notes:~~

~~(1) For requirements on minimum distance to air intakes, see 7.6.2.4 .~~

~~(2) For requirements on minimum distance to building openings including exits, see 7.6.2.5 .~~

~~(3) When 8.6.3.2 is used as a means of distance reduction, the configuration of the fire barriers should be designed to allow natural ventilation to prevent the accumulation of hazardous gas concentrations.~~

Statement of Problem and Substantiation for Public Input

Separation distances for all types of hydrogen systems are addressed by NFPA 2. The simplest, least error prone way for NFPA 55 to coordinate with NFPA 2 regarding separation distances is to just refer the user to NFPA 2. This is best accomplished in 8.1.4.

Note: Per the committee scope statements the HYD Committee has "primary responsibility for documents on the storage, transfer, production, and use hydrogen" and the IMG "Committee shall coordinate the material on gaseous and liquid hydrogen storage and use with the Hydrogen Technology Committee."

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 81-NFPA 55-2020 [New Section after 8.1.3]	Refers user to NFPA 2 for requirements re: hydrogen.

Submitter Information Verification

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Committee: IMG-AAA

Attachment F - NFPA 55 Public Inputs

Public Input No. 82-NFPA 55-2020 [Section No. 8.13.11.3.3]

8.13.11.3.3 Vehicle Loading and Unloading Areas.

Loading and unloading areas shall be constructed in accordance with the requirements of Chapter 9 for liquid oxygen, ~~Chapter 11 for~~ NFPA 2 for liquid hydrogen, Chapter 13 for liquid carbon dioxide, and Chapter 16 for liquid nitrous oxide or ANSI/CGA P-18, *Standard for Bulk Inert Gas Systems at Consumer Sites,* for inert cryogenic fluids, as applicable.

Statement of Problem and Substantiation for Public Input

Loading and unloading liquid hydrogen is addressed by NFPA 2. The simplest, least error prone way for NFPA 55 to coordinate with NFPA 2 regarding separation distances is to just refer the user to NFPA 2.

Note: Per the committee scope statements the HYD Committee has "primary responsibility for documents on the storage, transfer, production, and use hydrogen" and the IMG "Committee shall coordinate the material on gaseous and liquid hydrogen storage and use with the Hydrogen Technology Committee."

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 83-NFPA 55-2020 [Section No. 8.13.11.3.4 [Excluding any Sub-Sections]]	

Submitter Information Verification

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Submittal Date: Sun Jun 28 17:05:58 EDT 2020
Committee: IMG-AAA

Attachment F - NFPA 55 Public Inputs

Public Input No. 48-NFPA 55-2020 [Section No. 8.13.11.3.4]

8.13.11.3.4*

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

8.13.11.3.4.1*

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

Statement of Problem and Substantiation for Public Input

Removed references to chapter 13 (carbon dioxide) and CGA P-18 (inert gases) because those references do not require noncombustible spill pads. Current wording implies these requirements for all the references.

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Attachment F - NFPA 55 Public Inputs

Public Input No. 83-NFPA 55-2020 [Section No. 8.13.11.3.4 [Excluding any Sub-Sections]]

A noncombustible, delivery vehicle spill pad shall be provided when required by the material-specific requirements of Chapter 9 for liquid oxygen, ~~Chapter 11 for~~ NFPA 2 for liquid hydrogen, Chapter 13 for liquid carbon dioxide, and Chapter 16 for liquid nitrous oxide or ANSI/CGA P-18, *Standard for Bulk Inert Gas Systems at Consumer Sites*.

Statement of Problem and Substantiation for Public Input

Loading and unloading liquid hydrogen is addressed by NFPA 2. The simplest, least error prone way for NFPA 55 to coordinate with NFPA 2 regarding separation distances is to just refer the user to NFPA 2.

Note: Per the committee scope statements the HYD Committee has "primary responsibility for documents on the storage, transfer, production, and use hydrogen" and the IMG "Committee shall coordinate the material on gaseous and liquid hydrogen storage and use with the Hydrogen Technology Committee."

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 82-NFPA 55-2020 [Section No. 8.13.11.3.3]	Similar subject

Submitter Information Verification

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Attachment F - NFPA 55 Public Inputs

Public Input No. 84-NFPA 55-2020 [Section No. 9.3.2 [Excluding any Sub-Sections]]

Attachment F - NFPA 55 Public Inputs

Oxygen systems located outdoors shall be separated from exposure hazards in accordance with the requirements of Table 9.3.2 as applicable.

Table 9.3.2 Minimum Separation Distances Between Bulk Liquid Oxygen Systems and Exposure Hazards

Type of Exposure	Distance (See 9.3.2.1.) ft	m
(1) Buildings of Type I and II construction as defined by the building code	1	0.3
(2) Buildings of Type III, IV, or V construction as defined by the building code	50	15
(3) Wall openings as measured from high-pressure gas or liquefied gas regulators, pressure relief devices, vaporizers, manifolds, and interconnected piping	10	3
(4) Property lines	5	1.5
(5) Public sidewalks	10	3
(6) Public assembly	50	15
(7) Areas occupied by nonambulatory patients as measured from the primary pressure relief device discharge vent and from filling and vent connections	50	15
(8) Parked vehicles	10	3
(9) Exterior walls that encroach on the container to form a court with three or more sides	*See 8.13.2.7*	
(10) All classes of flammable and combustible liquids above ground *(See 9.3.2.2.)*	–	–
(a) 0 gal to 1000 gal (0 to 3785 L)	25	7.5
(b) Over 1000 gal (3785 L)	50	15
(11) All classes of flammable and combustible liquids in belowground tanks or vaults	–	–
(a) Horizontal distance from oxygen storage container to tank or vault	15	4.6
(b) Horizontal distance from oxygen storage container to filling and vent connections or other openings to tank or vault	25	7.5
(12) Flammable gases aboveground	–	–
~~(a) Liquefied hydrogen (any quantity)~~	75	22.5
~~– (b) Other liquefied gas, 0 gal to 1000 gal (0 L to 3785 L)~~	~~25~~	~~7.5~~
~~(c) Other liquefied gas, over 1000 gal (3785 L)~~	~~50~~	~~15~~
~~(d) Nonliquefied or dissolved gases, 0 scf to 25,000 scf (0 Nm³ to 708 Nm³)~~	~~25~~	~~7.5~~
~~(e) Nonliquefied or dissolved gases, over 25,000 scf (708 Nm³)~~	~~50~~	~~15~~
~~(~~ 13) Rapidly burning solids, including, but not limited to, excelsior, paper, or combustible waste	50	15
(14) Slowly burning solids, including, but not limited to, heavy timber or coal	25	7.5
(15) Inlets to underground sewer or drainage systems from liquid delivery connections, pressure relief device outlets, mobile supply equipment, and liquid withdrawal connections	8	2.5
(16) Areas below connections where liquid can fall during loading or unloading operations and system operation from combustible surfaces, including, but not limited to, asphalt or bitumastic paving and expansion joint fillers *(See 9.3.2.3.)*	3	1
(17) Encroachment by overhead utilities	–	–
(a) Horizontal distance from the vertical plane below the nearest overhead wire of an electric trolley, train, or bus line	50	15
(b) Horizontal distance from the vertical plane below the nearest overhead electrical wire other than those noted in (a)	5	1.5
(c) Piping containing other hazardous materials	15	4.6
(18) Aboveground exposed piping and piping components of flammable gas systems	15	4.6

Statement of Problem and Substantiation for Public Input

It doesn't matter what type of flammable gas is being stored; it all needs to be kept away from oxygen. (With oxygen everything is a fuel.) There is no justification for different types of flammable gases to be different distances from oxygen.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 110-NFPA 55-2020 [Section No. A.9.3.2]	

Submitter Information Verification

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Attachment F - NFPA 55 Public Inputs

Public Input No. 58-NFPA 55-2020 [Chapter 10]

~~**Chapter 10** – Gas Hydrogen Systems~~

~~**10.1** – Applicability.~~

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

~~**10.1.1** – Quantities Less Than or Equal to the MAQ.~~

~~The storage, use, and handling of hydrogen in gaseous hydrogen systems in quantities less than or equal to the MAQ shall be in accordance with Sections 10.1 and 10.2 .~~

~~**10.1.2** – Quantities Greater Than the MAQ.~~

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

~~**10.1.3 *** – Quantities Greater Than 5000 scf (141.6 Nm ^{3}).~~

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

~~**10.2** – General.~~

~~**10.2.1** – Marking.~~

~~**10.2.1.1** –~~

~~Hazard identification signs shall be provided in accordance with Section 6.13 .~~

~~**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 *** – Piping Systems.~~

~~Piping, tubing, valves, and fittings shall be designed and installed in accordance with applicable sections of ASME B31 *Code for Pressure Piping* , and Sections 704.1.2.3, 704.1.2.4, and 704.1.2.5 of the ICC *International Fuel Gas Code (IFGC)* . Cast, ductile, malleable, or high-silicon iron pipe, valves, and fittings shall not be used.~~

~~**10.2.2.1** –~~

~~Prior to acceptance and initial operation, all piping installations shall be inspected and pressure tested in accordance with ASME B31 *Code for Pressure Piping* , and Section 705 of the ICC *International Fuel Gas Code (IFGC)* .~~

~~**10.2.2.2** –~~

~~Brazing materials used for joints in piping and tubing systems shall have a melting point above 1000°F (538°C).~~

~~**10.2.2.3** –~~

~~Underground piping systems shall be in accordance with 7.1.17 .~~

~~**10.2.3** – Hydrogen-Venting Systems.~~

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

~~**10.2.3.1** –~~

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

Attachment F - NFPA 55 Public Inputs

~~**10.2.3.1.1**~~ –

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

~~**10.2.3.2**~~ –

~~Cleaning and purging of piping systems shall be in accordance with 7.1.18 .~~

~~**10.2.4** – Equipment Assembly.~~

~~**10.2.4.1**~~ –

~~Valves, gauges, regulators, and other accessories used for 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 hydrogen compressed gas systems shall be accessible and shall be protected against physical damage and tampering.~~

~~**10.2.4.2**~~ –

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

~~**10.2.4.3**~~ –

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

~~**10.2.5** – Compression and Processing Equipment.~~

~~Compression and gas processing equipment integral to hydrogen compressed gas storage systems shall be designed for use with gaseous hydrogen (GH_2) and for maximum pressures and temperatures to which it can be subjected under normal operating conditions.~~

~~**10.2.5.1**~~ –

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

~~**10.2.5.2**~~ –

~~Where GH_2 compression equipment is operated unattended, it shall be equipped with a high discharge and a low suction pressure automatic shutdown control.~~

~~**10.2.5.3**~~ –

~~When an automatic shutdown control shuts down a system, the system shall remain out of service until personnel authorized by the owner determines the cause of the shut down and that the system is safe to restart.~~

~~**10.2.5.4** – Stationary Compressors.~~

~~**10.2.5.4.1** – Valves.~~

~~**10.2.5.4.1.1**~~ –

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

~~**10.2.5.4.1.2**~~ –

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

~~**10.2.5.5** – Foundations.~~

~~**10.2.5.5.1**~~ –

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

~~**10.2.5.5.2**~~ –

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

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~~**10.2.5.6** – Emergency Shutdown.~~

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

~~**10.2.5.7** – Relief Valves.~~

~~**10.2.5.7.1** –~~

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

~~**10.2.5.7.2** –~~

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

~~**10.2.5.8** – Pressure Monitoring.~~

~~**10.2.5.8.1** –~~

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

~~**10.2.5.8.2** –~~

~~Discharge pressures in excess of the equipment maximum operating pressure shall cause the compressor to shut down.~~

~~**10.2.5.9** – Protection.~~

~~Transfer piping and compressors shall be protected from vehicular damage.~~

~~**10.2.6** – Operation and Maintenance.~~

~~**10.2.6.1** – Operating Instructions.~~

~~**10.2.6.1.1** –~~

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

~~**10.2.6.1.2** –~~

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

~~**10.2.7** –~~

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

~~**10.2.8** * – Listed or Approved Hydrogen Equipment.~~

~~**10.2.8.1** –~~

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

~~**10.2.8.2** –~~

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

~~**10.2.9** * – Metal Hydride Storage Systems.~~

~~**10.2.9.1** – General Requirements.~~

~~**10.2.9.1.1** – Metal Hydride Storage System Requirements.~~

~~The storage and use of metal hydride storage systems shall be in accordance with 10.2.9 .~~

~~**10.2.9.1.2** – Metal Hydride Systems Storing or Supplying Hydrogen.~~

~~Those portions of the system that are used as a means to store or supply hydrogen shall also comply with Chapter 7 and Chapter 10 as applicable.~~

~~**10.2.9.1.3** – Classification.~~

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

~~**10.2.9.1.4** – Listed or Approved Systems.~~

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

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~~**10.2.9.1.5** – Containers, Design, and Construction.~~

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

~~**10.2.9.1.6** – Service Life and Inspection of Containers.~~

~~Metal hydride storage system cylinders, containers, and tanks shall be inspected at intervals not to exceed 5 years.~~

~~**10.2.9.1.7** – Marking and Labeling.~~

~~Marking and labeling of cylinders, containers, tanks, and systems shall be in accordance with 7.1.5 and the requirements in 10.2.9.1.7.1 through 10.2.9.1.7.4 .~~

~~**10.2.9.1.7.1** – System Marking.~~

~~Metal hydride storage systems shall be marked with the following:~~

(1) ~~Manufacturer's name~~

(2) ~~Service life indicating the last date the system can be used~~

(3) ~~A unique code or serial number specific to the unit~~

(4) ~~System name or product code that identifies the system by the type of chemistry used in the system~~

(5) ~~Emergency contact name, telephone number, or other contact information~~

(6) ~~Limitations on refilling of containers to include rated charging pressure and capacity~~

~~**10.2.9.1.7.2** – Valve Marking.~~

~~Metal hydride storage system valves shall be marked with the following:~~

(1) ~~Manufacturer's name~~

(2) ~~Service life indicating the last date the valve can be used~~

(3) ~~Metal hydride service in which the valve can be used or a product code that is traceable to this information~~

~~**10.2.9.1.7.3** – Pressure Relief Device Marking.~~

~~Metal hydride storage system pressure relief devices shall be marked with the following:~~

(1) ~~Manufacturer's name~~

(2) ~~Metal hydride service in which the device can be used or a product code that is traceable to this information~~

(3) ~~Activation parameters to include temperature, pressure, or both~~

~~**(A)** – Pressure Relief Devices Integral to Container Valves.~~

~~The required markings for pressure relief devices that are integral components of valves used on cylinders, containers, and tanks shall be allowed to be placed on the valve.~~

~~**10.2.9.1.7.4** – Pressure Vessel Markings.~~

~~Cylinders, containers, and tanks used in metal hydride storage systems shall be marked with the following:~~

(1) ~~Manufacturer's name~~

(2) ~~Design specification to which the vessel was manufactured~~

(3) ~~Authorized body approving the design and initial inspection and test of the vessel~~

(4) ~~Manufacturer's original test date~~

(5) ~~Unique serial number for the vessel~~

(6) ~~Service life identifying the last date the vessel can be used~~

(7) ~~System name or product code that identifies the system by the type of chemistry used in the system~~

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~~**10.2.9.1.8** – Temperature Extremes.~~

~~Metal hydride storage systems, whether full or partially full, shall not be exposed to temperatures exceeding the range stipulated by the manufacturer.~~

~~**10.2.9.1.9** – Falling Objects.~~

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

~~**10.2.9.1.10** – Piping Systems.~~

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

~~**10.2.9.1.10.1** – Leaking Systems.~~

~~Leaking systems shall be removed from service.~~

~~**10.2.9.1.11** – Refilling of Containers.~~

~~The refilling of listed or approved metal hydride storage systems shall be in accordance with the listing requirements and manufacturers' instructions.~~

~~**10.2.9.1.11.1** – Industrial Trucks.~~

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

~~**10.2.9.1.11.2** – Hydrogen Purity.~~

~~The purity of hydrogen used for the purpose of refilling containers shall be in accordance with the listing and the manufacturers' instructions.~~

~~**10.2.9.1.12** – Electrical.~~

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

~~**10.2.9.2** – Portable Containers or Systems.~~

~~**10.2.9.2.1** – Securing Containers.~~

~~Cylinders, containers, and tanks shall be secured in accordance with 7.1.8.4 .~~

~~**10.2.9.2.1.1** – Use on Mobile Equipment.~~

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

~~**10.2.9.2.1.2** – Motorized Equipment.~~

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

~~**(A)** – Protection from Damage.~~

~~Metal hydride storage systems, including cylinders, containers, tanks, and fittings, shall not extend beyond the platform of the mobile equipment.~~

~~**10.2.9.2.2** – Valves.~~

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

~~**10.3** – Hydrogen Systems Having Quantities Greater Than the MAQ.~~

~~**10.3.1** –~~

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

~~**10.3.2** – Hydrogen Equipment Enclosures.~~

~~Hydrogen equipment enclosures shall be in accordance with NFPA 2.~~

~~**10.3.3** – Bonding and Grounding.~~

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

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~~**10.3.3.1**~~ –

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

~~**10.3.4**~~ – ~~Cargo Transport Unloading.~~

~~**10.3.4.1**~~ –

~~Vehicular protection shall be provided in accordance with 7.1.8.3 .~~

~~**10.3.4.2**~~ –

~~Unloading connections on delivery equipment shall not be positioned closer to any of the exposures than the distances given for the bulk hydrogen compressed gas storage system.~~

~~**10.3.4.3**~~ –

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

~~**10.3.4.4**~~ –

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

~~**10.3.4.5**~~ –

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

~~**10.3.4.6**~~ – ~~Transfer System Depressurization.~~

~~**10.3.4.6.1**~~ –

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

~~**10.3.4.6.2**~~ –

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

~~**10.3.4.7**~~ –

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

~~**10.3.4.8**~~ –

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

~~**10.3.4.9**~~ –

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

~~**10.3.5**~~ – ~~Indoor Non-Bulk Hydrogen Compressed Gas System Location.~~

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~~**10.3.5.1**~~ –

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

(1) ~~In a ventilated area in accordance with the provisions of Section 6.17~~

(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~~

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

(6) ~~Emergency shutoff valves shall be provided in accordance with 7.3.1.11~~

(7) ~~A distance of 50 ft (15 m) from other flammable gas storage~~

(8) ~~Protected against damage in accordance with the provisions of 7.1.8.3~~

~~**10.3.5.2**~~ – ~~Systems Installed in One Room.~~

~~**10.3.5.2.1**~~ –

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

~~**10.3.5.2.2**~~ –

~~The separation distance between multiple systems of 5000 scf (141.6 Nm ^{3}) or less shall be permitted to be reduced to 25 ft (7.6 m) in buildings where the space between storage areas is free of combustible materials and protected with a sprinkler system designed for Extra Hazard, Group 1 occupancies in accordance with the requirements of Section 6.11 .~~

~~**10.3.5.2.3**~~ –

~~The required separation distance between individual portable systems in the process of being filled or serviced in facilities associated with the manufacture or distribution of hydrogen and its mixtures shall not be limited by 10.3.5.2.1 or 10.3.5.2.2 when such facilities are provided with Protection Level 2 controls and the applicable requirements of Chapters 1 through 7 .~~

~~**10.3.6**~~ – ~~Outdoor Non-Bulk Hydrogen Compressed Gas Location.~~

~~**10.3.6.1**~~ –

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

~~**10.3.7**~~ – ~~Maintenance.~~

~~**10.3.7.1**~~ –

~~Maintenance shall be performed annually by a qualified representative of the equipment owner.~~

~~**10.3.7.2**~~ –

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

~~**10.3.7.3**~~ –

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

~~**10.4**~~ – ~~Bulk Gaseous Hydrogen System.~~

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~~**10.4.1** –~~

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

~~**10.4.2** – Outdoor Bulk Hydrogen Compressed Gas Systems.~~

~~**10.4.2.1** – General Requirements.~~

~~**10.4.2.1.1** – Bulk Hydrogen Compressed Gas.~~

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

~~**10.4.2.1.2** –~~

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

~~**10.4.2.1.2.1** –~~

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

~~Table 10.4.2.1.2.1 Electrical Area Classification~~

~~Location Classification Extent of Classified Area Within 3 ft (1 m) of any vent outlet and any points where hydrogen is vented to the atmosphere under normal operations Class 1, Division 1 Between 0 ft (0 m) and 3 ft (0.9 m) and measured spherically from the outlet. Between 3 ft (1 m) and 15 ft (4.6 m) of any vent outlet and any points where hydrogen is vented to the atmosphere under normal operations Class I, Division 2 Between 3 ft (0.9 m) and 15 ft (4.6 m) and measured spherically from the vent outlet. Storage equipment excluding the piping system downstream of the source valve Class I, Division 2 Between 0 ft (0 m) and 15 ft (4.6 m) and measured spherically from the source.~~

~~**10.4.2.2** – Location.~~

~~**10.4.2.2.1** * – Minimum Distance.~~

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

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

~~Pressure >15 to ≤250 psig >250 to ≤3000 psig >3000 to ≤7500 psig >7500 to ≤15,000 psig Internal Pipe Diameter (ID) >103.4 to ≤1724 kPa >1724 to ≤20,684 kPa >20,684 to ≤51,711 kPa >51,711 to ≤103,421 kPa *d* mm *d* = 52.5 mm *d* = 18.97 mm *d* = 7.31 mm *d* = 7.16 mm **Group 1 Exposures m ft m ft m ft m ft** Lot lines 5 16 6 20 4 13 5 16 Air intakes (HVAC, compressors, other) - - - - - - - - Operable openings in buildings and structures - - - - - - - - Ignition sources such as open flames and welding - - - - - - - - **Group 2 Exposures m ft m ft m ft m ft** Exposed persons other than those servicing the system 5 16 6 20 3 10 4 13 Parked cars - - - - - - - - **Group 3 Exposures m ft m ft m ft m ft** Buildings of noncombustible non-fire-rated construction 4 13 5 16 3 10 4 13 Buildings of combustible construction - - - - - - - - Flammable gas storage systems above or below ground - - - - - - - - Hazardous materials storage systems above or below ground - - - - - - - - Heavy timber, coal, or other slow-burning combustible solids - - - - - - - - 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 - - - - - - - - Unopenable openings in buildings and structures - - - - - - - - Encroachment by overhead utilities (horizontal distance from the vertical plane below the nearest overhead electrical wire of building service) - - - - - - - - Piping containing other hazardous materials - - - - - - - - Flammable gas metering and regulating stations such as natural gas or propane - - - - - - - -~~

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

~~- >15 to ≤250 psig~~

~~>103.4 to ≤1724 kPa >250 to ≤3000 psig~~

~~>1724 to ≤20,684 kPa Pressure Exposures *‡ Exposures *‡ Internal Pipe Diameter (ID) Group 1 Group 2 Group 3 Group 1 Group 2 Group 3 ID~~

~~(in.) d~~

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~~(mm) D = 0.0952d D = 0.1019d - 0.3485 D = 0.0762 D = 0.3168d D = 0.3384d - 0.4188 D = 0.2636d m ft m ft m ft m ft m ft m ft 0.2 5.1 0.5 2.0 0.2 1.0 0.4 1.0 1.6 5.0 1.3 4.0 1.3 4.0 0.3 7.6 0.7 2.0 0.4 1.0 0.6 2~~

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

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

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

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

~~- >3000 to ≤7500 psig~~

~~>20,684 to ≤51,711 kPa >7500 to ≤15,000 psig~~

~~>51,711 to ≤103,421 kPa Pressure Exposures *‡ Exposures *‡ Internal Pipe Diameter (ID) Group 1 Group 2 Group 3 Group 1 Group 2 Group 3 ID~~

~~(in.) d~~

~~(mm) D = 1.105d - 4.078 D = 0.6831d - 1.99 D = 0.459d - 0.355 D = 1.448d - 5.368 D = 0.9291d - 2.65 D = 0.602d.- 0.3103 m ft m ft m ft m ft m ft m ft 0.2 5.1 1.6 5.0 1.5 5.0 2.0 7.0 2.0 7.0 2.0 7.0 3.0 9.0 0.3 7.6 4.3 14.0 3.2 11.0 3.0~~

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

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

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

~~**10.4.2.2.1.1**~~ –

~~The distance shall be measured from the part of the bulk hydrogen compressed gas system closest to the exposure.~~

~~**10.4.2.2.1.2***~~ –

~~The vent stack shall not be considered part of the bulk hydrogen compressed gas system for determining separation distances in 10.4.2.2 . [See *Table 10.4.2.2.1(a)* , *Table 10.4.2.2.1(b)* , and *Table 10.4.2.2.1(c)* .]~~

~~**10.4.2.2.1.3**~~ –

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

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

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

~~**10.4.2.2.2.1*** – Determination of Internal Diameter.~~

~~The internal diameter of the piping system shall be determined by the diameter of the piping serving that portion of a storage array with content greater than 5000 scf (141.6 Nm^3^). The piping system size used in the application of Table 10.4.2.2.1(a) , Table 10.4.2.2.1(b) , or Table 10.4.2.2.1(c) shall be determined based on that portion of the system with the greatest maximum internal diameter.~~

~~**10.4.2.2.2.2**~~ –

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

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~~**10.4.2.2.3** * – Determination of System Pressure.~~

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

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

~~**10.4.2.2.4.1** * – Passive Means.~~

~~Except for distances to air intakes, the distances to Group 1 and 2 exposures shown in Table 10.4.2.2.1(a) , Table 10.4.2.2.1(b) , and Table 10.4.2.2.1(c) shall be permitted to be reduced by one-half and Group 3 exposures shall be permitted to be reduced to 0 ft (0 m) where fire barrier walls are located between the system and the exposure and constructed in accordance with the following:~~

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

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

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

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

(5) ~~The fire barrier wall shall not have more than two sides at 90 degree (1.57 rad) directions or not more than three sides with connecting angles of 135 degrees (2.36 rad), except as provided in 10.4.2.2.4.1(6) .~~

(6)* ~~The connecting angles between fire barrier walls shall be permitted to be reduced to less than 135 degrees (2.36 rad) for installations consisting of three walls when in accordance with 8.12.2.7.2 .~~

(7) ~~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 and shall be designed to resist the overturning effects caused by lateral forces due to wind, soil, flood, and seismic events.~~

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

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

(10) ~~The construction requirements for a fire barrier wall that is part of a hydrogen equipment enclosure and used to reduce separation distances shall be in accordance with 7.1.23.16 of NFPA 2.~~

~~**10.4.2.2.4.2** * – Active Means.~~

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

~~**10.4.2.2.5** – Required Separation Distance for All Systems.~~

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

~~**10.4.2.2.5.1** –~~

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

~~**10.4.2.2.5.2** –~~

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

~~**10.4.2.2.5.3** –~~

~~Systems within 50 ft (15 m) of aboveground storage of all classes of flammable and combustible liquids shall be located on ground higher than such storage, except where dikes, diversion curbs, grading, or separating solid walls are used to prevent accumulation of these liquids under the system.~~

~~**10.4.2.2.6** * –~~

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

~~**10.4.2.2.6.1**~~ –

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

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

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

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

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

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

~~**10.4.3.1** – Underground Systems.~~

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

~~**10.4.3.1.1** – Design.~~

~~Pressure-compressed gas containers installed underground using burial methods shall be of seamless construction in accordance with the ASME *Boiler and Pressure Vessel Code* .~~

~~**10.4.3.1.1.1** *~~ –

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

~~**10.4.3.1.1.2** – Compressed Gas Container Examination.~~

~~**(A)**~~ –

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

~~**(B)**~~ –

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

~~**10.4.3.1.2** – Composite Containers. (Reserved)~~

~~**10.4.3.1.3** – Corrosion Protection.~~

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

~~**10.4.3.1.4** * – Outlet Connections.~~

~~**10.4.3.1.4.1**~~ –

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

~~**10.4.3.1.4.2**~~ –

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

~~**10.4.3.1.5** – Piping Systems.~~

~~**10.4.3.1.5.1**~~ –

~~Joints in the piping system shall be installed and inspected in accordance with the requirements of ASME B31, *Code for Pressure Piping* , or other approved standards.~~

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~~**10.4.3.1.5.2** –~~

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

~~**10.4.3.1.6** – Location.~~

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

~~**10.4.3.1.6.1** –~~

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

~~**10.4.3.1.6.2** –~~

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

~~**10.4.3.1.6.3** –~~

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

~~**10.4.3.1.6.4** –~~

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

~~**10.4.3.1.6.5** –~~

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

~~**10.4.3.1.6.6** * –~~

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

~~**10.4.3.1.7** – Foundations.~~

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

~~**10.4.3.1.7.1** –~~

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

~~**10.4.3.1.8** – Depth, Cover, and Fill.~~

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

~~**10.4.3.1.9** * – Anchorage and Security.~~

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

~~**10.4.3.1.10** – Venting of Underground Compressed Gas Containers.~~

~~Vent pipes for underground compressed gas containers shall be in accordance with 10.2.2 .~~

~~**10.4.3.1.11** – Overfill Protection and Prevention Systems.~~

~~An approved means or method shall be provided to prevent the overfilling of the storage containers.~~

~~**10.4.3.1.12** – Physical Protection.~~

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

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

~~**10.4.5** – Indoor Bulk Hydrogen Compressed Gas Systems.~~

~~**10.4.5.1** – General.~~

~~**10.4.5.1.1** –~~

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

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~~Table 10.4.5.1.1 Location of Bulk Hydrogen Compressed Gas Systems~~

~~- Quantity of Hydrogen Location ≥5000 to <15,000 scf~~

~~(≥142 to <425 Nm ^{3}) ≥15,000 scf~~

~~(≥425 Nm ^{3}) In a detached building in accordance with Section 6.5 A A In a Protection Level 2 occupancy in accordance with Section 6.3.2 A Detached building required in accordance with Section 6.5 Not in a Protection Level 2 occupancy N/A Detached building required in accordance with Section 6.5~~

~~A: Allowed. N/A: Not allowed.~~

~~**10.4.5.1.2** * – Fire Protection.~~

~~Fire protection shall be in accordance with the requirements of Section 6.11 .~~

~~**10.4.5.2** – Detached Buildings.~~

~~**10.4.5.2.1** –~~

~~Detached buildings shall be constructed of noncombustible or limited-combustible materials in accordance with the requirements of Section 6.6 .~~

~~**10.4.5.2.2** –~~

~~Ventilation shall be provided in accordance with the requirements of Section 6.17 .~~

~~**10.4.5.2.2.1** –~~

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

~~**10.4.5.2.2.2** –~~

~~Inlet and outlet openings shall each have a minimum total area of 1 ft ^{2} /1000 ft ^{3} (1 m ^{2} /305 m ^{3}) of room volume.~~

~~**10.4.5.2.2.3** –~~

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

~~**10.4.5.2.3** * –~~

~~Explosion control shall be provided in accordance with the requirements of Section 6.10 .~~

~~**10.4.5.2.4** –~~

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

~~**10.4.5.2.5** –~~

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

~~**10.4.6** – Security.~~

~~**10.4.6.1** * –~~

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

~~**10.4.6.2** –~~

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

~~**10.4.6.3** –~~

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

~~Harmonize NFPA 55 Chapter 10 with NFPA 2 Chapter 7~~

Statement of Problem and Substantiation for Public Input

This public input is proposing to re-align NFPA 2 with the requirements in NFPA 55. It is a placeholder comment to allow work to be done by a task group in the future to better align the documents based upon feedback from the NFPA2/55 Scope Joint Working Group. A Public Comment will be submitted with exact language changes.

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Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 56-NFPA 55-2020 [Chapter 7]	Related PI
Public Input No. 57-NFPA 55-2020 [Chapter 6]	Related PI
Public Input No. 59-NFPA 55-2020 [Chapter 11]	Related PI
Public Input No. 56-NFPA 55-2020 [Chapter 7]	
Public Input No. 57-NFPA 55-2020 [Chapter 6]	
Public Input No. 59-NFPA 55-2020 [Chapter 11]	

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Public Input No. 85-NFPA 55-2020 [Chapter 10]

~~**Chapter 10** – Gas Hydrogen Systems~~

~~**10.1** – Applicability.~~

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

~~**10.1.1** – Quantities Less Than or Equal to the MAQ.~~

~~The storage, use, and handling of hydrogen in gaseous hydrogen systems in quantities less than or equal to the MAQ shall be in accordance with Sections 10.1 and 10.2 .~~

~~**10.1.2** – Quantities Greater Than the MAQ.~~

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

~~**10.1.3** * – Quantities Greater Than 5000 scf (141.6 Nm ^{3}).~~

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

~~**10.2** – General.~~

~~**10.2.1** – Marking.~~

~~**10.2.1.1** –~~

~~Hazard identification signs shall be provided in accordance with Section 6.13 .~~

~~**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** * – Piping Systems.~~

~~Piping, tubing, valves, and fittings shall be designed and installed in accordance with applicable sections of ASME B31 *Code for Pressure Piping* , and Sections 704.1.2.3, 704.1.2.4, and 704.1.2.5 of the ICC *International Fuel Gas Code (IFGC)* . Cast, ductile, malleable, or high-silicon iron pipe, valves, and fittings shall not be used.~~

~~**10.2.2.1** –~~

~~Prior to acceptance and initial operation, all piping installations shall be inspected and pressure tested in accordance with ASME B31 *Code for Pressure Piping* , and Section 705 of the ICC *International Fuel Gas Code (IFGC)* .~~

~~**10.2.2.2** –~~

~~Brazing materials used for joints in piping and tubing systems shall have a melting point above 1000°F (538°C).~~

~~**10.2.2.3** –~~

~~Underground piping systems shall be in accordance with 7.1.17 .~~

~~**10.2.3** – Hydrogen-Venting Systems.~~

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

~~**10.2.3.1** –~~

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

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~~**10.2.3.1.1**~~ –

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

~~**10.2.3.2**~~ –

~~Cleaning and purging of piping systems shall be in accordance with 7.1.18 .~~

~~**10.2.4**~~ – ~~Equipment Assembly.~~

~~**10.2.4.1**~~ –

~~Valves, gauges, regulators, and other accessories used for 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 hydrogen compressed gas systems shall be accessible and shall be protected against physical damage and tampering.~~

~~**10.2.4.2**~~ –

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

~~**10.2.4.3**~~ –

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

~~**10.2.5**~~ – ~~Compression and Processing Equipment.~~

~~Compression and gas processing equipment integral to hydrogen compressed gas storage systems shall be designed for use with gaseous hydrogen (GH~~ $_2$ ~~) and for maximum pressures and temperatures to which it can be subjected under normal operating conditions.~~

~~**10.2.5.1**~~ –

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

~~**10.2.5.2**~~ –

~~Where GH~~ $_2$ ~~compression equipment is operated unattended, it shall be equipped with a high discharge and a low suction pressure automatic shutdown control.~~

~~**10.2.5.3**~~ –

~~When an automatic shutdown control shuts down a system, the system shall remain out of service until personnel authorized by the owner determines the cause of the shut down and that the system is safe to restart.~~

~~**10.2.5.4**~~ – ~~Stationary Compressors.~~

~~**10.2.5.4.1**~~ – ~~Valves.~~

~~**10.2.5.4.1.1**~~ –

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

~~**10.2.5.4.1.2**~~ –

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

~~**10.2.5.5**~~ – ~~Foundations.~~

~~**10.2.5.5.1**~~ –

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

~~**10.2.5.5.2**~~ –

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

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~~**10.2.5.6** – Emergency Shutdown.~~

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

~~**10.2.5.7** – Relief Valves.~~

~~**10.2.5.7.1** –~~

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

~~**10.2.5.7.2** –~~

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

~~**10.2.5.8** – Pressure Monitoring.~~

~~**10.2.5.8.1** –~~

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

~~**10.2.5.8.2** –~~

~~Discharge pressures in excess of the equipment maximum operating pressure shall cause the compressor to shut down.~~

~~**10.2.5.9** – Protection.~~

~~Transfer piping and compressors shall be protected from vehicular damage.~~

~~**10.2.6** – Operation and Maintenance.~~

~~**10.2.6.1** – Operating Instructions.~~

~~**10.2.6.1.1** –~~

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

~~**10.2.6.1.2** –~~

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

~~**10.2.7** –~~

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

~~**10.2.8** * – Listed or Approved Hydrogen Equipment.~~

~~**10.2.8.1** –~~

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

~~**10.2.8.2** –~~

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

~~**10.2.9** * – Metal Hydride Storage Systems.~~

~~**10.2.9.1** – General Requirements.~~

~~**10.2.9.1.1** – Metal Hydride Storage System Requirements.~~

~~The storage and use of metal hydride storage systems shall be in accordance with 10.2.9 .~~

~~**10.2.9.1.2** – Metal Hydride Systems Storing or Supplying Hydrogen.~~

~~Those portions of the system that are used as a means to store or supply hydrogen shall also comply with Chapter 7 and Chapter 10 as applicable.~~

~~**10.2.9.1.3** – Classification.~~

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

~~**10.2.9.1.4** – Listed or Approved Systems.~~

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

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~~**10.2.9.1.5** – Containers, Design, and Construction.~~

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

~~**10.2.9.1.6** – Service Life and Inspection of Containers.~~

~~Metal hydride storage system cylinders, containers, and tanks shall be inspected at intervals not to exceed 5 years.~~

~~**10.2.9.1.7** – Marking and Labeling.~~

~~Marking and labeling of cylinders, containers, tanks, and systems shall be in accordance with 7.1.5 and the requirements in 10.2.9.1.7.1 through 10.2.9.1.7.4 .~~

~~**10.2.9.1.7.1** – System Marking.~~

~~Metal hydride storage systems shall be marked with the following:~~

(1) ~~Manufacturer's name~~

(2) ~~Service life indicating the last date the system can be used~~

(3) ~~A unique code or serial number specific to the unit~~

(4) ~~System name or product code that identifies the system by the type of chemistry used in the system~~

(5) ~~Emergency contact name, telephone number, or other contact information~~

(6) ~~Limitations on refilling of containers to include rated charging pressure and capacity~~

~~**10.2.9.1.7.2** – Valve Marking.~~

~~Metal hydride storage system valves shall be marked with the following:~~

(1) ~~Manufacturer's name~~

(2) ~~Service life indicating the last date the valve can be used~~

(3) ~~Metal hydride service in which the valve can be used or a product code that is traceable to this information~~

~~**10.2.9.1.7.3** – Pressure Relief Device Marking.~~

~~Metal hydride storage system pressure relief devices shall be marked with the following:~~

(1) ~~Manufacturer's name~~

(2) ~~Metal hydride service in which the device can be used or a product code that is traceable to this information~~

(3) ~~Activation parameters to include temperature, pressure, or both~~

~~**(A)** – Pressure Relief Devices Integral to Container Valves.~~

~~The required markings for pressure relief devices that are integral components of valves used on cylinders, containers, and tanks shall be allowed to be placed on the valve.~~

~~**10.2.9.1.7.4** – Pressure Vessel Markings.~~

~~Cylinders, containers, and tanks used in metal hydride storage systems shall be marked with the following:~~

(1) ~~Manufacturer's name~~

(2) ~~Design specification to which the vessel was manufactured~~

(3) ~~Authorized body approving the design and initial inspection and test of the vessel~~

(4) ~~Manufacturer's original test date~~

(5) ~~Unique serial number for the vessel~~

(6) ~~Service life identifying the last date the vessel can be used~~

(7) ~~System name or product code that identifies the system by the type of chemistry used in the system~~

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~~**10.2.9.1.8** – Temperature Extremes.~~

~~Metal hydride storage systems, whether full or partially full, shall not be exposed to temperatures exceeding the range stipulated by the manufacturer.~~

~~**10.2.9.1.9** – Falling Objects.~~

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

~~**10.2.9.1.10** – Piping Systems.~~

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

~~**10.2.9.1.10.1** – Leaking Systems.~~

~~Leaking systems shall be removed from service.~~

~~**10.2.9.1.11** – Refilling of Containers.~~

~~The refilling of listed or approved metal hydride storage systems shall be in accordance with the listing requirements and manufacturers' instructions.~~

~~**10.2.9.1.11.1** – Industrial Trucks.~~

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

~~**10.2.9.1.11.2** – Hydrogen Purity.~~

~~The purity of hydrogen used for the purpose of refilling containers shall be in accordance with the listing and the manufacturers' instructions.~~

~~**10.2.9.1.12** – Electrical.~~

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

~~**10.2.9.2** – Portable Containers or Systems.~~

~~**10.2.9.2.1** – Securing Containers.~~

~~Cylinders, containers, and tanks shall be secured in accordance with 7.1.8.4 .~~

~~**10.2.9.2.1.1** – Use on Mobile Equipment.~~

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

~~**10.2.9.2.1.2** – Motorized Equipment.~~

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

~~**(A)** – Protection from Damage.~~

~~Metal hydride storage systems, including cylinders, containers, tanks, and fittings, shall not extend beyond the platform of the mobile equipment.~~

~~**10.2.9.2.2** – Valves.~~

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

~~**10.3** – Hydrogen Systems Having Quantities Greater Than the MAQ.~~

~~**10.3.1** –~~

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

~~**10.3.2** – Hydrogen Equipment Enclosures.~~

~~Hydrogen equipment enclosures shall be in accordance with NFPA 2.~~

~~**10.3.3** – Bonding and Grounding.~~

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

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~~**10.3.3.1**~~ –

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

~~**10.3.4** – Cargo Transport Unloading.~~

~~**10.3.4.1**~~ –

~~Vehicular protection shall be provided in accordance with 7.1.8.3 .~~

~~**10.3.4.2**~~ –

~~Unloading connections on delivery equipment shall not be positioned closer to any of the exposures than the distances given for the bulk hydrogen compressed gas storage system.~~

~~**10.3.4.3**~~ –

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

~~**10.3.4.4**~~ –

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

~~**10.3.4.5**~~ –

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

~~**10.3.4.6** – Transfer System Depressurization.~~

~~**10.3.4.6.1**~~ –

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

~~**10.3.4.6.2**~~ –

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

~~**10.3.4.7**~~ –

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

~~**10.3.4.8**~~ –

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

~~**10.3.4.9**~~ –

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

~~**10.3.5** – Indoor Non-Bulk Hydrogen Compressed Gas System Location.~~

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~~**10.3.5.1**~~ –

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

(1) ~~In a ventilated area in accordance with the provisions of Section 6.17~~

(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~~

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

(6) ~~Emergency shutoff valves shall be provided in accordance with 7.3.1.11~~

(7) ~~A distance of 50 ft (15 m) from other flammable gas storage~~

(8) ~~Protected against damage in accordance with the provisions of 7.1.8.3~~

~~**10.3.5.2**~~ – ~~Systems Installed in One Room.~~

~~**10.3.5.2.1**~~ –

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

~~**10.3.5.2.2**~~ –

~~The separation distance between multiple systems of 5000 scf (141.6 Nm ^{3}) or less shall be permitted to be reduced to 25 ft (7.6 m) in buildings where the space between storage areas is free of combustible materials and protected with a sprinkler system designed for Extra Hazard, Group 1 occupancies in accordance with the requirements of Section 6.11 .~~

~~**10.3.5.2.3**~~ –

~~The required separation distance between individual portable systems in the process of being filled or serviced in facilities associated with the manufacture or distribution of hydrogen and its mixtures shall not be limited by 10.3.5.2.1 or 10.3.5.2.2 when such facilities are provided with Protection Level 2 controls and the applicable requirements of Chapters 1 through 7 .~~

~~**10.3.6**~~ – ~~Outdoor Non-Bulk Hydrogen Compressed Gas Location.~~

~~**10.3.6.1**~~ –

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

~~**10.3.7**~~ – ~~Maintenance.~~

~~**10.3.7.1**~~ –

~~Maintenance shall be performed annually by a qualified representative of the equipment owner.~~

~~**10.3.7.2**~~ –

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

~~**10.3.7.3**~~ –

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

~~**10.4**~~ – ~~Bulk Gaseous Hydrogen System.~~

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~~**10.4.1** –~~

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

~~**10.4.2** – Outdoor Bulk Hydrogen Compressed Gas Systems.~~

~~**10.4.2.1** – General Requirements.~~

~~**10.4.2.1.1** – Bulk Hydrogen Compressed Gas.~~

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

~~**10.4.2.1.2** –~~

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

~~**10.4.2.1.2.1** –~~

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

~~Table 10.4.2.1.2.1 Electrical Area Classification~~

~~Location Classification Extent of Classified Area Within 3 ft (1 m) of any vent outlet and any points where hydrogen is vented to the atmosphere under normal operations Class 1, Division 1 Between 0 ft (0 m) and 3 ft (0.9 m) and measured spherically from the outlet. Between 3 ft (1 m) and 15 ft (4.6 m) of any vent outlet and any points where hydrogen is vented to the atmosphere under normal operations Class I, Division 2 Between 3 ft (0.9 m) and 15 ft (4.6 m) and measured spherically from the vent outlet. Storage equipment excluding the piping system downstream of the source valve Class I, Division 2 Between 0 ft (0 m) and 15 ft (4.6 m) and measured spherically from the source.~~

~~**10.4.2.2** – Location.~~

~~**10.4.2.2.1** * – Minimum Distance.~~

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

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

~~Pressure >15 to ≤250 psig >250 to ≤3000 psig >3000 to ≤7500 psig >7500 to ≤15,000 psig Internal Pipe Diameter (ID) >103.4 to ≤1724 kPa >1724 to ≤20,684 kPa >20,684 to ≤51,711 kPa >51,711 to ≤103,421 kPa *d* mm *d* = 52.5 mm *d* = 18.97 mm *d* = 7.31 mm *d* = 7.16 mm **Group 1 Exposures m ft m ft m ft m ft** Lot lines 5 16 6 20 4 13 5 16 Air intakes (HVAC, compressors, other) - - - - - - - - Operable openings in buildings and structures - - - - - - - - Ignition sources such as open flames and welding - - - - - - - - **Group 2 Exposures m ft m ft m ft m ft** Exposed persons other than those servicing the system 5 16 6 20 3 10 4 13 Parked cars - - - - - - - - **Group 3 Exposures m ft m ft m ft m ft** Buildings of noncombustible non-fire-rated construction 4 13 5 16 3 10 4 13 Buildings of combustible construction - - - - - - - - Flammable gas storage systems above or below ground - - - - - - - - Hazardous materials storage systems above or below ground - - - - - - - - Heavy timber, coal, or other slow-burning combustible solids - - - - - - - - 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 - - - - - - - - Unopenable openings in buildings and structures - - - - - - - - Encroachment by overhead utilities (horizontal distance from the vertical plane below the nearest overhead electrical wire of building service) - - - - - - - - Piping containing other hazardous materials - - - - - - - - Flammable gas metering and regulating stations such as natural gas or propane - - - - - - - -~~

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

~~- >15 to ≤250 psig~~

~~>103.4 to ≤1724 kPa >250 to ≤3000 psig~~

~~>1724 to ≤20,684 kPa Pressure Exposures *‡ Exposures *‡ Internal Pipe Diameter (ID) Group 1 Group 2 Group 3 Group 1 Group 2 Group 3 ID~~

~~(in.) d~~

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~~(mm) D = 0.0952d D = 0.1019d - 0.3485 D = 0.0762 D = 0.3168d D = 0.3384d - 0.4188 D = 0.2636d m ft m ft m ft m ft m ft m ft 0.2 5.1 0.5 2.0 0.2 1.0 0.4 1.0 1.6 5.0 1.3 4.0 1.3 4.0 0.3 7.6 0.7 2.0 0.4 1.0 0.6 2~~

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

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

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

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

~~- >3000 to ≤7500 psig~~

~~>20,684 to ≤51,711 kPa >7500 to ≤15,000 psig~~

~~>51,711 to ≤103,421 kPa Pressure Exposures *‡ Exposures *‡ Internal Pipe Diameter (ID) Group 1 Group 2 Group 3 Group 1 Group 2 Group 3 ID~~

~~(in.) d~~

~~(mm) D = 1.105d - 4.078 D = 0.6831d - 1.99 D = 0.459d - 0.355 D = 1.448d - 5.368 D = 0.9291d - 2.65 D = 0.602d.- 0.3103 m ft m ft m ft m ft m ft m ft 0.2 5.1 1.6 5.0 1.5 5.0 2.0 7.0 2.0 7.0 2.0 7.0 3.0 9.0 0.3 7.6 4.3 14.0 3.2 11.0 3.0~~

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

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

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

~~**10.4.2.2.1.1**~~ –

~~The distance shall be measured from the part of the bulk hydrogen compressed gas system closest to the exposure.~~

~~**10.4.2.2.1.2** *~~ –

~~The vent stack shall not be considered part of the bulk hydrogen compressed gas system for determining separation distances in 10.4.2.2 . [See Table 10.4.2.2.1(a) , Table 10.4.2.2.1(b) , and Table 10.4.2.2.1(c) .]~~

~~**10.4.2.2.1.3**~~ –

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

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

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

~~**10.4.2.2.2.1** * – Determination of Internal Diameter.~~

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

~~**10.4.2.2.2.2**~~ –

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

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~~**10.4.2.2.3** * – Determination of System Pressure.~~

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

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

~~**10.4.2.2.4.1** * – Passive Means.~~

~~Except for distances to air intakes, the distances to Group 1 and 2 exposures shown in Table 10.4.2.2.1(a) , Table 10.4.2.2.1(b) , and Table 10.4.2.2.1(c) shall be permitted to be reduced by one-half and Group 3 exposures shall be permitted to be reduced to 0 ft (0 m) where fire barrier walls are located between the system and the exposure and constructed in accordance with the following:~~

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

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

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

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

(5) ~~The fire barrier wall shall not have more than two sides at 90 degree (1.57 rad) directions or not more than three sides with connecting angles of 135 degrees (2.36 rad), except as provided in 10.4.2.2.4.1(6) .~~

(6)* ~~The connecting angles between fire barrier walls shall be permitted to be reduced to less than 135 degrees (2.36 rad) for installations consisting of three walls when in accordance with 8.12.2.7.2 .~~

(7) ~~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 and shall be designed to resist the overturning effects caused by lateral forces due to wind, soil, flood, and seismic events.~~

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

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

(10) ~~The construction requirements for a fire barrier wall that is part of a hydrogen equipment enclosure and used to reduce separation distances shall be in accordance with 7.1.23.16 of NFPA 2.~~

~~**10.4.2.2.4.2** * – Active Means.~~

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

~~**10.4.2.2.5** – Required Separation Distance for All Systems.~~

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

~~**10.4.2.2.5.1** –~~

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

~~**10.4.2.2.5.2** –~~

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

~~**10.4.2.2.5.3** –~~

~~Systems within 50 ft (15 m) of aboveground storage of all classes of flammable and combustible liquids shall be located on ground higher than such storage, except where dikes, diversion curbs, grading, or separating solid walls are used to prevent accumulation of these liquids under the system.~~

~~**10.4.2.2.6** * –~~

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

~~**10.4.2.2.6.1**~~ –

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

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

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

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

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

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

~~**10.4.3.1** – Underground Systems.~~

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

~~**10.4.3.1.1** – Design.~~

~~Pressure-compressed gas containers installed underground using burial methods shall be of seamless construction in accordance with the ASME *Boiler and Pressure Vessel Code* .~~

~~**10.4.3.1.1.1** *~~ –

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

~~**10.4.3.1.1.2** – Compressed Gas Container Examination.~~

~~**(A)**~~ –

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

~~**(B)**~~ –

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

~~**10.4.3.1.2** – Composite Containers. (Reserved)~~

~~**10.4.3.1.3** – Corrosion Protection.~~

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

~~**10.4.3.1.4** * – Outlet Connections.~~

~~**10.4.3.1.4.1**~~ –

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

~~**10.4.3.1.4.2**~~ –

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

~~**10.4.3.1.5** – Piping Systems.~~

~~**10.4.3.1.5.1**~~ –

~~Joints in the piping system shall be installed and inspected in accordance with the requirements of ASME B31, *Code for Pressure Piping* , or other approved standards.~~

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~~**10.4.3.1.5.2** –~~

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

~~**10.4.3.1.6** – Location.~~

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

~~**10.4.3.1.6.1** –~~

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

~~**10.4.3.1.6.2** –~~

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

~~**10.4.3.1.6.3** –~~

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

~~**10.4.3.1.6.4** –~~

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

~~**10.4.3.1.6.5** –~~

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

~~**10.4.3.1.6.6** * –~~

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

~~**10.4.3.1.7** – Foundations.~~

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

~~**10.4.3.1.7.1** –~~

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

~~**10.4.3.1.8** – Depth, Cover, and Fill.~~

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

~~**10.4.3.1.9** * – Anchorage and Security.~~

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

~~**10.4.3.1.10** – Venting of Underground Compressed Gas Containers.~~

~~Vent pipes for underground compressed gas containers shall be in accordance with 10.2.2 .~~

~~**10.4.3.1.11** – Overfill Protection and Prevention Systems.~~

~~An approved means or method shall be provided to prevent the overfilling of the storage containers.~~

~~**10.4.3.1.12** – Physical Protection.~~

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

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

~~**10.4.5** – Indoor Bulk Hydrogen Compressed Gas Systems.~~

~~**10.4.5.1** – General.~~

~~**10.4.5.1.1** –~~

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

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~~Table 10.4.5.1.1 Location of Bulk Hydrogen Compressed Gas Systems~~

~~- Quantity of Hydrogen Location ≥5000 to <15,000 scf~~

~~(≥142 to <425 Nm~~ ^{3} ~~) ≥15,000 scf~~

~~(≥425 Nm~~ ^{3} ~~) In a detached building in accordance with Section 6.5 A A In a Protection Level 2 occupancy in accordance with Section 6.3.2 A Detached building required in accordance with Section 6.5 Not in a Protection Level 2 occupancy N/A Detached building required in accordance with Section 6.5~~

~~A: Allowed. N/A: Not allowed.~~

~~**10.4.5.1.2** * – Fire Protection.~~

~~Fire protection shall be in accordance with the requirements of Section 6.11 .~~

~~**10.4.5.2** – Detached Buildings.~~

~~**10.4.5.2.1** –~~

~~Detached buildings shall be constructed of noncombustible or limited-combustible materials in accordance with the requirements of Section 6.6 .~~

~~**10.4.5.2.2** –~~

~~Ventilation shall be provided in accordance with the requirements of Section 6.17 .~~

~~**10.4.5.2.2.1** –~~

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

~~**10.4.5.2.2.2** –~~

~~Inlet and outlet openings shall each have a minimum total area of 1 ft~~ ^{2} ~~/1000 ft~~ ^{3} ~~(1 m~~ ^{2} ~~/305 m~~ ^{3} ~~) of room volume.~~

~~**10.4.5.2.2.3** –~~

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

~~**10.4.5.2.3** * –~~

~~Explosion control shall be provided in accordance with the requirements of Section 6.10 .~~

~~**10.4.5.2.4** –~~

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

~~**10.4.5.2.5** –~~

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

~~**10.4.6** – Security.~~

~~**10.4.6.1** * –~~

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

~~**10.4.6.2** –~~

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

~~**10.4.6.3** –~~

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

Statement of Problem and Substantiation for Public Input

The storage, use, handling, and many other aspects of hydrogen are addressed by NFPA 2. Per the committee scope statements the HYD Committee has "primary responsibility for documents on the storage, transfer, production, and use hydrogen" and the IMG "Committee shall coordinate the material on gaseous and liquid hydrogen storage and use with the Hydrogen Technology Committee." The simplest, least error prone way for NFPA 55 to coordinate with NFPA 2 regarding hydrogen gas is to just refer the user to NFPA 2. This is best

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accomplished in in 7.6.1.2 and 8.1.4. This nullifies the need for Chapter 10.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 77-NFPA 55-2020 [Section No. 7.6.1.2]	Refers user to NFPA 2 for requirements re: gaseous hydrogen.
Public Input No. 81-NFPA 55-2020 [New Section after 8.1.3]	Refers user to NFPA 2 for requirements re: liquid hydrogen.
Public Input No. 95-NFPA 55-2020 [Sections A.10.1.3, A.10.2.2, A.10.2.8, A.10.2.9, A.10.4.2.2...]	
Public Input No. 98-NFPA 55-2020 [Chapter E]	
Public Input No. 99-NFPA 55-2020 [Chapter G]	
Public Input No. 100-NFPA 55-2020 [Chapter H]	
Public Input No. 101-NFPA 55-2020 [Section No. 3.3.69]	
Public Input No. 102-NFPA 55-2020 [Section No. 3.3.70]	
Public Input No. 103-NFPA 55-2020 [Section No. 3.3.95.9]	

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Committee:	IMG-AAA

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Public Input No. 114-NFPA 55-2020 [New Section after 10.4.2.2.1]

Air Intakes (HVAC, compressors, other)

Distances in Table 10.4.2.2.1(a) to air intakes shall apply only to Mechanical Connections that are part of the Outdoor Bulk Hydrogen Compressed Gas System.

Statement of Problem and Substantiation for Public Input

The hazard posed by hydrogen systems to HVAC units and air intakes is the entertainment of un-ignited hydrogen. The side-walls of a hydrogen storage vessel, for example, pose no threat of releasing un-ignited hydrogen that could be entrained into an HVAC system; the threat is only from credible leak points. These are encompassed in the existing code definition of Mechanical Connection as proposed here.

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Committee: IMG-AAA

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Public Input No. 115-NFPA 55-2020 [Section No. 10.4.2.2.1 [Excluding any Sub-Sections]]

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

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

Pressure	**>15 to ≤250 psig**		**>250 to ≤3000 psig**		**>3000 to ≤7500 psig**		**>7500 to ≤15,000 psig**	
Internal Pipe Diameter (ID)	**>103.4 to ≤1724 kPa**		**>1724 to ≤20,684 kPa**		**>20,684 to ≤51,711 kPa**		**>51,711 to ≤103,421 kPa**	
***d*mm**	***d* = 52.5mm**		***d* = 18.97mm**		***d* = 7.31mm**		***d* = 7.16mm**	
Group 1 Exposures	**m**	**ft**	**m**	**ft**	**m**	**ft**	**m**	**ft**
Lot lines	5	16	6	20	4	13	5	16
Air intakes (HVAC, compressors, other)	-	-	-	-	-	-	-	-
Operable openings in buildings and structures	-	-	-	-	-	-	-	-
Ignition sources such as open flames and welding	-	-	-	-	-	-	-	-
Group 2 Exposures	**m**	**ft**	**m**	**ft**	**m**	**ft**	**m**	**ft**
Exposed persons other than those servicing the system	5	16	6	20	3	10	4	13
Parked cars	-	-	-	-	-	-	-	-
Group 3 Exposures	**m**	**ft**	**m**	**ft**	**m**	**ft**	**m**	**ft**
Buildings of noncombustible non-fire-rated construction	4	13	5	16	3	10	4	13
Buildings of combustible construction	-	-	-	-	-	-	-	-
Flammable gas storage systems above or below ground	-	-	-	-	-	-	-	-
Hazardous materials storage systems above or below ground	-	-	-	-	-	-	-	-
Heavy timber, coal, or other slow-burning combustible solids	-	-	-	-	-	-	-	-
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	-	-	-	-	-	-	-	-
Unopenable openings in buildings and structures	-	-	-	-	-	-	-	-
Encroachment by overhead utilities operating above 50 volts (horizontal distance from the vertical plane below the nearest overhead electrical wire of building service)	-	-	-	-	-	-	-	-
Piping containing other hazardous materials	-	-	-	-	-	-	-	-
Flammable gas metering and regulating stations such as natural gas or propane	-	-	-	-	-	-	-	-

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

Pressure	-	**>15 to ≤250 psig** **>103.4 to ≤1724 kPa**	**>250 to ≤3000 psig** **>1724 to ≤20,684 kPa**
	Exposures*†		**Exposures*†**

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Internal Pipe Diameter (ID)		Group 1		Group 2		Group 3		Group 1		Group 2		Group 3	
ID	d	D = 0.0952d		D = 0.1019d - 0.3485		D = 0.0762		D = 0.3168d		D = 0.3384d - 0.4188		D = 0.2636d	
(in.)	(mm)	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft
0.2	5.1	0.5	2.0	0.2	1.0	0.4	1.0	1.6	5.0	1.3	4.0	1.3	4.0
0.3	7.6	0.7	2.0	0.4	1.0	0.6	2.0	2.4	8.0	2.2	7.0	2.0	7.0
0.4	10.2	1.0	3.0	0.7	2.0	0.8	3.0	3.2	11.0	3.0	10.0	2.7	9.0
0.5	12.7	1.2	4.0	0.9	3.0	1.0	3.0	4.0	13.0	3.9	13.0	3.3	11.0
0.6	15.2	1.4	5.0	1.2	4.0	1.2	4.0	4.8	16.0	4.7	16.0	4.0	13.0
0.7	17.8	1.7	6.0	1.5	5.0	1.4	4.0	5.6	19.0	5.6	18.0	4.7	15.0
0.8	20.3	1.9	6.0	1.7	6.0	1.5	5.0	6.4	21.0	6.5	21.0	5.4	18.0
0.9	22.9	2.2	7.0	2.0	7.0	1.7	6.0	7.3	24.0	7.3	24.0	6.0	20.0
1.0	25.4	2.4	8.0	2.2	7.0	1.9	6.0	8.0	26.0	8.2	27.0	6.7	22.0
1.1	27.9	2.7	9.0	2.5	8.0	2.1	7.0	8.8	29.0	9.0	30.0	7.4	24.0
1.2	30.5	2.9	10.0	2.8	9.0	2.3	8.0	9.7	32.0	9.9	32.0	8.0	26.0
1.3	33.0	3.1	10.0	3.0	10.0	2.5	8.0	10.5	34.0	10.7	35.0	8.7	29.0
1.4	35.6	3.4	11.0	3.3	11.0	2.7	9.0	11.3	37.0	11.6	38.0	9.4	31.0
1.5	38.1	3.6	12.0	3.5	12.0	2.9	10.0	12.1	40.0	12.5	41.0	10.0	33.0
1.6	40.6	3.9	13.0	3.8	12.0	3.1	10.0	12.9	42.0	13.3	44.0	10.7	35.0
1.7	43.2	4.1	13.0	4.1	13.0	3.3	11.0	13.7	45.0	14.2	47.0	11.4	37.0
1.8	45.7	4.4	14.0	4.3	14.0	3.5	11.0	14.5	47.0	15.0	49.0	12.0	40.0
1.9	48.3	4.6	15.0	4.6	15.0	3.7	12.0	15.3	50.0	15.9	52.0	12.7	42.0
2.0	50.8	4.8	16.0	4.8	16.0	3.9	13.0	16.1	53.0	16.8	55.0	13.4	44.0
2.1	53.3	5.1	17.0	5.1	17.0	4.1	13.0	16.9	55.0	17.6	58.0	14.0	46.0

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

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

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

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

Pressure		-		>3000 to ≤7500 psig >20,684 to ≤51,711 kPa				>7500 to ≤15,000 psig >51,711 to ≤103,421 kPa					
		Exposures*†						Exposures*†					
Internal Pipe Diameter (ID)		Group 1		Group 2		Group 3		Group 1		Group 2		Group 3	
ID	d	D = 1.105d - 4.078		D = 0.6831d - 1.99		D = 0.459d - 0.355		D = 1.448d - 5.368		D = 0.9291d - 2.65		D = 0.602d.- 0.3103	
(in.)	(mm)	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft
0.2	5.1	1.6	5.0	1.5	5.0	2.0	7.0	2.0	7.0	2.0	7.0	3.0	9.0
0.3	7.6	4.3	14.0	3.2	11.0	3.0	10.0	6.0	18.0	4.0	14.0	4.0	14.0
0.4	10.2	7.2	24.0	5.0	16.0	4.0	14.0	9.0	31.0	7.0	22.0	6.0	19.0
0.5	12.7	10.0	33.0	6.7	22.0	5.0	18.0	13.0	43.0	9.0	30.0	7.0	24.0
0.6	15.2	12.7	42.0	8.4	28.0	7.0	22.0	17.0	55.0	11.0	38.0	9.0	29.0
0.7	17.8	15.6	51.0	10.2	33.0	8.0	26.0	20.0	67.0	14.0	46.0	10.0	34.0

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Pressure		-		>3000 to ≤7500 psig >20,684 to ≤51,711 kPa						>7500 to ≤15,000 psig >51,711 to ≤103,421 kPa			
		Exposures*†						Exposures*†					
Internal Pipe Diameter (ID)		Group 1		Group 2		Group 3		Group 1		Group 2		Group 3	
ID	d	D = 1.105d - 4.078		D = 0.6831d - 1.99		D = 0.459d - 0.355		D = 1.448d - 5.368		D = 0.9291d - 2.65		D = 0.602d.- 0.3103	
(in.)	(mm)	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft
0.8	20.3	18.4	60.0	11.9	39.0	9.0	29.0	24.0	79.0	16.0	53.0	12.0	39.0
0.9	22.9	21.2	70.0	13.7	45.0	10.0	33.0	28.0	91.0	19.0	61.0	13.0	44.0
1.0	25.4	24.0	79.0	15.4	50.0	11.0	37.0	31.0	103.00	21.0	69.0	15.0	49.0
1.1	27.9	26.8	88.0	17.1	56.0	12.0	41.0	35.0	115.00	23.0	76.0	16.0	54.0
1.2	30.5	29.6	97.0	18.8	62.0	14.0	45.0	39.0	127.00	26.0	84.0	18.0	59.0
1.3	33.0	32.4	106.0	20.6	67.0	15.0	49.0	42.0	139.00	28.0	92.0	20.0	64.0
1.4	35.6	35.3	116.0	22.3	73.0	16.0	52.0	46.0	152.00	30.0	100.0	21.0	69.0
1.5	38.1	38.0	125.0	24.0	79.0	17.0	56.0	50.0	163.00	33.0	107.0	23.0	74.0
1.6	40.6	40.8	134.0	25.7	84.0	18.0	60.0	53.0	175.00	35.0	115.0	24.0	79.0
1.7	43.2	43.7	143.0	27.5	90.0	19.0	64.0	57.0	188.00	37.0	123.0	26.0	84.0
1.8	45.7	46.4	152.0	29.2	96.0	21.0	68.0	61.0	199.00	40.0	131.0	27.0	89.0
1.9	48.3	49.3	162.0	31.0	102.0	22.0	72.0	65.0	212.0	42.0	139.0	29.0	94.0
2.0	50.8	52.1	171.0	32.7	107.0	23.0	75.0	68.0	224.0	45.0	146.0	30.0	99.0

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

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

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

Statement of Problem and Substantiation for Public Input

If the intent for separation from utilities is intended to prevent ignition of un-ignited releases, then utilities such as phone lines, internet lines, etc. should not apply.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 116-NFPA 55-2020 [Section No. 11.3.2.2 [Excluding any Sub-Sections]]	

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Public Input No. 69-NFPA 55-2020 [Section No. 10.4.2.2.1 [Excluding any Sub-Sections]]

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

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

Pressure	**>15 to ≤250 psig**		**>250 to ≤3000 psig**		**>3000 to ≤7500 psig**		**>7500 to ≤15,000 psig**	
Internal Pipe Diameter (ID)	**>103.4 to ≤1724 kPa**		**>1724 to ≤20,684 kPa**		**>20,684 to ≤51,711 kPa**		**>51,711 to ≤103,421 kPa**	
***d*mm**	***d* = 52.5mm**		***d* = 18.97mm**		***d* = 7.31mm**		***d* = 7.16mm**	
Group 1 Exposures	**m**	**ft**	**m**	**ft**	**m**	**ft**	**m**	**ft**
Lot lines	5	16	6	20	4	13	5	16
Air intakes (HVAC, compressors, other)	-	-	-	-	-	-	-	-
Operable openings in buildings and structures	-	-	-	-	-	-	-	-
Ignition sources such as open flames and welding	-	-	-	-	-	-	-	-
Group 2 Exposures	**m**	**ft**	**m**	**ft**	**m**	**ft**	**m**	**ft**
Exposed persons other than those servicing the system	5	16	6	20	3	10	4	13
Parked cars	-	-	-	-	-	-	-	-
Group 3 Exposures	**m**	**ft**	**m**	**ft**	**m**	**ft**	**m**	**ft**
Buildings of noncombustible non-fire-rated construction	4	13	5	16	3	10	4	13
Buildings of combustible construction	-	-	-	-	-	-	-	-
Flammable gas storage systems above or below ground	-	-	-	-	-	-	-	-
Hazardous materials storage systems above or below ground	-	-	-	-	-	-	-	-
Heavy timber, coal, or other slow-burning combustible solids	-	-	-	-	-	-	-	-

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Pressure	>15 to ≤250 psig	>250 to ≤3000 psig	>3000 to ≤7500 psig	>7500 to ≤15,000 psig		
Internal Pipe Diameter (ID)	>103.4 to ≤1724 kPa	>1724 to ≤20,684 kPa	>20,684 to ≤51,711 kPa	>51,711 to ≤103,421 kPa		
*d*mm	*d* = 52.5mm	*d* = 18.97mm	*d* = 7.31mm	*d* = 7.16mm		
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	- -	- -	- -	- -		
Unopenable openings in buildings and structures	- -	- -	- -	- -		
Encroachment by overhead utilities (horizontal distance from the vertical plane below the nearest overhead electrical wire of building service)	- -	- -	- -	- -		
Piping containing other hazardous materials	- -	- -	- -	- -		
Flammable gas metering and regulating stations such as natural gas or propane	- -	- -	- -	- -	Building or Structure (a) Sprinklered building or structure or unspinklered building or structure having noncombustible contents (b) Building with adjacent walls with fire resistance rating of 2 hours or greater with footnote: Where clearance is required for the performance of service or maintenance-	0 0 0 0 0 0 0 0

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Pressure	>15 to ≤250 psig	>250 to ≤3000 psig	>3000 to ≤7500 psig	>7500 to ≤15,000 psig	
Internal Pipe Diameter (ID)	>103.4 to ≤1724 kPa	>1724 to ≤20,684 kPa	>20,684 to ≤51,711 kPa	>51,711 to ≤103,421 kPa	
*d*mm	*d* = 52.5mm	*d* = 18.97mm	*d* = 7.31mm	*d* = 7.16mm	
					related activities, a minimum horizontal clearance of 5' shall be provided between the exterior wall and the system

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

Pressure		-		>15 to ≤250 psig >103.4 to ≤1724 kPa				>250 to ≤3000 psig >1724 to ≤20,684 kPa					
		Exposures*†						Exposures*†					
Internal Pipe Diameter (ID)		Group 1		Group 2		Group 3		Group 1		Group 2		Group 3	
ID	d	D = 0.0952d		D = 0.1019d - 0.3485		D = 0.0762		D = 0.3168d		D = 0.3384d - 0.4188		D = 0.2636d	
(in.)	(mm)	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft
0.2	5.1	0.5	2.0	0.2	1.0	0.4	1.0	1.6	5.0	1.3	4.0	1.3	4.0
0.3	7.6	0.7	2.0	0.4	1.0	0.6	2.0	2.4	8.0	2.2	7.0	2.0	7.0
0.4	10.2	1.0	3.0	0.7	2.0	0.8	3.0	3.2	11.0	3.0	10.0	2.7	9.0
0.5	12.7	1.2	4.0	0.9	3.0	1.0	3.0	4.0	13.0	3.9	13.0	3.3	11.0
0.6	15.2	1.4	5.0	1.2	4.0	1.2	4.0	4.8	16.0	4.7	16.0	4.0	13.0
0.7	17.8	1.7	6.0	1.5	5.0	1.4	4.0	5.6	19.0	5.6	18.0	4.7	15.0
0.8	20.3	1.9	6.0	1.7	6.0	1.5	5.0	6.4	21.0	6.5	21.0	5.4	18.0
0.9	22.9	2.2	7.0	2.0	7.0	1.7	6.0	7.3	24.0	7.3	24.0	6.0	20.0
1.0	25.4	2.4	8.0	2.2	7.0	1.9	6.0	8.0	26.0	8.2	27.0	6.7	22.0
1.1	27.9	2.7	9.0	2.5	8.0	2.1	7.0	8.8	29.0	9.0	30.0	7.4	24.0
1.2	30.5	2.9	10.0	2.8	9.0	2.3	8.0	9.7	32.0	9.9	32.0	8.0	26.0
1.3	33.0	3.1	10.0	3.0	10.0	2.5	8.0	10.5	34.0	10.7	35.0	8.7	29.0
1.4	35.6	3.4	11.0	3.3	11.0	2.7	9.0	11.3	37.0	11.6	38.0	9.4	31.0
1.5	38.1	3.6	12.0	3.5	12.0	2.9	10.0	12.1	40.0	12.5	41.0	10.0	33.0
1.6	40.6	3.9	13.0	3.8	12.0	3.1	10.0	12.9	42.0	13.3	44.0	10.7	35.0
1.7	43.2	4.1	13.0	4.1	13.0	3.3	11.0	13.7	45.0	14.2	47.0	11.4	37.0
1.8	45.7	4.4	14.0	4.3	14.0	3.5	11.0	14.5	47.0	15.0	49.0	12.0	40.0
1.9	48.3	4.6	15.0	4.6	15.0	3.7	12.0	15.3	50.0	15.9	52.0	12.7	42.0
2.0	50.8	4.8	16.0	4.8	16.0	3.9	13.0	16.1	53.0	16.8	55.0	13.4	44.0
2.1	53.3	5.1	17.0	5.1	17.0	4.1	13.0	16.9	55.0	17.6	58.0	14.0	46.0

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

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

†When calculating the minimum separation distance (D) using the formulas indicated, based on the

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

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

Pressure		-		>3000 to ≤7500 psig >20,684 to ≤51,711 kPa						>7500 to ≤15,000 psig >51,711 to ≤103,421 kPa			
		Exposures*†						Exposures*†					
Internal Pipe Diameter (ID)		Group 1		Group 2		Group 3		Group 1		Group 2		Group 3	
ID	d	D = 1.105d - 4.078		D = 0.6831d - 1.99		D = 0.459d - 0.355		D = 1.448d - 5.368		D = 0.9291d - 2.65		D = 0.602d.- 0.3103	
(in.)	(mm)	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft
0.2	5.1	1.6	5.0	1.5	5.0	2.0	7.0	2.0	7.0	2.0	7.0	3.0	9.0
0.3	7.6	4.3	14.0	3.2	11.0	3.0	10.0	6.0	18.0	4.0	14.0	4.0	14.0
0.4	10.2	7.2	24.0	5.0	16.0	4.0	14.0	9.0	31.0	7.0	22.0	6.0	19.0
0.5	12.7	10.0	33.0	6.7	22.0	5.0	18.0	13.0	43.0	9.0	30.0	7.0	24.0
0.6	15.2	12.7	42.0	8.4	28.0	7.0	22.0	17.0	55.0	11.0	38.0	9.0	29.0
0.7	17.8	15.6	51.0	10.2	33.0	8.0	26.0	20.0	67.0	14.0	46.0	10.0	34.0
0.8	20.3	18.4	60.0	11.9	39.0	9.0	29.0	24.0	79.0	16.0	53.0	12.0	39.0
0.9	22.9	21.2	70.0	13.7	45.0	10.0	33.0	28.0	91.0	19.0	61.0	13.0	44.0
1.0	25.4	24.0	79.0	15.4	50.0	11.0	37.0	31.0	103.00	21.0	69.0	15.0	49.0
1.1	27.9	26.8	88.0	17.1	56.0	12.0	41.0	35.0	115.00	23.0	76.0	16.0	54.0
1.2	30.5	29.6	97.0	18.8	62.0	14.0	45.0	39.0	127.00	26.0	84.0	18.0	59.0
1.3	33.0	32.4	106.0	20.6	67.0	15.0	49.0	42.0	139.00	28.0	92.0	20.0	64.0
1.4	35.6	35.3	116.0	22.3	73.0	16.0	52.0	46.0	152.00	30.0	100.0	21.0	69.0
1.5	38.1	38.0	125.0	24.0	79.0	17.0	56.0	50.0	163.00	33.0	107.0	23.0	74.0
1.6	40.6	40.8	134.0	25.7	84.0	18.0	60.0	53.0	175.00	35.0	115.0	24.0	79.0
1.7	43.2	43.7	143.0	27.5	90.0	19.0	64.0	57.0	188.00	37.0	123.0	26.0	84.0
1.8	45.7	46.4	152.0	29.2	96.0	21.0	68.0	61.0	199.00	40.0	131.0	27.0	89.0
1.9	48.3	49.3	162.0	31.0	102.0	22.0	72.0	65.0	212.0	42.0	139.0	29.0	94.0
2.0	50.8	52.1	171.0	32.7	107.0	23.0	75.0	68.0	224.0	45.0	146.0	30.0	99.0

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

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

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

Statement of Problem and Substantiation for Public Input

This line was removed, but left a gap for distance between these exposures and the hydrogen bulk system. These have been 0 or 5 feet depending on the need for maintenance. Fire barrier or exterior building walls would be in this category. This also makes more consistent with the Chapter 11 LH2 table with the exception of the fire resistance rating of 2 hours in instead of 3 to better align with the gaseous requirements.

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Attachment F - NFPA 55 Public Inputs

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Public Input No. 67-NFPA 55-2020 [New Section after 10.4.2.2.1.1]

TITLE OF NEW CONTENT

Insert new: 10.4.2.2.1.2* The minimum distance to exposures for individual components of the bulk hydrogen compressed gas system shall be taken from Table 10.4.2.2.1 (a), (b), or (c) based on the maxiumum internal diameter and respective system design pressure in which they are installed.

Annex A.10.4.2.2.1.2 Table 10.4.2.2.1 (a), (b), and (c) define minimum distances between exposures and components of a bulk hydrogen compressed gas system. The exposure distances are a function of exposure type (Groups 1, 2, and 3), system design pressure, and maximum internal diameter. A bulk hydrogen compressed gas system may have portions of the system that operate within differing pressure ranges. For example, components that operate within a system between 15 and 250 psig with a largest pipe size less than or equal to 52.5 mm have a minimum Group 1 exposure distance of 16 feet. Components that operate within a different portion of the system between 250 psig and 3000 psig with the largest pipe size less than or equal to 18.97 mm have a minimum Group 1 exposure of 20 feet. It is not necessary to apply the 20 feet minimum Group 1 exposure distances to the components that form a portion of the system that operate between 15 and 250 psig.

Statement of Problem and Substantiation for Public Input

The separation distances are a function of Exposure Group, system pressure and line diameter. Many systems have portions which operate at differing pressures or are of different line size. Since the hazard is aligned with the potential leakage, it's logical to apply the appropriate separation distance for each portion of the system of a given pressure or line size. This is also consistent with existing material that uses similar logic for LH2 and GH2 distances being applied to their respective portions of the system.

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Public Input No. 64-NFPA 55-2020 [Section No. 10.4.2.2.4.1]

10.4.2.2.4.1* Passive Means.

Except for distances to air intakes, the distances to Group 1 and 2 exposures shown in Table 10.4.2.2.1(a), Table 10.4.2.2.1(b), and Table 10.4.2.2.1(c) shall be permitted to be reduced by one-half and Group 3 exposures shall be permitted to be reduced to 0 ft (0 m) where fire barrier walls are located between the system and the exposure and constructed in accordance with the following:

(1) The fire barrier wall shall be without openings or penetrations.

(2) Penetrations of the fire barrier wall by conduit or pipign shall be permitted provided that the penetration is protected with a firestop system in accordance with the adopted building code.

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

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

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

(6) The ~~number of~~

(7) fire barrier ~~walls used to separate individual systems shall be limited to three.~~

(8) ~~The fire barrier~~ wall shall not have more than two sides at 90 degree (1.57 rad) directions or not more than three sides with connecting angles of 135 degrees (2.36 rad), except as provided in 10.4.2.2.4.1(6).

(9)* The connecting angles between fire barrier walls shall be permitted to be reduced to less than 135 degrees (2.36 rad) for installations consisting of three walls when in accordance with 8.12.2.7.2.

(10) Where the number of fire barrier walls creates a court or enclosed court, the requirements of Section X.X.X shall apply.

(11) 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 and~~ construction and shall be designed to resist the overturning effects or failure caused by lateral forces due to deflagration overpressure, wind, ~~soil~~ flood , ~~flood,~~ and seismic events.

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

(13) 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.

(14) The construction requirements for a fire barrier wall that is part of a hydrogen equipment enclosure and used to reduce separation distances shall be in accordance with 7.1.23.16 of NFPA 2.

Statement of Problem and Substantiation for Public Input

This proposal is complementary to the Public Input for Courts and makes modifications to the current fire barrier requirements to match. The first subparagraph was added to make consistent with Chapter 8 and NFPA 2 Chapter 7.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 63-NFPA 55-2020 [New Section after 10.4.3.1.12]	

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Attachment F - NFPA 55 Public Inputs

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Public Input No. 113-NFPA 55-2020 [Section No. 10.4.2.2.5.2]

10.4.2.2.5.2

The ~~minimum~~ separation distance between independent gaseous and liquid systems ~~integrated into a single system where the liquid source is vaporized, compressed, and stored in the gaseous state shall be 15 ft (4.6 m).~~ shall meet the minimum distance requirements for Group 3 Exposures shown in Tamle 7.3.2.3.1.1(A)(a), Table 7.3.2.3.1.1(A)(b), and Table 7.3.2.3.1.1(A)(c) unless integrated with a shared control system in which case the distance can be reduced to 0 ft (0 m). [**55:** 10.4.2.2.5.2]

Statement of Problem and Substantiation for Public Input

The way the code is currently written appears to be the opposite of the way that it should be. An integrated GH2/LH2 system should not require separation distances, whereas two independent systems that happen to be sited adjacent to one another should be treated as separate Group 3 hazards.

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Public Input No. 60-NFPA 55-2020 [New Section after 10.4.3.1.6.6]

10.4.3.1.6.7 The minimum distances to exposures in Table 10.4.2.2.1(a), Table 10.4.2.2.1(b), and Table 10.4.2.2.1(c) shall not apply to those portions of the system which are located underground in accordance with 10.4.3, but shall apply to any portions of the system which are above ground.

Statement of Problem and Substantiation for Public Input

Currently it is not clear whether the setback distances would apply to parts of the system that are buried. The setback distance tables are specified and required in Section 10.4.2, whereas the requirements for bulk underground systems are given in 10.4.3; if a system was installing a system as per 10.4.3, the setback distances in 10.4.2 would seem to not apply, except for the the portions of the system which are not physically underground in which case 10.4.2 would seem to apply. This makes that distinction explicit and states which portions of the system are subject to the setback distances.

This addition was developed as part of the NFPA 2 Storage Task Group and is submitted with the consensus of that group.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 61-NFPA 55-2020 [New Section after 11.4.3.2.4]	Similar proposals for gas and liquid
Public Input No. 61-NFPA 55-2020 [New Section after 11.4.3.2.4]	

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Attachment F - NFPA 55 Public Inputs

Public Input No. 63-NFPA 55-2020 [New Section after 10.4.3.1.12]

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7.3.2.5 Courts

Where a bulk gas system is located within 3 or more exterior building or fire barrier walls that form a court, the installatio

a) Courts shall have natural or mechanical ventilation in accordance with Section 6.18.

b) Explosion control shall be provided in accordance with the requirements of Section 6.10.

c) The distance from any part of the system to exterior building walls and related exposures must meet the requirements

d) Fire barrier walls must meet the requirements of Section 7.3.2.3.1.2 (A) subparagraphs 1 through 4 and 7 through 10.

e) Vents and ventilation exhausts shall terminate above the walls or outside of the court.

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Statement of Problem and Substantiation for Public Input

Three and four wall courts have been widely used for gaseous hydrogen systems even though they are not permitted per Chapter 7. The intent of this proposal is to require necessary design features to safely install these systems. Bulk gas systems are allowed within indoor areas and detached buildings. This proposal conservatively requires comparable safeguards for 3 and 4 wall enclosures as are currently required for these indoor and detached building installations that also include a roof. 3 or 4 walls with no roof inherently increases safety by providing less confinement and less ability to trap hydrogen.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 64-NFPA 55-2020 [Section No. 10.4.2.2.4.1]	

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Attachment F - NFPA 55 Public Inputs

Public Input No. 59-NFPA 55-2020 [Chapter 11]

~~**Chapter 11** – Bulk Liquefied Hydrogen Systems~~

~~**11.1 *** – General.~~

~~**11.1.1 *** –~~

~~The storage, use, and handling of bulk liquefied hydrogen shall be in accordance with the provisions of Chapter 1 and Chapters 4 through 11 , as applicable.~~

~~**11.1.2** –~~

~~Portable containers having a total liquefied hydrogen content of less than 39.7 gal (150 L) in compliance with the requirements of Chapter 8 shall not be required to comply with Chapter 11 .~~

~~**11.2** – Design of Bulk Liquefied Hydrogen Systems.~~

~~**11.2.1** – Fire Protection of Structural Supports.~~

~~**11.2.1.1** –~~

~~Steel supports in excess of 18 in. (457 mm) in height shall have a minimum 2-hour fire resistance rating in accordance with ASTM E1529, *Determining the Effects of Large Hydrocarbon Pool Fires on Structural Members and Assemblies* .~~

~~**11.2.1.2** –~~

~~Containers shall be marked in accordance with the provisions of Section 8.4 and as follows:~~

~~LIQUEFIED HYDROGEN — FLAMMABLE GAS~~

~~**11.2.2** – Pressure Relief Devices.~~

~~Stationary and portable containers and tanks shall be provided with pressure relief devices in accordance with the requirements of 8.2.4 and with 11.2.2.1 through 11.2.2.4 .~~

~~**11.2.2.1** –~~

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

~~**11.2.2.2** –~~

~~Pressure relief devices serving stationary containers shall be in accordance with the provisions of 8.2.4.6.1 and arranged to discharge unobstructed to the outdoors.~~

~~**11.2.2.3** –~~

~~Hydrogen venting systems discharging to the atmosphere shall be in accordance with CGA G-5.5, *Hydrogen Vent Systems* .~~

~~**11.2.2.4** –~~

~~Stationary containers shall be provided with a sign, placed in proximity to the primary tank pressure relief valve vent stack, that warns against spraying water on or into the vent opening.~~

~~**11.2.3 *** – Piping, Tubing, and Fittings.~~

~~**11.2.3.1** –~~

~~Piping and tubing shall be in accordance with the requirements of ASME B31, *Pressure 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 ASME B31, *Pressure Piping* .~~

~~**11.2.3.2.1** –~~

~~Piping and tubing materials that have a minimum design metal temperature (MDMT) of –425°F (–254°C) or lower, as defined and specified in ASME B31, *Pressure Piping* , shall be permitted to be used without impact testing.~~

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~~**11.2.3.2.2**~~ –

~~Piping and tubing materials that have an MDMT greater than –425°F (–254°C) shall be permitted to be used after impact testing has been performed and the materials have passed.~~

~~**11.2.3.3**~~ –

~~Joints in piping and tubing shall be in accordance with the requirements of ASME B31, *Pressure Piping* .~~

~~**11.2.3.4**~~ –

~~Brazing materials, where used, shall have a melting point above 1000°F (538°C).~~

~~**11.2.3.5**~~ –

~~Aluminum piping systems and components external to the storage vessel shall not be used with liquefied hydrogen, except for ambient air vaporizers.~~

~~**11.2.3.6** *~~ –

~~Means shall be provided to minimize exposure of persons to piping operating at low temperatures and to prevent air condensate from contacting piping, structural members, and surfaces not designed for cryogenic temperatures.~~

~~**11.2.3.6.1**~~ –

~~Insulation on piping systems used to convey cryogenic fluids shall be of noncombustible material and shall be designed to have a vaportight seal in the outer covering to prevent the condensation of air and subsequent oxygen enrichment within the insulation.~~

~~**11.2.3.6.2**~~ –

~~The insulation material and outside shield shall be designed to prevent deterioration of the insulation due to normal operating conditions.~~

~~**11.2.3.7**~~ –

~~Uninsulated piping and equipment that operates at liquefied hydrogen temperatures shall not be installed above asphalt or other combustible materials or surfaces in order to prevent the contact of liquid air with such materials.~~

~~**11.2.3.8**~~ –

~~Drip pans shall be allowed to be installed under uninsulated piping and equipment to retain and vaporize condensed liquid air.~~

~~**11.2.3.9**~~ –

~~Cleaning and purging of piping systems shall be in accordance with 7.1.18 .~~

~~**11.2.4**~~ – ~~Equipment Assembly.~~

~~**11.2.4.1**~~ –

~~Installation of bulk liquefied hydrogen systems shall be supervised by personnel knowledgeable about the applicable standards and the construction and use of the system to be installed.~~

~~**11.2.4.2**~~ –

~~Storage containers, piping, valves, regulating equipment, and other accessories shall be accessible and shall be protected against physical damage and tampering.~~

~~**11.2.4.2.1**~~ –

~~Emergency shutoff valves shall be located in liquid and vapor use lines as close to the container as practical to terminate all flow to use lines during an emergency.~~

~~**11.2.4.2.2**~~ –

~~Containers exceeding 2000 gal (7570 L) capacity shall be provided with an automatic emergency shutoff valve.~~

~~**11.2.4.2.2.1** *~~ –

~~The remotely operated emergency isolation valve shall be operated by a remotely located, manually activated shutdown control.~~

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~~**11.2.4.2.2.2** *~~ –

~~The shutoff valve shall be connected to the primary container by means of welded connections without the use of flanges or other appurtenances, except that a manual shutoff valve equipped with welded connections is allowed to be installed immediately upstream of the automatic shutoff valve to allow for maintenance of the automatic valve.~~

~~**11.2.4.2.2.3**~~ –

~~Connections downstream of the shutoff valve shall be in accordance with ASME B31, *Process Piping* .~~

~~**11.2.4.3**~~ –

~~Cabinets or enclosures containing hydrogen control equipment shall be ventilated to prevent any accumulation of hydrogen gas.~~

~~**11.2.5**~~ – ~~Liquefied Hydrogen Vaporizers.~~

~~**11.2.5.1** *~~ –

~~Heat supplied to a liquefied hydrogen vaporizer shall be by indirect means utilizing a transfer medium.~~

~~**11.2.5.2** *~~ –

~~A low-temperature shutoff switch or valve shall be provided in the vaporizer discharge piping to prevent flow of liquefied hydrogen downstream of the vaporizer in the event that liquid is discharged from the vaporizer.~~

~~**11.2.6**~~ – ~~Electrical Systems.~~

~~**11.2.6.1**~~ –

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

~~**11.2.6.2**~~ –

~~Specific locations for Class 1, Division 1, Group B (hydrogen) and Class 1, Division 2, Group B (hydrogen) areas shall be in accordance with Table 11.2.6.2 .~~

~~Table 11.2.6.2 Electrical Area Classification~~

~~Location Division Extent of Classified Area 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 1 Within 3 ft (1 m) measured spherically from system fill connection, system pressure relief vent outlets, or other points of release when the system is operating as designed. 2 Between 3 ft (1 m) and 25 ft (7.6 m) measured spherically from the system fill connection, any vent outlet, and within 25 ft (7.6 m) of any portion of the bulk supply system that contains liquefied hydrogen.~~

~~**11.2.6.3**~~ –

~~Where equipment approved for Class I, Group B atmospheres is not commercially available, the equipment used shall meet at least one of the following:~~

(1) ~~Purged or ventilated in accordance with NFPA 496~~

(2) ~~Intrinsically safe~~

~~**11.2.6.4**~~ –

~~Electrical equipment installed on mobile supply trucks or tank cars from which the storage container is filled shall not be subject to 11.2.6.3 .~~

~~**11.2.7**~~ – ~~Bonding and Grounding.~~

~~The bulk liquefied hydrogen system shall be electrically bonded and grounded.~~

~~**11.2.8**~~ – ~~Stationary Pumps and Compressors.~~

~~**11.2.8.1**~~ – ~~Valve Isolation.~~

~~**11.2.8.1.1**~~ –

~~Valves shall be installed such that each pump or compressor can be isolated for maintenance.~~

~~**11.2.8.1.2**~~ –

~~Where pumps or compressors are installed for operation in parallel, each discharge line shall be equipped with a check valve to prevent the backflow of liquid from one system to the other.~~

~~**11.2.8.2**~~ – ~~Foundation Design and Construction.~~

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~~**11.2.8.2.1**~~ –

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

~~**11.2.8.2.2**~~ –

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

~~**11.2.8.3**~~ – ~~Emergency Shutdown System Operation.~~

~~When an emergency shutdown (ESD) is required, activation of the ESD system shall shut down operation of all pumps and compressors.~~

~~**11.2.8.4**~~ – ~~Pump or Compressor Venting.~~

~~**11.2.8.4.1**~~ –

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

~~**11.2.8.4.2**~~ –

~~Pressure relief devices used to serve pumps or compression equipment shall be connected to a vent pipe system in accordance with 11.2.2.3 .~~

~~**11.2.8.5**~~ ~~*~~ – ~~Pressure Monitoring.~~

~~The pressure on the pump or 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 pump or compressor to shut down.~~

~~**11.2.8.6**~~ – ~~Protection of Transfer Piping, Pumps, and Compressors.~~

~~Transfer piping, pumps, and compressors shall be protected from vehicular damage.~~

~~**11.2.9**~~ – ~~Emergency Shutdown System.~~

~~**11.2.9.1**~~ –

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

~~**11.2.9.2**~~ –

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

~~**11.2.9.3**~~ –

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

~~**11.2.9.4**~~ –

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

~~**11.2.9.5**~~ –

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

~~**11.3**~~ – ~~Location of Bulk Liquefied Hydrogen Systems.~~

~~**11.3.1**~~ – ~~General.~~

~~**11.3.1.1**~~ –

~~Stationary storage containers shall be located so that they are accessible from mobile supply equipment.~~

~~**11.3.1.2**~~ ~~*~~ – ~~Diking.~~

~~**11.3.1.2.1**~~ –

~~Diking shall not be used to contain a liquid hydrogen spill.~~

~~**11.3.1.2.2**~~ –

~~Diking or berms shall be permitted to direct the spill away from exposures.~~

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~~**11.3.1.3**~~

~~Storage sites shall be placarded as follows:~~

~~**WARNING:**~~

~~LIQUEFIED HYDROGEN~~

~~FLAMMABLE GAS~~

~~NO SMOKING — NO OPEN FLAMES~~

~~**11.3.2** Specific Requirements.~~

~~**11.3.2.1**~~

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

~~Table 11.3.2.1 Location of Bulk Liquefied Hydrogen Systems~~

~~Quantity of Hydrogen Location MAQ >MAQ to 300 gal~~

~~(>170.32 to 1135.5 L) >300 to 600 gal~~

~~(>1135.5 to 2271 L) >600 gal~~

~~(>2271 L) Outdoors A A A A In a detached building A A A NA In a gas room A A NA NA Inside a building (not in a gas room or detached building) and exposed to other occupancies A NA NA NA~~

~~MAQ: Maximum allowable quantity. A: Allowed. NA: Not allowed.~~

~~**11.3.2.2** *~~

~~The minimum distance from bulk liquefied hydrogen systems of indicated capacity shall be in accordance with Table 11.3.2.2 .~~

~~Table 11.3.2.2 Minimum Distance from Bulk Liquefied Hydrogen Systems to Exposures~~

~~Total Bulk Liquefied Hydrogen Storage - 39.7 gal to 3500 gal 150 L to 13,250 L - 3501 gal to 15,000 gal 13,251 L to 56,781 L - 15,001 gal to 75,000 gal 56,782 L to 283,906 L Type of Exposure ft m - ft m - ft m **Group 1** - - - - - - - - 1. Lot lines 25 7.6 - 50 15 - 75 23 2. Air intakes [heating, ventilating, or air-conditioning equipment (HVAC), compressors, other] 75 23 - 75 23 - 75 23 3. Wall openings - - - - - - - - - Operable openings in buildings and structures 75 23 - 75 23 - 75 23 4. Ignition sources such as open flames and welding 50 15 - 50 15 - 50 15 **Group 2** - - - - - - - - 5. Places of public assembly 75 23 - 75 23 - 75 23 6. Parked cars (distance shall be measured from the container fill connection) 25 7.6 - 25 7.6 - 25 7.6 **Group 3** - - - - - - - - 7. Building or structure - - - - - - - - - (a) Buildings constructed of noncombustible or limited-combustible materials - - - - - - - - (1) Sprinklered building or structure or unsprinklered building or structure having noncombustible contents 5 [a] 1.5 - 5 [a] 1.5 - 5 [a] 1.5 (2) Unsprinklered building or structure with combustible contents - - - - - - - - (i) Adjacent wall(s) with fire resistance rating less than 3 hours 25 7.6 - 50 15 - 75 23 (ii) Adjacent wall(s) with fire resistance rating of 3 hours or greater [b] 5 1.5 - 5 1.5 - 5 1.5 (b) Buildings of combustible construction - - - - - - - - (1) Sprinklered building or structure 50 15 - 50 15 - 50 15 (2) Unsprinklered building or structure 50 15 - 75 23 - 100 30.5 8. Flammable gas storage or systems (other than hydrogen) above or below ground 50 15 - 75 23 - 75 23 9. Between stationary liquefied hydrogen containers 5 1.5 - 5 1.5 - 5 1.5 10. All classes of flammable and combustible liquids (above ground and vent or fill openings if below ground) [c] 50 15 - 75 23 - 100 30.5 11. Hazardous materials storage or systems including liquid oxygen storage and other oxidizers, above or below ground 75 23 - 75 23 - 75 23 12. Heavy timber, coal, or other slow-burning combustible solids 50 15 - 75 23 - 100 30.5 13. Wall openings - - - - - - - - - Unopenable openings in buildings and structures 25 7.6 - 50 15 - 50 15 14. Inlet to underground sewers 5 1.5 - 5 1.5 - 5 1.5 15. Utilities overhead, including electric power, building services, or hazardous materials piping systems - - - - - - - - - (a) Horizontal distance from the vertical plane below the nearest overhead wire of an electric trolley, train, or bus line 50 15 - 50 15 - 50 15 (b) Horizontal distance from the vertical plane below the nearest overhead electrical wire 25 7.5 - 25 7.5 - 25 7.5 (c) Piping containing other hazardous materials 15 4.6 - 15 4.6 - 15 4.6 16. Flammable gas metering and regulating stations above grade 15 4.6 - 15 4.6 - 15 4.6~~

~~[a] Portions of wall less than 10 ft (3.1 m) (measured horizontally) from any part of a system must have a fire resistance rating of not less than 1 hour.~~

~~[b] Exclusive of windows and doors.~~

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~~C The separation distances for Class IIIB combustible liquids shall be permitted to be reduced to 15 ft (4.6 m).~~

~~**11.3.2.2.1 ***~~ –

~~The distance shall be measured from the part of the bulk liquefied hydrogen system closest to the exposure.~~

~~**11.3.2.2.2 ***~~ –

~~The vent stack shall not be considered part of the bulk liquid hydrogen system for determining separation distances in 11.3.2.2 . (See Table 11.3.2.2 .)~~

~~**11.3.2.2.3**~~ –

~~The distances in 1, 7, 8, 10, 11, and 12 in Table 11.3.2.2 shall be permitted to be reduced by two-thirds, but to not less than 5 ft (1.5 m), for insulated portions of the system.~~

~~**11.3.2.2.4 ***~~ –

~~The distances in 1, 7, 8, 10, 11, and 12 in Table 11.3.2.2 shall be permitted to be reduced to 0 ft (0 m) by the use of fire barrier walls having a fire resistance rating of not less than 2 hours when constructed in accordance with 8.6.2.1 and 11.3.2.2 .~~

~~**11.3.2.2.5**~~ –

~~The fire barrier or the insulated liquefied hydrogen tank shall interrupt the line of sight between uninsulated portions of the liquefied hydrogen storage system and the exposure.~~

~~**11.3.2.2.6**~~ –

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

~~**11.3.2.2.6.1 ***~~ –

~~The connecting angles between fire barrier walls shall be permitted to be reduced to less than 135 degrees (2.36 rad) for installations consisting of three walls when in accordance with 8.12.2.7.2 .~~

~~**11.3.2.2.6.2 ***~~ –

~~When fire barrier walls of three sides are used, piping and control systems serving stationary tanks shall be located at the open side of the enclosure created by the barrier walls to provide access for filling and ventilation.~~

~~**(A)**~~ –

~~Vertical tanks shall be located at a distance not less than one tank diameter from the enclosing walls.~~

~~**(B)**~~ –

~~Where horizontal tanks are used, the distance to any enclosing wall shall be not less than one-half the length of the tank.~~

~~**11.3.2.3**~~ –

~~Unloading connections 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.~~

~~**11.3.2.4 ***~~ –

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

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~~**11.3.3** – Installation of LH_2 Inside Buildings Other Than Detached Buildings and Gas Rooms.~~

~~Portable liquefied hydrogen (LH_2) containers of 39.7 gal (150 L) or less capacity where housed inside buildings, not located in a gas room, and exposed to other occupancies shall comply with the following minimum requirements:~~

(1) ~~Containers shall be located 20 ft (6.1 m) from all classes of flammable or combustible liquids and combustible materials such as excelsior or paper.~~

(2) ~~Containers shall be located 25 ft (7.6 m) from ordinary electrical equipment and other sources of ignition, including process or analytical equipment. *(See Section 8.6 .)*~~

(3) ~~Containers shall be located 50 ft (15 m) from intakes for ventilation, air-conditioning equipment, or compressors.~~

(4) ~~Containers shall be located 50 ft (15 m) from storage or use of other flammable gases or storage or use of incompatible gases.~~

(5) ~~Containers shall be protected against physical damage in accordance with the requirements of 8.5.5 .~~

(6) ~~Containers shall be secured in accordance with the requirements of 8.5.3 .~~

(7) ~~Welding or cutting operations and smoking shall be prohibited while hydrogen is in the room, and signs shall be provided as required by 6.13.2.2 .~~

(8) ~~Ventilation shall be provided in accordance with the requirements of Section 6.17 .~~

(9) ~~Pressure relief devices on stationary or portable containers shall be vented directly outdoors or to an exhaust hood. *(See 8.2.4.6 .)*~~

~~**11.4** – Design Considerations at Specific Locations.~~

~~**11.4.1** – Outdoor Locations.~~

~~**11.4.1.1**~~ –

~~Roadways and yard surfaces located below liquefied hydrogen piping as well as areas located under the fill connections and delivery vehicles' uninsulated hydrogen piping from which liquid air is able to drip shall be constructed of noncombustible materials.~~

~~**11.4.1.1.1**~~ –

~~The area of noncombustible surfacing provided under liquid mobile supply equipments shall have a width not less than 12 ft (3.7 m) and a length not less than 12 ft (3.7 m) in the direction of the vehicle axis.~~

~~**11.4.1.1.2**~~ –

~~Asphalt and bitumastic paving shall be assumed to be combustible.~~

~~**11.4.1.1.3**~~ –

~~Expansion joints and fillers used in the construction of concrete slabs shall be of noncombustible materials.~~

~~**11.4.1.2**~~ –

~~Weather protection shall be constructed in accordance with the requirements of Section 6.7 and the building code.~~

~~**11.4.1.3** *~~ –

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

~~**11.4.1.3.1**~~ –

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

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~~**11.4.1.3.1.1**~~ –

~~In installations where administrative controls are used to restrict access to the storage use and handling areas, signs shall be installed within 25 ft (7.6 m) of the equipment indicating:~~

~~**WARNING:** HYDROGEN~~

~~AUTHORIZED PERSONNEL ONLY~~

~~**11.4.1.3.2**~~ –

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

~~**11.4.2** – Aboveground Tanks.~~

~~**11.4.2.1** – Construction.~~

~~Stationary storage tanks for liquid hydrogen shall be designed and constructed in accordance with ASME *Boiler and Pressure Vessel Code* (Section VIII, Division 1) and shall be vacuum jacketed in accordance with 11.4.2.2 .~~

~~**11.4.2.2** – Construction of the Vacuum Jacket (Outer Vessel).~~

~~**11.4.2.2.1**~~ –

~~The vacuum jacket used as an outer vessel for storage tanks in liquid hydrogen service shall be of welded steel construction designed to withstand the maximum internal and external pressures to which it will be subjected under operating conditions to include conditions of emergency pressure relief of the annular space between the inner and outer vessel.~~

~~**11.4.2.2.2**~~ –

~~The jacket shall be designed to withstand a minimum collapsing pressure differential of 30 psi (207 kPa).~~

~~**11.4.2.3** – Vacuum Level Monitoring.~~

~~**11.4.2.3.1**~~ –

~~A connection shall be provided on the exterior of the vacuum jacket to allow measurement of the pressure within the annular space between the inner and outer vessels.~~

~~**11.4.2.3.2**~~ –

~~The connection shall be fitted with a bellows-sealed or diaphragm-type valve equipped with a vacuum gauge tube that is shielded to protect against damage from impact.~~

~~**11.4.3** – Underground Tanks.~~

~~Underground tanks for the storage of liquid hydrogen shall be in accordance with this subsection.~~

~~**11.4.3.1** – Construction.~~

~~Storage tanks for liquid hydrogen shall be designed and constructed in accordance with the ASME *Boiler and Pressure Vessel Code* and shall be vacuum jacketed in accordance with 11.4.3.1.1 .~~

~~**11.4.3.1.1** – Vacuum Jacket Construction.~~

~~**11.4.3.1.1.1**~~ –

~~The vacuum jacket shall be designed and constructed in accordance with the ASME *Boiler and Pressure Vessel Code* and shall be designed to withstand the anticipated loading, including loading from vehicular traffic, where applicable.~~

~~**11.4.3.1.1.2**~~ –

~~Portions of the vacuum jacket installed below grade shall be designed to withstand anticipated soil, hydrostatic, and seismic loading.~~

~~**11.4.3.1.1.3**~~ –

~~The vacuum jacket shall be constructed of stainless steel or other approved corrosion-resistant material.~~

~~**11.4.3.1.1.4** – Corrosion Protection.~~

~~**(A)**~~ –

~~The vacuum jacket shall be protected by an engineered cathodic protection system.~~

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~~**(B)**~~ –

~~A cathodic protection system maintenance schedule shall be provided and reconciled by the owner/operator.~~

~~**(C)**~~ –

~~Exposed components shall be inspected at least twice a year.~~

~~**11.4.3.2**~~ – ~~Location.~~

~~Tanks shall be located in accordance with 11.4.3.2.1 through 11.4.3.2.4 .~~

~~**11.4.3.2.1**~~ –

~~Underground storage tanks shall not be located beneath buildings.~~

~~**11.4.3.2.2**~~ –

~~Tanks 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.~~

~~**11.4.3.2.3**~~ –

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

~~**11.4.3.2.4**~~ –

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

~~**11.4.3.3**~~ – ~~Depth, Cover, and Fill.~~

~~**11.4.3.3.1**~~ –

~~The tank shall be buried such that the top of the vacuum jacket 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.~~

~~**11.4.3.3.2**~~ –

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

~~**11.4.3.3.3**~~ –

~~Underground tanks 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.~~

~~**11.4.3.3.4**~~ –

~~The vertical extension of the vacuum jacket required for service connections shall be allowed to extend above grade.~~

~~**11.4.3.4**~~ – ~~Anchorage and Security.~~

~~Tanks and systems shall be secured against accidental dislodgment due to seismic events or flooding.~~

~~**11.4.3.5**~~ – ~~Venting of Underground Tanks.~~

~~Vent pipes for underground storage tanks shall be in accordance with 11.2.2.3 .~~

~~**11.4.3.6**~~ – ~~Underground Liquid Hydrogen Piping.~~

~~**11.4.3.6.1**~~ –

~~Underground liquid hydrogen piping shall be vacuum jacketed.~~

~~**11.4.3.6.2**~~ –

~~Unjacketed piping shall not be buried and shall exit the tank annular space above grade.~~

~~**11.4.3.7**~~ – ~~Overfill Protection and Prevention Systems.~~

~~An approved means or method shall be provided to prevent the overfilling of storage tanks.~~

~~**11.4.3.8**~~ – ~~Vacuum Level Monitoring.~~

~~An approved monitoring method shall be provided to indicate vacuum degradation within the vacuum jacket(s).~~

~~**11.4.3.9**~~ – ~~Physical Protection.~~

~~Piping and control equipment ancillary to the underground tank located above ground shall be protected from physical damage in accordance with 8.5.5 .~~

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~~**11.4.3.10** – Tanks Not in Service.~~

~~Tanks not in service shall be maintained in accordance with 11.4.3.10.1 .~~

~~**11.4.3.10.1** –~~

~~Corrosion protection shall be maintained in operation.~~

~~**11.4.4** – Detached Buildings.~~

~~**11.4.4.1** – Explosion Control.~~

~~**11.4.4.1.1** –~~

~~Detached buildings containing more than 300 gal (1136 L) of liquefied hydrogen shall be constructed of noncombustible or limited-combustible materials in accordance with the requirements of the building code.~~

~~**11.4.4.1.2** –~~

~~Explosion control shall be provided in accordance with the requirements of Section 6.10 .~~

~~**11.4.4.2** – Ventilation.~~

~~Ventilation shall be provided in accordance with the requirements of Section 6.17 and 11.4.4.2.1 through 11.4.4.2.4 .~~

~~**11.4.4.2.1** –~~

~~Inlet openings shall be located within 18 in. (0.46 m) of the floor in exterior walls only.~~

~~**11.4.4.2.2** –~~

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

~~**11.4.4.2.3** –~~

~~Both the inlet and outlet vent openings shall have a minimum total area of 1 ft^2 /1000 scf (1 m^2 /300 Nm^3) of room volume.~~

~~**11.4.4.2.4** –~~

~~Discharge from outlet openings shall be directed or conducted to a location that allows for dissipation of the exhaust air in the ambient surroundings away from air intakes and occupied spaces.~~

~~**11.4.4.3*** – Ignition Sources.~~

~~There shall be no sources of ignition within the room or area where the hydrogen system is installed.~~

~~**11.4.4.4** – Heating.~~

~~**11.4.4.4.1** –~~

~~Heating, if provided, shall be by indirect means such as steam or hot water.~~

~~**11.4.4.4.2** –~~

~~Electrical heating in accordance with Section 8.7 shall be allowed.~~

~~**11.4.5** – Gas Rooms.~~

~~**11.4.5.1** –~~

~~Heating, if provided, shall be by steam, hot water, or other indirect means.~~

~~**11.4.5.2** –~~

~~Electrical heating in accordance with Section 8.7 shall be allowed.~~

~~**11.5** – Cargo Transport Unloading.~~

~~**11.5.1** –~~

~~Unloading connections 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.~~

~~**11.5.2** –~~

~~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.~~

~~**11.5.3** –~~

~~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.~~

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~~11.5.4~~ –

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

~~11.5.5~~ –

~~The transfer systems shall be capable of depressurizing to facilitate disconnection. Bleed connections shall be connected to a hydrogen venting system in accordance with 11.2.2.3 .~~

~~11.5.6~~ –

~~Liquid hydrogen supply systems shall have a minimum 12 ft (3.7 m) by 12 ft (3.7 m) concrete off loading pad.~~

~~11.5.7~~ –

~~Prohibitions on smoking or the use of open flame shall be in accordance with 11.3.1.3 .~~

~~11.5.8~~ – ~~Maintenance.~~

~~11.5.8.1~~ –

~~Maintenance shall be performed annually by a qualified representative of the equipment owner.~~

~~11.5.8.2~~ –

~~The maintenance shall include inspection for physical damage, leaktightness, 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.~~

~~11.5.8.3~~ –

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

~~11.5.9~~ –

~~An emergency shutoff valve shall be provided in accordance with 8.13.11.2.3.1 .~~

~~Harmonize NFPA 55 Chapter 11 with NFPA 2 Chater 8~~

Statement of Problem and Substantiation for Public Input

This public input is proposing to re-align NFPA 2 with the requirements in NFPA 55. It is a placeholder comment to allow work to be done by a task group in the future to better align the documents based upon feedback from the NFPA2/55 Scope Joint Working Group. A Public Comment will be submitted with exact language changes.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 56-NFPA 55-2020 [Chapter 7]	Related PI
Public Input No. 57-NFPA 55-2020 [Chapter 6]	Related PI
Public Input No. 58-NFPA 55-2020 [Chapter 10]	Related PI
Public Input No. 56-NFPA 55-2020 [Chapter 7]	
Public Input No. 57-NFPA 55-2020 [Chapter 6]	
Public Input No. 58-NFPA 55-2020 [Chapter 10]	

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Committee:	IMG-AAA

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Public Input No. 86-NFPA 55-2020 [Chapter 11]

~~**Chapter 11** – Bulk Liquefied Hydrogen Systems~~

~~**11.1** * – General.~~

~~**11.1.1** * –~~

~~The storage, use, and handling of bulk liquefied hydrogen shall be in accordance with the provisions of Chapter 1 and Chapters 4 through 11 , as applicable.~~

~~**11.1.2** –~~

~~Portable containers having a total liquefied hydrogen content of less than 39.7 gal (150 L) in compliance with the requirements of Chapter 8 shall not be required to comply with Chapter 11 .~~

~~**11.2** – Design of Bulk Liquefied Hydrogen Systems.~~

~~**11.2.1** – Fire Protection of Structural Supports.~~

~~**11.2.1.1** –~~

~~Steel supports in excess of 18 in. (457 mm) in height shall have a minimum 2-hour fire resistance rating in accordance with ASTM E1529, *Determining the Effects of Large Hydrocarbon Pool Fires on Structural Members and Assemblies* .~~

~~**11.2.1.2** –~~

~~Containers shall be marked in accordance with the provisions of Section 8.4 and as follows:~~

~~LIQUEFIED HYDROGEN — FLAMMABLE GAS~~

~~**11.2.2** – Pressure Relief Devices.~~

~~Stationary and portable containers and tanks shall be provided with pressure relief devices in accordance with the requirements of 8.2.4 and with 11.2.2.1 through 11.2.2.4 .~~

~~**11.2.2.1** –~~

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

~~**11.2.2.2** –~~

~~Pressure relief devices serving stationary containers shall be in accordance with the provisions of 8.2.4.6.1 and arranged to discharge unobstructed to the outdoors.~~

~~**11.2.2.3** –~~

~~Hydrogen venting systems discharging to the atmosphere shall be in accordance with CGA G-5.5, *Hydrogen Vent Systems* .~~

~~**11.2.2.4** –~~

~~Stationary containers shall be provided with a sign, placed in proximity to the primary tank pressure relief valve vent stack, that warns against spraying water on or into the vent opening.~~

~~**11.2.3** * – Piping, Tubing, and Fittings.~~

~~**11.2.3.1** –~~

~~Piping and tubing shall be in accordance with the requirements of ASME B31, *Pressure 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 ASME B31, *Pressure Piping* .~~

~~**11.2.3.2.1** –~~

~~Piping and tubing materials that have a minimum design metal temperature (MDMT) of –425°F (–254°C) or lower, as defined and specified in ASME B31, *Pressure Piping* , shall be permitted to be used without impact testing.~~

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~~**11.2.3.2.2**~~ –

~~Piping and tubing materials that have an MDMT greater than –425°F (–254°C) shall be permitted to be used after impact testing has been performed and the materials have passed.~~

~~**11.2.3.3**~~ –

~~Joints in piping and tubing shall be in accordance with the requirements of ASME B31, *Pressure Piping* .~~

~~**11.2.3.4**~~ –

~~Brazing materials, where used, shall have a melting point above 1000°F (538°C).~~

~~**11.2.3.5**~~ –

~~Aluminum piping systems and components external to the storage vessel shall not be used with liquefied hydrogen, except for ambient air vaporizers.~~

~~**11.2.3.6**~~ ~~*~~ –

~~Means shall be provided to minimize exposure of persons to piping operating at low temperatures and to prevent air condensate from contacting piping, structural members, and surfaces not designed for cryogenic temperatures.~~

~~**11.2.3.6.1**~~ –

~~Insulation on piping systems used to convey cryogenic fluids shall be of noncombustible material and shall be designed to have a vaportight seal in the outer covering to prevent the condensation of air and subsequent oxygen enrichment within the insulation.~~

~~**11.2.3.6.2**~~ –

~~The insulation material and outside shield shall be designed to prevent deterioration of the insulation due to normal operating conditions.~~

~~**11.2.3.7**~~ –

~~Uninsulated piping and equipment that operates at liquefied hydrogen temperatures shall not be installed above asphalt or other combustible materials or surfaces in order to prevent the contact of liquid air with such materials.~~

~~**11.2.3.8**~~ –

~~Drip pans shall be allowed to be installed under uninsulated piping and equipment to retain and vaporize condensed liquid air.~~

~~**11.2.3.9**~~ –

~~Cleaning and purging of piping systems shall be in accordance with 7.1.18 .~~

~~**11.2.4**~~ – ~~Equipment Assembly.~~

~~**11.2.4.1**~~ –

~~Installation of bulk liquefied hydrogen systems shall be supervised by personnel knowledgeable about the applicable standards and the construction and use of the system to be installed.~~

~~**11.2.4.2**~~ –

~~Storage containers, piping, valves, regulating equipment, and other accessories shall be accessible and shall be protected against physical damage and tampering.~~

~~**11.2.4.2.1**~~ –

~~Emergency shutoff valves shall be located in liquid and vapor use lines as close to the container as practical to terminate all flow to use lines during an emergency.~~

~~**11.2.4.2.2**~~ –

~~Containers exceeding 2000 gal (7570 L) capacity shall be provided with an automatic emergency shutoff valve.~~

~~**11.2.4.2.2.1**~~ ~~*~~ –

~~The remotely operated emergency isolation valve shall be operated by a remotely located, manually activated shutdown control.~~

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~~**11.2.4.2.2.2** * –~~

~~The shutoff valve shall be connected to the primary container by means of welded connections without the use of flanges or other appurtenances, except that a manual shutoff valve equipped with welded connections is allowed to be installed immediately upstream of the automatic shutoff valve to allow for maintenance of the automatic valve.~~

~~**11.2.4.2.2.3** –~~

~~Connections downstream of the shutoff valve shall be in accordance with ASME B31, *Process Piping* .~~

~~**11.2.4.3** –~~

~~Cabinets or enclosures containing hydrogen control equipment shall be ventilated to prevent any accumulation of hydrogen gas.~~

~~**11.2.5** – Liquefied Hydrogen Vaporizers.~~

~~**11.2.5.1** * –~~

~~Heat supplied to a liquefied hydrogen vaporizer shall be by indirect means utilizing a transfer medium.~~

~~**11.2.5.2** * –~~

~~A low-temperature shutoff switch or valve shall be provided in the vaporizer discharge piping to prevent flow of liquefied hydrogen downstream of the vaporizer in the event that liquid is discharged from the vaporizer.~~

~~**11.2.6** – Electrical Systems.~~

~~**11.2.6.1** –~~

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

~~**11.2.6.2** –~~

~~Specific locations for Class 1, Division 1, Group B (hydrogen) and Class 1, Division 2, Group B (hydrogen) areas shall be in accordance with Table 11.2.6.2 .~~

~~Table 11.2.6.2 Electrical Area Classification~~

~~Location Division Extent of Classified Area 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 1 Within 3 ft (1 m) measured spherically from system fill connection, system pressure relief vent outlets, or other points of release when the system is operating as designed. 2 Between 3 ft (1 m) and 25 ft (7.6 m) measured spherically from the system fill connection, any vent outlet, and within 25 ft (7.6 m) of any portion of the bulk supply system that contains liquefied hydrogen.~~

~~**11.2.6.3** –~~

~~Where equipment approved for Class I, Group B atmospheres is not commercially available, the equipment used shall meet at least one of the following:~~

(1) ~~Purged or ventilated in accordance with NFPA 496~~

(2) ~~Intrinsically safe~~

~~**11.2.6.4** –~~

~~Electrical equipment installed on mobile supply trucks or tank cars from which the storage container is filled shall not be subject to 11.2.6.3 .~~

~~**11.2.7** – Bonding and Grounding.~~

~~The bulk liquefied hydrogen system shall be electrically bonded and grounded.~~

~~**11.2.8** – Stationary Pumps and Compressors.~~

~~**11.2.8.1** – Valve Isolation.~~

~~**11.2.8.1.1** –~~

~~Valves shall be installed such that each pump or compressor can be isolated for maintenance.~~

~~**11.2.8.1.2** –~~

~~Where pumps or compressors are installed for operation in parallel, each discharge line shall be equipped with a check valve to prevent the backflow of liquid from one system to the other.~~

~~**11.2.8.2** – Foundation Design and Construction.~~

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~~**11.2.8.2.1** –~~

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

~~**11.2.8.2.2** –~~

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

~~**11.2.8.3** – Emergency Shutdown System Operation.~~

~~When an emergency shutdown (ESD) is required, activation of the ESD system shall shut down operation of all pumps and compressors.~~

~~**11.2.8.4** – Pump or Compressor Venting.~~

~~**11.2.8.4.1** –~~

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

~~**11.2.8.4.2** –~~

~~Pressure relief devices used to serve pumps or compression equipment shall be connected to a vent pipe system in accordance with 11.2.2.3 .~~

~~**11.2.8.5** * – Pressure Monitoring.~~

~~The pressure on the pump or 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 pump or compressor to shut down.~~

~~**11.2.8.6** – Protection of Transfer Piping, Pumps, and Compressors.~~

~~Transfer piping, pumps, and compressors shall be protected from vehicular damage.~~

~~**11.2.9** – Emergency Shutdown System.~~

~~**11.2.9.1** –~~

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

~~**11.2.9.2** –~~

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

~~**11.2.9.3** –~~

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

~~**11.2.9.4** –~~

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

~~**11.2.9.5** –~~

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

~~**11.3** – Location of Bulk Liquefied Hydrogen Systems.~~

~~**11.3.1** – General.~~

~~**11.3.1.1** –~~

~~Stationary storage containers shall be located so that they are accessible from mobile supply equipment.~~

~~**11.3.1.2** * – Diking.~~

~~**11.3.1.2.1** –~~

~~Diking shall not be used to contain a liquid hydrogen spill.~~

~~**11.3.1.2.2** –~~

~~Diking or berms shall be permitted to direct the spill away from exposures.~~

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~~**11.3.1.3**~~

~~Storage sites shall be placarded as follows:~~

~~**WARNING:**~~

~~LIQUEFIED HYDROGEN~~

~~FLAMMABLE GAS~~

~~NO SMOKING — NO OPEN FLAMES~~

~~**11.3.2** Specific Requirements.~~

~~**11.3.2.1**~~

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

~~Table 11.3.2.1 Location of Bulk Liquefied Hydrogen Systems~~

~~Quantity of Hydrogen Location MAQ >MAQ to 300 gal~~

~~(>170.32 to 1135.5 L) >300 to 600 gal~~

~~(>1135.5 to 2271 L) >600 gal~~

~~(>2271 L) Outdoors A A A A In a detached building A A A NA In a gas room A A NA NA Inside a building (not in a gas room or detached building) and exposed to other occupancies A NA NA NA~~

~~MAQ: Maximum allowable quantity. A: Allowed. NA: Not allowed.~~

~~**11.3.2.2** *~~

~~The minimum distance from bulk liquefied hydrogen systems of indicated capacity shall be in accordance with Table 11.3.2.2 .~~

~~Table 11.3.2.2 Minimum Distance from Bulk Liquefied Hydrogen Systems to Exposures~~

~~Total Bulk Liquefied Hydrogen Storage - 39.7 gal to 3500 gal 150 L to 13,250 L - 3501 gal to 15,000 gal 13,251 L to 56,781 L - 15,001 gal to 75,000 gal 56,782 L to 283,906 L Type of Exposure ft m - ft m - ft m **Group 1** - - - - - - - - 1. Lot lines 25 7.6 - 50 15 - 75 23 2. Air intakes [heating, ventilating, or air-conditioning equipment (HVAC), compressors, other] 75 23 - 75 23 - 75 23 3. Wall openings - - - - - - - - — Operable openings in buildings and structures 75 23 - 75 23 - 75 23 4. Ignition sources such as open flames and welding 50 15 - 50 15 - 50 15 **Group 2** - - - - - - - - 5. Places of public assembly 75 23 - 75 23 - 75 23 6. Parked cars (distance shall be measured from the container fill connection) 25 7.6 - 25 7.6 - 25 7.6 **Group 3** - - - - - - - - 7. Building or structure - - - - - - - - — (a) Buildings constructed of noncombustible or limited-combustible materials - - - - - - - - —— (1) Sprinklered building or structure or unsprinklered building or structure having noncombustible contents 5 [a] 1.5 - 5 [a] 1.5 - 5 [a] 1.5 —— (2) Unsprinklered building or structure with combustible contents - - - - - - - - ——— (i) Adjacent wall(s) with fire resistance rating less than 3 hours 25 7.6 - 50 15 - 75 23 ——— (ii) Adjacent wall(s) with fire resistance rating of 3 hours or greater [b] 5 1.5 - 5 1.5 - 5 1.5 — (b) Buildings of combustible construction - - - - - - - - —— (1) Sprinklered building or structure 50 15 - 50 15 - 50 15 —— (2) Unsprinklered building or structure 50 15 - 75 23 - 100 30.5 8. Flammable gas storage or systems (other than hydrogen) above or below ground 50 15 - 75 23 - 75 23 9. Between stationary liquefied hydrogen containers 5 1.5 - 5 1.5 - 5 1.5 10. All classes of flammable and combustible liquids (above ground and vent or fill openings if below ground) [c] 50 15 - 75 23 - 100 30.5 11. Hazardous materials storage or systems including liquid oxygen storage and other oxidizers, above or below ground 75 23 - 75 23 - 75 23 12. Heavy timber, coal, or other slow-burning combustible solids 50 15 - 75 23 - 100 30.5 13. Wall openings - - - - - - - - — Unopenable openings in buildings and structures 25 7.6 - 50 15 - 50 15 14. Inlet to underground sewers 5 1.5 - 5 1.5 - 5 1.5 15. Utilities overhead, including electric power, building services, or hazardous materials piping systems - - - - - - - - — (a) Horizontal distance from the vertical plane below the nearest overhead wire of an electric trolley, train, or bus line 50 15 - 50 15 - 50 15 — (b) Horizontal distance from the vertical plane below the nearest overhead electrical wire 25 7.5 - 25 7.5 - 25 7.5 — (c) Piping containing other hazardous materials 15 4.6 - 15 4.6 - 15 4.6 16. Flammable gas metering and regulating stations above grade 15 4.6 - 15 4.6 - 15 4.6~~

~~[a] Portions of wall less than 10 ft (3.1 m) (measured horizontally) from any part of a system must have a fire resistance rating of not less than 1 hour.~~

~~[b] Exclusive of windows and doors.~~

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~~c The separation distances for Class IIIB combustible liquids shall be permitted to be reduced to 15 ft (4.6 m).~~

~~**11.3.2.2.1** *~~ –

~~The distance shall be measured from the part of the bulk liquefied hydrogen system closest to the exposure.~~

~~**11.3.2.2.2** *~~ –

~~The vent stack shall not be considered part of the bulk liquid hydrogen system for determining separation distances in 11.3.2.2 . (See Table 11.3.2.2 .)~~

~~**11.3.2.2.3**~~ –

~~The distances in 1, 7, 8, 10, 11, and 12 in Table 11.3.2.2 shall be permitted to be reduced by two-thirds, but to not less than 5 ft (1.5 m), for insulated portions of the system.~~

~~**11.3.2.2.4** *~~ –

~~The distances in 1, 7, 8, 10, 11, and 12 in Table 11.3.2.2 shall be permitted to be reduced to 0 ft (0 m) by the use of fire barrier walls having a fire resistance rating of not less than 2 hours when constructed in accordance with 8.6.2.1 and 11.3.2.2 .~~

~~**11.3.2.2.5**~~ –

~~The fire barrier or the insulated liquefied hydrogen tank shall interrupt the line of sight between uninsulated portions of the liquefied hydrogen storage system and the exposure.~~

~~**11.3.2.2.6**~~ –

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

~~**11.3.2.2.6.1** *~~ –

~~The connecting angles between fire barrier walls shall be permitted to be reduced to less than 135 degrees (2.36 rad) for installations consisting of three walls when in accordance with 8.12.2.7.2 .~~

~~**11.3.2.2.6.2** *~~ –

~~When fire barrier walls of three sides are used, piping and control systems serving stationary tanks shall be located at the open side of the enclosure created by the barrier walls to provide access for filling and ventilation.~~

~~**(A)**~~ –

~~Vertical tanks shall be located at a distance not less than one tank diameter from the enclosing walls.~~

~~**(B)**~~ –

~~Where horizontal tanks are used, the distance to any enclosing wall shall be not less than one-half the length of the tank.~~

~~**11.3.2.3**~~ –

~~Unloading connections 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.~~

~~**11.3.2.4** *~~ –

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

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~~**11.3.3** – Installation of LH_2 Inside Buildings Other Than Detached Buildings and Gas Rooms.~~

~~Portable liquefied hydrogen (LH_2) containers of 39.7 gal (150 L) or less capacity where housed inside buildings, not located in a gas room, and exposed to other occupancies shall comply with the following minimum requirements:~~

(1) ~~Containers shall be located 20 ft (6.1 m) from all classes of flammable or combustible liquids and combustible materials such as excelsior or paper.~~

(2) ~~Containers shall be located 25 ft (7.6 m) from ordinary electrical equipment and other sources of ignition, including process or analytical equipment. *(See Section 8.6 .)*~~

(3) ~~Containers shall be located 50 ft (15 m) from intakes for ventilation, air-conditioning equipment, or compressors.~~

(4) ~~Containers shall be located 50 ft (15 m) from storage or use of other flammable gases or storage or use of incompatible gases.~~

(5) ~~Containers shall be protected against physical damage in accordance with the requirements of 8.5.5 .~~

(6) ~~Containers shall be secured in accordance with the requirements of 8.5.3 .~~

(7) ~~Welding or cutting operations and smoking shall be prohibited while hydrogen is in the room, and signs shall be provided as required by 6.13.2.2 .~~

(8) ~~Ventilation shall be provided in accordance with the requirements of Section 6.17 .~~

(9) ~~Pressure relief devices on stationary or portable containers shall be vented directly outdoors or to an exhaust hood. *(See 8.2.4.6 .)*~~

~~**11.4** – Design Considerations at Specific Locations.~~

~~**11.4.1** – Outdoor Locations.~~

~~**11.4.1.1**~~ –

~~Roadways and yard surfaces located below liquefied hydrogen piping as well as areas located under the fill connections and delivery vehicles' uninsulated hydrogen piping from which liquid air is able to drip shall be constructed of noncombustible materials.~~

~~**11.4.1.1.1**~~ –

~~The area of noncombustible surfacing provided under liquid mobile supply equipments shall have a width not less than 12 ft (3.7 m) and a length not less than 12 ft (3.7 m) in the direction of the vehicle axis.~~

~~**11.4.1.1.2**~~ –

~~Asphalt and bitumastic paving shall be assumed to be combustible.~~

~~**11.4.1.1.3**~~ –

~~Expansion joints and fillers used in the construction of concrete slabs shall be of noncombustible materials.~~

~~**11.4.1.2**~~ –

~~Weather protection shall be constructed in accordance with the requirements of Section 6.7 and the building code.~~

~~**11.4.1.3** *~~ –

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

~~**11.4.1.3.1**~~ –

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

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~~**11.4.1.3.1.1**~~ –

~~In installations where administrative controls are used to restrict access to the storage use and handling areas, signs shall be installed within 25 ft (7.6 m) of the equipment indicating:~~

~~**WARNING:** HYDROGEN~~

~~AUTHORIZED PERSONNEL ONLY~~

~~**11.4.1.3.2**~~ –

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

~~**11.4.2**~~ – ~~Aboveground Tanks.~~

~~**11.4.2.1**~~ – ~~Construction.~~

~~Stationary storage tanks for liquid hydrogen shall be designed and constructed in accordance with ASME *Boiler and Pressure Vessel Code* (Section VIII, Division 1) and shall be vacuum jacketed in accordance with 11.4.2.2 .~~

~~**11.4.2.2**~~ – ~~Construction of the Vacuum Jacket (Outer Vessel).~~

~~**11.4.2.2.1**~~ –

~~The vacuum jacket used as an outer vessel for storage tanks in liquid hydrogen service shall be of welded steel construction designed to withstand the maximum internal and external pressures to which it will be subjected under operating conditions to include conditions of emergency pressure relief of the annular space between the inner and outer vessel.~~

~~**11.4.2.2.2**~~ –

~~The jacket shall be designed to withstand a minimum collapsing pressure differential of 30 psi (207 kPa).~~

~~**11.4.2.3**~~ – ~~Vacuum Level Monitoring.~~

~~**11.4.2.3.1**~~ –

~~A connection shall be provided on the exterior of the vacuum jacket to allow measurement of the pressure within the annular space between the inner and outer vessels.~~

~~**11.4.2.3.2**~~ –

~~The connection shall be fitted with a bellows-sealed or diaphragm-type valve equipped with a vacuum gauge tube that is shielded to protect against damage from impact.~~

~~**11.4.3**~~ – ~~Underground Tanks.~~

~~Underground tanks for the storage of liquid hydrogen shall be in accordance with this subsection.~~

~~**11.4.3.1**~~ – ~~Construction.~~

~~Storage tanks for liquid hydrogen shall be designed and constructed in accordance with the ASME *Boiler and Pressure Vessel Code* and shall be vacuum jacketed in accordance with 11.4.3.1.1 .~~

~~**11.4.3.1.1**~~ – ~~Vacuum Jacket Construction.~~

~~**11.4.3.1.1.1**~~ –

~~The vacuum jacket shall be designed and constructed in accordance with the ASME *Boiler and Pressure Vessel Code* and shall be designed to withstand the anticipated loading, including loading from vehicular traffic, where applicable.~~

~~**11.4.3.1.1.2**~~ –

~~Portions of the vacuum jacket installed below grade shall be designed to withstand anticipated soil, hydrostatic, and seismic loading.~~

~~**11.4.3.1.1.3**~~ –

~~The vacuum jacket shall be constructed of stainless steel or other approved corrosion-resistant material.~~

~~**11.4.3.1.1.4**~~ – ~~Corrosion Protection.~~

~~**(A)**~~ –

~~The vacuum jacket shall be protected by an engineered cathodic protection system.~~

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~~**(B)**~~ –

~~A cathodic protection system maintenance schedule shall be provided and reconciled by the owner/operator.~~

~~**(C)**~~ –

~~Exposed components shall be inspected at least twice a year.~~

~~**11.4.3.2**~~ – ~~Location.~~

~~Tanks shall be located in accordance with 11.4.3.2.1 through 11.4.3.2.4 .~~

~~**11.4.3.2.1**~~ –

~~Underground storage tanks shall not be located beneath buildings.~~

~~**11.4.3.2.2**~~ –

~~Tanks 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.~~

~~**11.4.3.2.3**~~ –

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

~~**11.4.3.2.4**~~ –

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

~~**11.4.3.3**~~ – ~~Depth, Cover, and Fill.~~

~~**11.4.3.3.1**~~ –

~~The tank shall be buried such that the top of the vacuum jacket 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.~~

~~**11.4.3.3.2**~~ –

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

~~**11.4.3.3.3**~~ –

~~Underground tanks 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.~~

~~**11.4.3.3.4**~~ –

~~The vertical extension of the vacuum jacket required for service connections shall be allowed to extend above grade.~~

~~**11.4.3.4**~~ – ~~Anchorage and Security.~~

~~Tanks and systems shall be secured against accidental dislodgment due to seismic events or flooding.~~

~~**11.4.3.5**~~ – ~~Venting of Underground Tanks.~~

~~Vent pipes for underground storage tanks shall be in accordance with 11.2.2.3 .~~

~~**11.4.3.6**~~ – ~~Underground Liquid Hydrogen Piping.~~

~~**11.4.3.6.1**~~ –

~~Underground liquid hydrogen piping shall be vacuum jacketed.~~

~~**11.4.3.6.2**~~ –

~~Unjacketed piping shall not be buried and shall exit the tank annular space above grade.~~

~~**11.4.3.7**~~ – ~~Overfill Protection and Prevention Systems.~~

~~An approved means or method shall be provided to prevent the overfilling of storage tanks.~~

~~**11.4.3.8**~~ – ~~Vacuum Level Monitoring.~~

~~An approved monitoring method shall be provided to indicate vacuum degradation within the vacuum jacket(s).~~

~~**11.4.3.9**~~ – ~~Physical Protection.~~

~~Piping and control equipment ancillary to the underground tank located above ground shall be protected from physical damage in accordance with 8.5.5 .~~

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~~**11.4.3.10** – Tanks Not in Service.~~

~~Tanks not in service shall be maintained in accordance with 11.4.3.10.1 .~~

~~**11.4.3.10.1** –~~

~~Corrosion protection shall be maintained in operation.~~

~~**11.4.4** – Detached Buildings.~~

~~**11.4.4.1** – Explosion Control.~~

~~**11.4.4.1.1** –~~

~~Detached buildings containing more than 300 gal (1136 L) of liquefied hydrogen shall be constructed of noncombustible or limited-combustible materials in accordance with the requirements of the building code.~~

~~**11.4.4.1.2** –~~

~~Explosion control shall be provided in accordance with the requirements of Section 6.10 .~~

~~**11.4.4.2** – Ventilation.~~

~~Ventilation shall be provided in accordance with the requirements of Section 6.17 and 11.4.4.2.1 through 11.4.4.2.4 .~~

~~**11.4.4.2.1** –~~

~~Inlet openings shall be located within 18 in. (0.46 m) of the floor in exterior walls only.~~

~~**11.4.4.2.2** –~~

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

~~**11.4.4.2.3** –~~

~~Both the inlet and outlet vent openings shall have a minimum total area of 1 ft^2 /1000 scf (1 m^2 /300 Nm^3) of room volume.~~

~~**11.4.4.2.4** –~~

~~Discharge from outlet openings shall be directed or conducted to a location that allows for dissipation of the exhaust air in the ambient surroundings away from air intakes and occupied spaces.~~

~~**11.4.4.3*** – Ignition Sources.~~

~~There shall be no sources of ignition within the room or area where the hydrogen system is installed.~~

~~**11.4.4.4** – Heating.~~

~~**11.4.4.4.1** –~~

~~Heating, if provided, shall be by indirect means such as steam or hot water.~~

~~**11.4.4.4.2** –~~

~~Electrical heating in accordance with Section 8.7 shall be allowed.~~

~~**11.4.5** – Gas Rooms.~~

~~**11.4.5.1** –~~

~~Heating, if provided, shall be by steam, hot water, or other indirect means.~~

~~**11.4.5.2** –~~

~~Electrical heating in accordance with Section 8.7 shall be allowed.~~

~~**11.5** – Cargo Transport Unloading.~~

~~**11.5.1** –~~

~~Unloading connections 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.~~

~~**11.5.2** –~~

~~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.~~

~~**11.5.3** –~~

~~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.~~

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~~**11.5.4**~~ –

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

~~**11.5.5**~~ –

~~The transfer systems shall be capable of depressurizing to facilitate disconnection. Bleed connections shall be connected to a hydrogen venting system in accordance with 11.2.2.3 .~~

~~**11.5.6**~~ –

~~Liquid hydrogen supply systems shall have a minimum 12 ft (3.7 m) by 12 ft (3.7 m) concrete off loading pad.~~

~~**11.5.7**~~ –

~~Prohibitions on smoking or the use of open flame shall be in accordance with 11.3.1.3 .~~

~~**11.5.8**~~ – ~~Maintenance.~~

~~**11.5.8.1**~~ –

~~Maintenance shall be performed annually by a qualified representative of the equipment owner.~~

~~**11.5.8.2**~~ –

~~The maintenance shall include inspection for physical damage, leaktightness, 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.~~

~~**11.5.8.3**~~ –

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

~~**11.5.9**~~ –

~~An emergency shutoff valve shall be provided in accordance with 8.13.11.2.3.1 .~~

Statement of Problem and Substantiation for Public Input

The storage, use, handling, and many other aspects of hydrogen are addressed by NFPA 2. Per the committee scope statements the HYD Committee has "primary responsibility for documents on the storage, transfer, production, and use hydrogen" and the IMG "Committee shall coordinate the material on gaseous and liquid hydrogen storage and use with the Hydrogen Technology Committee.” The simplest, least error prone way for NFPA 55 to coordinate with NFPA 2 regarding hydrogen gas is to just refer the user to NFPA 2. This is best accomplished in in 7.6.1.2 and 8.1.4. This nullifies the need for Chapter 11.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 77-NFPA 55-2020 [Section No. 7.6.1.2]	Refers user to NFPA 2 for requirements re: gaseous hydrogen.
Public Input No. 81-NFPA 55-2020 [New Section after 8.1.3]	Refers user to NFPA 2 for requirements re: liquid hydrogen.
Public Input No. 96-NFPA 55-2020 [Sections A.11.1, A.11.1.1, A.11.2.3, A.11.2.3.2, A.11.2.3.6...]	
Public Input No. 104-NFPA 55-2020 [Section No. 3.3.95.10]	

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Submittal Date: Sun Jun 28 17:25:13 EDT 2020
Committee: IMG-AAA

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Public Input No. 29-NFPA 55-2020 [Section No. 11.2.4.2.2.1]

11.2.4.2.2.1*

The remotely operated emergency ~~isolation~~ shutoff valve shall be operated by a remotely located, manually activated shutdown control.

Statement of Problem and Substantiation for Public Input

The defined term in 3.3.38 is for an Emergency Shutoff Valve not an Emergency Isolation Valve.

Submitter Information Verification

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Committee: IMG-AAA

Attachment F - NFPA 55 Public Inputs

Public Input No. 112-NFPA 55-2020 [Section No. 11.3.2.2]

11.3.2.2*

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The minimum distance from bulk liquefied hydrogen systems ~~of indicated capacity~~ to specified exposures shall be in accordance with Table 11.3.2.2 (a), Table 11 . 3.2.2 (b) and Table 11.3.2.2 (c) .

Table 11.3.2.~~2 Minimum~~ 2(a) Minimum Distance from Outdoor Bulk Liquefied Hydrogen [LH2] Systems to Exposures

~~- Total Bulk Liquefied Hydrogen Storage - 39.7 gal to 3500 gal 150 L to 13,250 L - 3501 gal to 15,000 gal 13,251 L to 56,781 L - 15,001 gal to 75,000 gal 56,782 L to 283,906 L Type of Exposure ft m - ft m - ft m **Group 1** - - - - - - - - 1. Lot lines 25 7.6 - 50 15 - 75 23 2. Air intakes [heating, ventilating, or air-conditioning equipment (HVAC), compressors, other] 75 23 - 75 23 - 75 23 3. Wall openings - - - - - - - - — Operable openings in buildings and structures 75 23 - 75 23 - 75 23 4. Ignition sources such as open flames and welding 50 15 - 50 15 - 50 15 **Group 2** - - - - - - - - 5. Places of public assembly 75 23 - 75 23 - 75 23 6. Parked cars (distance shall be measured from the container fill connection) 25 7.6 - 25 7.6 - 25 7.6 **Group 3** - - - - - - - - 7. Building or structure - - - - - - - - — (a) Buildings constructed of noncombustible or limited-combustible materials - - - - - - - - —— (1) Sprinklered building or structure or unsprinklered building or structure having noncombustible contents 5 [a] 1.5 - 5 [a] 1.5 - 5 [a] 1.5 —— (2) Unsprinklered building or structure with combustible contents - - - - - - - - ——— (i) Adjacent wall(s) with fire resistance rating less than 3 hours 25 7.6 - 50 15 - 75 23 ——— (ii) Adjacent wall(s) with fire resistance rating of 3 hours or greater [b] 5 1.5 - 5 1.5 - 5 1.5 — (b) Buildings of combustible construction - - - - - - - - —— (1) Sprinklered building or structure 50 15 - 50 15 - 50 15 —— (2) Unsprinklered building or structure 50 15 - 75 23 - 100 30.5 8. Flammable gas storage or systems (other than hydrogen) above or below ground 50 15 - 75 23 - 75 23 9. Between stationary liquefied hydrogen containers 5 1.5 - 5 1.5 - 5 1.5 10. All classes of flammable and combustible liquids (above ground and vent or fill openings if below ground) [c] 50 15 - 75 23 - 100 30.5 11. Hazardous materials storage or systems including liquid oxygen storage and other oxidizers, above or below ground 75 23 - 75 23 - 75 23 12. Heavy timber, coal, or other slow-burning combustible solids 50 15 - 75 23 - 100 30.5 13. Wall openings - - - - - - - - — Unopenable openings in buildings and structures 25 7.6 - 50 15 - 50 15 14. Inlet to underground sewers 5 1.5 - 5 1.5 - 5 1.5 15. Utilities overhead, including electric power, building services, or hazardous materials piping systems - - - - - - - - — (a) Horizontal distance from the vertical plane below the nearest overhead wire of an electric trolley, train, or bus line 50 15 - 50 15 - 50 15 — (b) Horizontal distance from the vertical plane below the nearest overhead electrical wire 25 7.5 - 25 7.5 - 25 7.5 — (c) Piping containing other hazardous materials 15 4.6 - 15 4.6 - 15 4.6 16. Flammable gas metering and regulating stations above grade 15 4.6 - 15 4.6 - 15 4.6~~

~~[a] Portions of wall less than 10 ft (3.1 m) (measured horizontally) from any part of a system must 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~~

~~— Typical Maximum Pipe Size (1.5 in [38.1 mm])~~

	~~<30 psig~~		~~30 to 75 psig~~		~~75 to 120 psig~~		~~12~~
~~**Relief Pressure (gauge)**~~	~~<21 kPa~~		~~21 to 52 kPa~~		~~52 to 83 kPa~~		~~8~~
~~**Exposures Group 1**~~	~~m~~	~~ft~~	~~m~~	~~ft~~	~~m~~	~~ft~~	
~~Lot lines~~ ~~Air intakes (HVAC, compressors, other)~~ ~~Operable openings in buildings and structures~~ ~~Ignition sources such as open flames and welding~~	~~7~~	~~23~~	~~9~~	~~30~~	~~11~~	~~36~~	~~1~~
~~**Exposures Group 2**~~	~~m~~	~~ft~~	~~m~~	~~ft~~	~~m~~	~~ft~~	
~~Exposed Persons other than those servicing the system~~ ~~Parked Cars~~	~~5~~	~~16~~	~~7~~	~~22~~	~~8~~	~~26~~	
~~**Exposures Group 3**~~	~~m~~	~~ft~~	~~m~~	~~ft~~	~~m~~	~~ft~~	
~~Buildings of non-combustible non-fire-rated construction~~ ~~Buildings of combustible construction~~	~~4~~	~~12~~	~~5~~	~~16~~	~~6~~	~~19~~	

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~~Flammable gas storage systems above or below ground~~

~~Hazardous materials storage systems above or below ground~~

~~Heavy timber, coal, or other slow burning combustible solids~~

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

~~Unopenable openings in buildings and structures~~

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

~~Piping containing other hazardous materials~~

~~Flammable gas metering and regulating stations such as natural gas or propane~~

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Table 11.3.2.2(b) Minimum Distance from Outdoor Bulk Liquefied Hydrogen [LH2] Systems to Exposures by Maximum Pipe Size

Relief Pressure (gauge)		< 30 psig						30 to 75 psig						75 to 120 psig					
		< 21 kPa						21 to 52 kPa						52 to 83 kPa					
Exposures		Group 1		Group 2		Group 3		Group 1		Group 2		Group 3		Group 1		Group 2		Group 3	
Internal Pipe Diameter																			
in	mm	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft
0.1	2.5	0.5	1.6	0.4	1.4	0.5	1.5	0.7	2.2	0.6	1.8	0.6	2	0.8	2.6	0.7	2.2	0.7	2.4
0.25	6.4	1.2	3.9	1	3.2	1	3.4	1.6	5.4	1.3	4.3	1.4	4.5	2	6.5	1.6	5.2	1.6	5.3
0.5	12.7	2.4	7.8	1.8	6.1	1.8	5.9	3.3	11	2.5	8.2	2.4	7.8	4	13	3	9.9	2.7	9
0.75	19	3.6	12	2.7	8.8	2.5	8	4.9	16	3.7	12	3.2	11	5.6	19	4.2	14	3.5	12
1	25.4	4.8	16	3.3	11	2.9	9.4	6.1	20	4.6	15	3.8	12	7.5	24	5.5	18	4.3	14
1.25	31.8	6	20	4.1	13	3.4	11	7.6	25	5.6	18	4.4	14	9.3	30	6.7	22	5	16
1.5	**38.1**	**7.1**	**23**	**4.8**	**16**	**3.8**	**12**	**9.1**	**30**	**6.6**	**22**	**5**	**16**	**11**	**36**	**7.9**	**26**	**5.7**	**19**
1.75	44.4	8.3	27	5.5	18	4.2	14	11	34	7.6	25	5.5	18	13	42	9.2	30	6.3	21
2	50.8	9.5	31	6.2	20	4.6	15	12	39	8.6	28	6	20	14	48	10	34	7.2	24
2.25	57.2	11	35	6.9	23	5	16	13	44	9.6	31	6.6	22	16	54	12	38	7.8	26
2.5	63.5	12	39	7.7	25	5.4	18	15	49	10	34	7.1	23	18	59	13	42	8.6	28
2.75	69.8	13	43	8.3	27	5.7	19	16	53	12	38	7.8	26	20	65	14	46	9.3	31
3	76.2	14	47	9	30	6.2	20	18	58	12	41	8.5	28	22	71	15	49	10	33

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

*For a list of exposures in each exposure group, see Column 1 of Table 11.3.2.2(a).

Table 11.3.2.2(c) Minimum Distance from Outdoor Bulk Liquefied Hydrogen [LH2] Systems to Exposures by Maximum Pipe Size

Relief Pressure (gauge)		120 to 165 psig						165 to 210 psig						210 to 255 psig					
		83 to 114 kPa						114 to 145 kPa						145 to 176 kPa					
Exposures		Group 1		Group 2		Group 3		Group 1		Group 2		Group 3		Group 1		Group 2		Group 3	
Internal Pipe Diameter																			
in	mm	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft
0.1	2.5	1	3.1	0.8	2.5	0.8	2.8	1.1	3.7	0.9	2.9	0.9	3	1.3	4.3	1	3.3	1	3.4
0.25	6.4	2.4	7.7	1.8	6	1.8	5.9	2.6	8.5	2	6.4	1.7	5.7	3	9.8	2.2	7.2	1.9	6.2
0.5	12.7	4.7	15	3.5	11	3	9.9	5	16	3.6	12	2.8	9	5.8	19	4.1	13	3	9.8
0.75	19	6.6	22	4.8	16	3.8	12	7.4	24	5.2	17	3.6	12	8.5	28	5.9	19	4	13
1	25.4	8.7	28	6.3	21	4.6	15	9.7	32	6.8	22	4.5	15	11	37	7.7	25	5.1	17
1.25	31.8	11	35	7.7	25	5.3	18	12	39	8.3	27	5.5	18	14	46	9.5	31	6.2	20
1.5	**38.1**	**13**	**42**	**9.1**	**30**	**6.2**	**20**	**14**	**47**	**9.8**	**32**	**6.3**	**21**	**17**	**54**	**11**	**37**	**7.2**	**24**
1.75	44.4	15	49	10	34	7.1	23	17	55	11	37	7.3	24	19	63	13	43	8.3	27
2	50.8	17	55	12	39	7.9	26	19	62	13	42	8.2	27	22	72	15	48	9.2	30
2.25	57.2	19	62	13	43	8.8	29	21	70	14	47	9	30	25	81	16	54	10	33
2.5	63.5	21	69	15	48	9.6	32	24	77	16	52	10	33	27	89	18	59	11	37
2.75	69.8	23	75	16	52	11	35	26	85	17	57	11	36	30	98	20	65	13	42
3	76.2	25	82	17	56	11	37	28	92	19	62	12	38	33	107	22	71	13	43

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

*For a list of exposures in each exposure group, see Column 1 of Table 11.3.2.2(a).

11.3.2.2.1 *

The distance shall be measured from the part of the bulk liquefied hydrogen system closest to the exposure.

11.3.2.2.2*

The vent stack shall not be considered part of the bulk liquid hydrogen system for determining separation distances in 11.3.2.2. *(See ~~Table~~ Tables 11.3.2.2 (a), (b) and (c) .)*

11.3.2.2.3*

~~The distances in 1, 7, 8, 10, 11, and 12 in Table~~

Except for distances to air intakes, the distances to Group 1 and 2 exposures shown in Tables 11.3.2.2

~~shall be permitted to be reduced by two-thirds, but to not less than 5 ft (1.5 m), for insulated portions of the system.~~

~~**11.3.2.2.4 ***~~

~~The distances in 1, 7, 8, 10, 11, and 12 in Table 11.3.2.2~~

(a), (b), and (c) shall be permitted to be reduced

~~to 0 ft (0 m) by the use of fire barrier walls having a fire resistance rating of not less than 2 hours~~

by one-half and shall not apply to Group 3 exposures where fire barrier walls are located between the system and the exposure and when constructed in accordance with 8.6.2.1 and 11.3.2.2

~~.~~

11.3.2.2.5

~~The fire barrier or the insulated liquefied hydrogen tank shall interrupt the line of sight between uninsulated portions of the liquefied hydrogen storage system and the exposure.~~

~~**11.3.2.2.6**~~

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

~~**11.3.2.2.6.1 ***~~

~~The connecting angles between fire barrier walls shall be permitted to be reduced to less than 135 degrees (2.36 rad) for installations consisting of three walls when in accordance with 8.12.2.7.2 .~~

~~**11.3.2.2.6.2 ***~~

4 *

When fire barrier walls of three sides are used, piping and control systems serving stationary tanks shall be located at the open side of the enclosure created by the barrier walls to provide access for filling and ventilation.

(A)

Vertical tanks shall be located at a distance not less than one tank diameter from the enclosing walls.

(B)

Where horizontal tanks are used, the distance to any enclosing wall shall be not less than one-half the length of the tank.

Statement of Problem and Substantiation for Public Input

The scientific basis for table 11.3.2.2 is unclear. There is no evidence that exposure distances should be a function of storage volume. With the exception of cold temperature hazard (cryogenic 'burn'), the hazards from liquid hydrogen system leaks are similar to compressed gaseous hydrogen leaks, and the extent of an unignited or ignited release will be a function of the system operating pressure and the leak size.

Following the logic in Annex E for gaseous bulk storage, we have regrouped the exposures and calculated exposure distances as a function of system pipe size and pressure. Calculations were done using Sandia's HyRAM models, assuming a 1% leak area as a typical size, and a factor of safety of 2 due to uncertainty in the leak size and the modeling. Group 1 distances were calculated as the greater of the streamline distance to an 8%

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concentration or a bird's-eye heat flux of 1.577 kW/m^2. Group 2 distances were calculated as the bird's-eye distance to a heat flux of 4.732 kW/m^2, and the Group 3 distances were calculated as the bird's eye view distance to a flame length or a heat flux of 20 kW/m^2.

We presented this material to the NFPA 2 storage task group with positive feedback regarding this approach.

This has also been submitted as Public Input 262 to NFPA 2, as this section is extracted to that document.

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Committee: IMG-AAA

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Public Input No. 49-NFPA 55-2020 [Section No. 11.3.2.2]

11.3.2.2*

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The minimum distance from bulk liquefied hydrogen systems of indicated capacity shall be in accordance with Table 11.3.2.2.

Table 11.3.2.2 Minimum Distance from Bulk Liquefied Hydrogen Systems to Exposures

	-	Total Bulk Liquefied Hydrogen Storage						
	-	39.7 gal to 3500 gal	150 L to 13,250 L	- 3501 gal to 15,000 gal	13,251 L to 56,781 L	-	15,001 gal to 75,000 gal	56,782 L to 283,906 L
Type of Exposure	ft	m	-	ft	m	-	ft	m
Group 1	-	-	-	- -	-	-	-	
1. Lot lines	25	7.6	-	50	15	-	75	23
2. Air intakes [heating, ventilating, or air-conditioning equipment (HVAC), compressors, other]	75	23	-	75	23	-	75	23
3. Wall openings	-	-	-	- -	-	-	-	
Operable openings in buildings and structures	75	23	-	75	23	-	75	23
4. Ignition sources such as open flames and welding	50	15	-	50	15	-	50	15
Group 2	-	-	-	- -	-	-	-	
5. Places of public assembly	75	23	-	75	23	-	75	23
6. Parked cars (distance shall be measured from the container fill connection)	25	7.6	-	25	7.6	-	25	7.6
Group 3	-	-	-	- -	-	-	-	
7. Building or structure	-	-	-	- -	-	-	-	
(a) Buildings constructed of noncombustible or limited-combustible materials	-	-	-	- -	-	-	-	
(1) Sprinklered building or structure or unsprinklered building or structure having noncombustible contents	5[a]	1.5	-	5[a]	1.5	-	5[a]	1.5
(2) Unsprinklered building or structure with combustible contents	-	-	-	- -	-	-	-	
(i) Adjacent wall(s) with fire resistance rating less than 3 hours	25	7.6	-	50	15	-	75	23

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	-	Total Bulk Liquefied Hydrogen Storage						
	-	39.7 gal to 3500 gal	150 L to 13,250 L	-	3501 gal to 15,000 gal	13,251 L to 56,781 L	-	15,001 gal to 75,000 gal / 56,782 L to 283,906 L
Type of Exposure	ft	m	-	ft	m	-	ft	m
(ii) Adjacent wall(s) with fire resistance rating of 3 hours or greater[b]	5	1.5	-	5	1.5	-	5	1.5
(b) Buildings of combustible construction	-	-	-	-	-	-	-	-
(1) Sprinklered building or structure	50	15	-	50	15	-	50	15
(2) Unsprinklered building or structure	50	15	-	75	23	-	100	30.5
8. Flammable gas storage or systems (other than hydrogen) above or below ground	50	15	-	75	23	-	75	23
9. Between stationary liquefied hydrogen containers	5	1.5	-	5	1.5	-	5	1.5
10. All classes of flammable and combustible liquids (above ground and vent or fill openings if below ground)[c]	50	15	-	75	23	-	100	30.5
11. Hazardous materials storage or systems including liquid oxygen storage and other oxidizers, above or below ground	75	23	-	75	23	-	75	23
12. Heavy timber, coal, or other slow-burning combustible solids	50	15	-	75	23	-	100	30.5
13. Wall openings	-	-	-	-	-	-	-	-
Unopenable openings in buildings and structures	25	7.6	-	50	15	-	50	15
14. Inlet to underground sewers	5	1.5	-	5	1.5	-	5	1.5
15. Utilities overhead, including electric power, building services, or hazardous materials piping	-	-	-	-	-	-	-	-

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	Total Bulk Liquefied Hydrogen Storage									
	-	39.7 gal to 3500 gal	150 L to 13,250 L	-	3501 gal to 15,000 gal	13,251 L to 56,781 L	-	15,001 gal to 75,000 gal	56,782 L to 283,906 L	
Type of Exposure	ft	m	-	ft	m	-	ft	m		
systems										
(a) Horizontal distance from the vertical plane below the nearest overhead wire of an electric trolley, train, or bus line	50	15	-	50	15	-	50	15		
(b) Horizontal distance from the vertical plane below the nearest overhead electrical wire	25	7.5	-	25	7.5	-	25	7.5		
(c) Piping containing other hazardous materials	15	4.6	-	15	4.6	-	15	4.6		
16. Flammable gas metering and regulating stations above grade	15	4.6	-	15	4.6	-	15	4.6		

[a] Portions of wall less than 10 ft (3.1 m) (measured horizontally) from any part of a system must 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).

11.3.2.2.1*

The distance shall be measured from the part of the bulk liquefied hydrogen system closest to the exposure.

11.3.2.2.2*

The vent stack shall not be considered part of the bulk liquid hydrogen system for determining separation distances in 11.3.2.2. *(See Table 11.3.2.2.)*

11.3.2.2.3

The distances in 1, 7, 8, 10, 11, 12, and ~~12 in~~ 13 in Table 11.3.2.2 shall be permitted to be reduced by two-thirds, but to not less than 5 ft (1.5 m), for insulated portions of the system.

11.3.2.2.4*

The distances in 1, 7, 8, 10, 11, 12, and ~~12~~ 13 in Table 11.3.2.2 shall be permitted to be reduced to 0 ft (0 m) by the use of fire barrier walls having a fire resistance rating of not less than 2 hours when constructed in accordance with 8.6.2.1 and 11.3.2.2.

11.3.2.2.5

The fire barrier or the insulated liquefied hydrogen tank shall interrupt the line of sight between uninsulated portions of the liquefied hydrogen storage system and the exposure.

11.3.2.2.6

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

11.3.2.2.6.1*

The connecting angles between fire barrier walls shall be permitted to be reduced to less than 135 degrees (2.36 rad) for installations consisting of three walls when in accordance with 8.12.2.7.2.

Attachment F - NFPA 55 Public Inputs

11.3.2.2.6.2*

When fire barrier walls of three sides are used, piping and control systems serving stationary tanks shall be located at the open side of the enclosure created by the barrier walls to provide access for filling and ventilation.

(A)

Vertical tanks shall be located at a distance not less than one tank diameter from the enclosing walls.

(B)

Where horizontal tanks are used, the distance to any enclosing wall shall be not less than one-half the length of the tank.

Statement of Problem and Substantiation for Public Input

The hazards from an inoperable window (line 13 in table 11.3.2.2) are equivalent to the hazards from other exposures that can have their distances reduced by the methods of sections 11.3.2.2.3 and 11.3.2.2.4.

Submitter Information Verification

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Submittal Date: Tue Jun 23 17:13:51 EDT 2020

Committee: IMG-AAA

Attachment F - NFPA 55 Public Inputs

Public Input No. 116-NFPA 55-2020 [Section No. 11.3.2.2 [Excluding any Sub-Sections]]

Attachment F - NFPA 55 Public Inputs

The minimum distance from bulk liquefied hydrogen systems of indicated capacity shall be in accordance with Table 11.3.2.2.

Table 11.3.2.2 Minimum Distance from Bulk Liquefied Hydrogen Systems to Exposures

	-	Total Bulk Liquefied Hydrogen Storage						
	- 39.7 gal to 3500 gal	150 L to 13,250 L	-	3501 gal to 15,000 gal	13,251 L to 56,781 L	-	15,001 gal to 75,000 gal	56,782 L to 283,906 L
Type of Exposure	**ft**	**m**	**-**	**ft**	**m**	**-**	**ft**	**m**
Group 1	–	–	–	– –	–	–	–	
1. Lot lines	25	7.6	–	50	15	–	75	23
2. Air intakes [heating, ventilating, or air-conditioning equipment (HVAC), compressors, other]	75	23	–	75	23	–	75	23
3. Wall openings	–	–	–	– –	–	–	–	
Operable openings in buildings and structures	75	23	–	75	23	–	75	23
4. Ignition sources such as open flames and welding	50	15	–	50	15	–	50	15
Group 2	–	–	–	– –	–	–	–	
5. Places of public assembly	75	23	–	75	23	–	75	23
6. Parked cars (distance shall be measured from the container fill connection)	25	7.6	–	25	7.6	–	25	7.6
Group 3	–	–	–	– –	–	–	–	
7. Building or structure	–	–	–	– –	–	–	–	
(a) Buildings constructed of noncombustible or limited-combustible materials	–	–	–	– –	–	–	–	
(1) Sprinklered building or structure or unsprinklered building or structure having noncombustible contents	5[a]	1.5	–	5[a]	1.5	–	5[a]	1.5
(2) Unsprinklered building or structure with combustible contents	–	–	–	– –	–	–	–	
(i) Adjacent wall(s) with fire resistance rating less than 3 hours	25	7.6	–	50	15	–	75	23
(ii) Adjacent wall(s) with fire resistance rating of	5	1.5	–	5	1.5	–	5	1.5

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	-	Total Bulk Liquefied Hydrogen Storage								
	-	39.7 gal to 3500 gal	150 L to 13,250 L	-	3501 gal to 15,000 gal	13,251 L to 56,781 L	-		15,001 gal to 75,000 gal	56,782 L to 283,906 L
Type of Exposure	ft	m	-		ft	m	-		ft	m
3 hours or greater[b]										
(b) Buildings of combustible construction	-	-	-	-	-	-	-	-		
(1) Sprinklered building or structure	50	15	-		50	15	-		50	15
(2) Unsprinklered building or structure	50	15	-		75	23	-		100	30.5
8. Flammable gas storage or systems (other than hydrogen) above or below ground	50	15	-		75	23	-		75	23
9. Between stationary liquefied hydrogen containers	5	1.5	-		5	1.5	-		5	1.5
10. All classes of flammable and combustible liquids (above ground and vent or fill openings if below ground)[c]	50	15	-		75	23	-		100	30.5
11. Hazardous materials storage or systems including liquid oxygen storage and other oxidizers, above or below ground	75	23	-		75	23	-		75	23
12. Heavy timber, coal, or other slow-burning combustible solids	50	15	-		75	23	-		100	30.5
13. Wall openings	-	-	-	-	-	-	-	-		
Unopenable openings in buildings and structures	25	7.6	-		50	15	-		50	15
14. Inlet to underground sewers	5	1.5	-		5	1.5	-		5	1.5
15. Utilities overhead, including electric power ~~, building services,~~ operating above 50 volts, or hazardous materials piping systems	-	-	-	-	-	-	-	-		
(a) Horizontal distance from the vertical plane below the nearest overhead wire of an	50	15	-		50	15	-		50	15

Attachment F - NFPA 55 Public Inputs

	Total Bulk Liquefied Hydrogen Storage							
	39.7 gal to 3500 gal	150 L to 13,250 L	-	3501 gal to 15,000 gal	13,251 L to 56,781 L	-	15,001 gal to 75,000 gal	56,782 L to 283,906 L
Type of Exposure	ft	m	-	ft	m	-	ft	m
electric trolley, train, or bus line								
(b) Horizontal distance from the vertical plane below the nearest overhead electrical wire	25	7.5	-	25	7.5	-	25	7.5
(c) Piping containing other hazardous materials	15	4.6	-	15	4.6	-	15	4.6
16. Flammable gas metering and regulating stations above grade	15	4.6	-	15	4.6	-	15	4.6

[a] Portions of wall less than 10 ft (3.1 m) (measured horizontally) from any part of a system must 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).

Statement of Problem and Substantiation for Public Input

If the intent for separation from utilities is intended to prevent ignition of un-ignited releases, then utilities such as phone lines, internet lines, etc. should not apply.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 115-NFPA 55-2020 [Section No. 10.4.2.2.1 [Excluding any Sub-Sections]]	Same change to both GH2 and LH2 tables

Submitter Information Verification

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Committee: IMG-AAA

Attachment F - NFPA 55 Public Inputs

Public Input No. 65-NFPA 55-2020 [Section No. 11.3.2.2 [Excluding any Sub-Sections]]

Attachment F - NFPA 55 Public Inputs

The minimum distance from bulk liquefied hydrogen systems of indicated capacity shall be in accordance with Table 11.3.2.2.

Table 11.3.2.2 Minimum Distance from Outdoor Bulk Liquefied Hydrogen Systems to Exposures

-	Total Bulk Liquefied Hydrogen Storage							
-	39.7 gal to 3500 gal	150 L to 13,250 L	-	3501 gal to 15,000 gal	13,251 L to 56,781 L	-	15,001 gal to 75,000 gal	56,782 L to 283,906 L
Type of Exposure	**ft**	**m**	-	**ft**	**m**	-	**ft**	**m**
Exposure Group 1	-	-	-	-	-	-	-	-
1. Lot lines	25	7.6	-	50	15	-	75	23
2. Air intakes [~~heating, ventilating, or air-conditioning equipment~~ ~~(~~ HVAC~~)~~ , compressors, other]	75	23	-	75	23	-	75	23
3. Wall openings	-	-	-	-	-	-	-	-
Operable openings in buildings and structures	75	23	-	75	23	-	75	23
4. Ignition sources such as open flames and welding	50	15	-	50	15	-	50	15
Exposure Group 2	-	-	-	-	-	-	-	-
~~5. Places of public assembly~~ 5. Exposed persons other than those servicing the system	75	23	-	75	23	-	75	23
6. Parked cars (distance shall be measured from the container fill connection)	25	7.6	-	25	7.6	-	25	7.6
Exposure Group 3	-	-	-	-	-	-	-	-
7. Building or structure	-	-	-	-	-	-	-	-
(a) Buildings constructed of noncombustible or limited-combustible materials	-	-	-	-	-	-	-	-
(1) Sprinklered building or structure or	5[a]	1.5	-	5[a]	1.5	-	5[a]	1.5

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	-	Total Bulk Liquefied Hydrogen Storage								
	-	39.7 gal to 3500 gal	150 L to 13,250 L	-		3501 gal to 15,000 gal	13,251 L to 56,781 L	-	15,001 gal to 75,000 gal	56,782 L to 283,906 L
Type of Exposure	ft	m	-		ft	m	-		ft	m
unsprinklered building or structure having noncombustible contents										
(2) Unsprinklered building or structure with combustible contents	-	-	-	-	-	-	-	-		
(i) Adjacent wall(s) with fire resistance rating less than 3 hours	25	7.6	-		50	15	-		75	23
(ii) Adjacent wall(s) with fire resistance rating of 3 hours or greater[b]	5	1.5	-		5	1.5	-		5	1.5
(b) Buildings of combustible construction	-	-	-	-	-	-	-	-		
(1) Sprinklered building or structure	50	15	-		50	15	-		50	15
(2) Unsprinklered building or structure	50	15	-		75	23	-		100	30.5
8. Flammable gas storage or systems (other than hydrogen) above or below ground	50	15	-		75	23	-		75	23
9. Between stationary liquefied hydrogen containers	5	1.5	-		5	1.5	-		5	1.5
10. All classes of flammable and combustible liquids (above ground and vent or fill openings if below ground)[c]	50	15	-		75	23	-		100	30.5
11. Hazardous materials storage or	75	23	-		75	23	-		75	23

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	-	Total Bulk Liquefied Hydrogen Storage							
	-	39.7 gal to 3500 gal	150 L to 13,250 L	-	3501 gal to 15,000 gal	13,251 L to 56,781 L	-	15,001 gal to 75,000 gal	56,782 L to 283,906 L
Type of Exposure	ft	m	-	ft	m	-	ft	m	
systems including liquid oxygen storage and other oxidizers, above or below ground									
12. Heavy timber, coal, or other slow-burning combustible solids	50	15	-	75	23	-	100	30.5	
13. Wall openings	-	-	-	-	-	-	-	-	
Unopenable openings in buildings and structures	25	7.6	-	50	15	-	50	15	
14. Inlet to underground sewers	~~5~~ 10	1.5	-	10 ~~5~~	1.5	-	10 ~~5~~	1.5	
15. Utilities overhead, including electric power, building services, or hazardous materials piping systems	-	-	-	-	-	-	-	-	
(a) Horizontal distance from the vertical plane below the nearest overhead wire of an electric trolley, train, or bus line	50	15	-	50	15	-	50	15	
(b) Horizontal distance from the vertical plane below the nearest overhead electrical wire	25	7.5	-	25	7.5	-	25	7.5	
(c) Piping containing other hazardous materials	15	4.6	-	15	4.6	-	15	4.6	
16. Flammable gas metering and regulating stations above grade	15	4.6	-	15	4.6	-	15	4.6	

Attachment F - NFPA 55 Public Inputs

[a] Portions of wall less than 10 ft (3.1 m) (measured horizontally) from any part of a system must 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).

Statement of Problem and Substantiation for Public Input

Align nomenclature and exposures with the GH2 table from Chapter 10.
Analysis has shown that LH2 spills can project as far as 10' from the leak source, so it's warranted to increase the distance to drains to 10' to prevent the migration of H2 into enclosed areas where the H cloud can propagate significant distance.

Submitter Information Verification

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Submittal Date: Fri Jun 26 00:19:33 EDT 2020

Committee: IMG-AAA

Attachment F - NFPA 55 Public Inputs

Public Input No. 68-NFPA 55-2020 [New Section after 11.3.2.2.1]

TITLE OF NEW CONTENT

New 11.3.2.2.2 The distances for combined gaseous and liquified hydrogen storage systems, upstream of their respective source valves, shall be taken from section 10.4.2.2 for the gaseous system and from section 11.3.2.2 for the liquefied system.

Annex A.11.3.2.2.2 For systems that are composed of combined gaseous and liquefied hydrogen storage systems and have separate source valves for both systems, the system can be viewed as having two source valves for determining minimum separation distances for bulk storage systems in accordance with 10.4.2.2 and 11.3.2.2. Identifying two source valves means that each portion of the system is subject to its respective minimum separation distances in accordance with 10.4.2.2 or 11.3.2.2.

Statement of Problem and Substantiation for Public Input

This proposal is moving content from the Annex of 3.3.95.10.1 and locating it in a more applicable location and within the body of the code text.

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Committee: IMG-AAA

Attachment F - NFPA 55 Public Inputs

Public Input No. 61-NFPA 55-2020 [New Section after 11.4.3.2.4]

11.4.3.2.5 The minimum distances to exposures in Table 11.3.2.2 shall not apply to those portions of the system which are located underground in accordance with 11.4.3, but shall apply to any portions of the system which are above ground.

Statement of Problem and Substantiation for Public Input

Currently it is not clear whether the setback distances would apply to parts of the system that are buried. The setback distance tables are specified and required in Section 11.3.2, whereas the requirements for bulk underground systems are given in 11.4.3; if a system was installing a system as per 11.4.3, the setback distances in 11.3.2 would seem to not apply, except for the the portions of the system which are not physically underground in which case 11.3.2 would seem to apply. This makes that distinction explicit and states which portions of the system are subject to the setback distances.

This addition was developed as part of the NFPA 2 Storage Task Group and is submitted with the consensus of that group.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 60-NFPA 55-2020 [New Section after 10.4.3.1.6.6]	Similar proposals for gas and liquid
Public Input No. 60-NFPA 55-2020 [New Section after 10.4.3.1.6.6]	

Submitter Information Verification

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Committee: IMG-AAA

Attachment F - NFPA 55 Public Inputs

Public Input No. 7-NFPA 55-2020 [New Section after 13.11.4]

13.11.4.1

Outdoor enclosures not large enough for a person to enter or occupy are not subject to this criteria .

Additional Proposed Changes

File Name	Description	Approved
NFPA_55_PC_49.pdf	NFPA 55 PC No. 49	

Statement of Problem and Substantiation for Public Input

Clarify & harmonize. AHJs are requiring CO2 gas detection to be installed in locations shown below that a person cannot enter due to the size and inaccessibility of the space.

Submitter Information Verification

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Submittal Date: Wed Mar 11 11:20:40 EDT 2020
Committee: IMG-AAA

Attachment F - PI7 (PC-49)

Public Comment No. 49-NFPA 55-2018 [New Section after 13.11.4]

13.11.4.1

Outdoor enclosures not large enough for a person to enter or occupy are not subject to this criteria.

Statement of Problem and Substantiation for Public Comment

Clarify & harmonize. AHJs are requiring CO2 gas detection to be installed in locations shown below that a person cannot enter due to the size and inaccessibility of the space.

Related Item

- FR 36

Submitter Information Verification

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Submittal Date: Mon Apr 30 09:55:04 EDT 2018

Committee:

Committee Statement

Committee Action: Rejected but held

Resolution: This is new material that should be held until the next revision cycle.

Attachment F - NFPA 55 Public Inputs

Public Input No. 45-NFPA 55-2020 [Section No. 16.3.3]

16.3.3 Insulation.

16.3.3.1

Insulated bulk liquid containers shall be vacuum insulated or mechanically insulated with an external vapor barrier.

16.3.3.2

Exposed insulating materials shall be noncombustible, in accordance with 4 .12.1 or limited combustible, in accordance with 4.12.2.

16.3.3.3* –

~~Insulation~~

Foam plastic insulating materials, such as polyurethane foam ~~having~~ , shall be permitted to be used outdoors if they comply with a flame spread ~~rating of 25 or less shall be permitted to be used if fully~~ index not exceeding 25 (when tested in accordance with ASTM E84 or ANSI/UL 723) and are fully covered with a protective metal or other noncombustible jacket.

16.3.3.

~~3.1~~

4 Foam plastic insulating materials, such as polyurethane foam, shall be permitted to be used indoors if they comply with a flame spread index not exceeding 25 (when tested in accordance with ASTM E84 or ANSI/UL 723) and are fully covered by a thermal barrier complying with NFPA 275.

16.3.3.5

Non-vacuum-insulated tanks shall have an internal cooling coil operated with refrigerant to maintain nitrous oxide as a liquefied gas.

16.3.3.~~3.2~~ 6 *

The refrigerant shall not be allowed to come in contact with the nitrous oxide.

Also

Add NFPA 275, Standard Method of Fire Tests for the Evaluation of Thermal Barriers, into section 2 on referenced NFPA standards.

Statement of Problem and Substantiation for Public Input

This PI proposes several changes.
1. It deletes the term "flame spread rating" and replaces it by the correct term "flame spread index"
2. It adds the fire test (ASTM E84 or UL 723) into the mandatory section to identify how the flame spread index is to be measured.
3. It allows both noncombustible and limited combustible insulation to be used exposed because almost none of the commercial insulation materials will comply with the requirements from ASTM E136 (as shown in 4.12.1) but those insulation materials that are typically said to be noncombustible materials will almost always comply with the requirements of a limited combustible material in accordance with 4.12.2.
4. It distinguishes between tanks insulated outdoors and those insulated indoors. If they are indoors, they should be protected with a thermal barrier (like all exposed insulation in any code) but if they are outdoors the protection already in the standard is OK.
5. It makes the type of insulation more generic: the same applies to polyurethane foam as to any other foam plastic insulation material.
6. Sections 16.3.3.3.1 and 16.3.3.3.2 are really no subsections of 16.3.3.3 and should be renumbered.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 50-NFPA 55-2020 [Section No. A.16.3.3.3]	

Attachment F - NFPA 55 Public Inputs

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Committee:	IMG-AAA

Attachment F - NFPA 55 Public Inputs

Public Input No. 53-NFPA 55-2020 [Chapter 17]

Chapter 17 Cryogenic Fluid Central Supply Systems for Health Care Facilities

Incorporate into Chapter 17 , Cryogenic Fluid Central Supply Systems for Health Care Facilities, applicable material from CGA SA-37, Safety Alert, Medical Oxygen Supply System Issues During the COVID-19 Crisis .

17. 1 General.

17.1.1*

The storage, use, and handling of cryogenic fluid central supply systems that deliver compressed medical gases (CMGs) to health care facilities shall be in accordance with the requirements of this chapter, Chapter 1 and Chapters 4 through 16 as applicable.

17.1.2 Applicability.

17.1.2.1

The source valve shall be the line separating the applicability between NFPA 55 and NFPA 99.

17.1.2.2

Cryogenic fluid central supply system installations up to, but not including, the source valve shall be covered by NFPA 55.

17.1.2.3

The source valve and all downstream piping and components, including wiring to storage system alarms, shall be covered by NFPA 99.

17.2 Cryogenic Fluid Central Supply Systems Installation.

17.2.1

Cryogenic fluid central supply systems shall be installed by personnel qualified in accordance with ANSI/CGA M-1, *Standard for Medical Gas Supply Systems at Health Care Facilities*, or ASSE 6015, *Professional Qualification Standard for Bulk Medical Gas Systems Installers*.

17.2.2

Cryogenic fluid central supply systems shall be installed in compliance with the Food and Drug Administration (FDA) Current Good Manufacturing Practices per 21 CFR 210 and 21 CFR 211.

17.2.3

Cryogenic fluid central supply systems shall be anchored with foundations in accordance with ANSI/CGA M-1, *Standard for Medical Gas Supply Systems at Health Care Facilities*.

17.2.4

Cryogenic fluid central supply systems shall have a minimum work space clearance of 3 ft (1 m) around the storage container, vaporizer(s), and cabinet opening or front side of the pressure-regulating manifold for system maintenance and operation.

17.2.5

Inert cryogenic fluid central supply systems shall be sited in accordance with Chapter 8 and CGA P-18, *Standard for Bulk Inert Gas Systems*.

17.2.6

Oxygen cryogenic fluid central supply systems shall be sited in accordance with Chapters 8 and 9, as applicable, and CGA M-1, *Standard for Medical Gas Supply Systems at Health Care Facilities*.

17.2.7

Carbon dioxide refrigerated liquid central supply systems shall be sited in accordance with Chapter 13 and CGA G-6.1, *Standard for Insulated Liquid Carbon Dioxide Systems at Consumer Sites*.

17.2.8

Nitrous oxide refrigerated liquid central supply systems shall be sited in accordance with Chapter 16 and CGA G-8.1, *Standard for Nitrous Oxide Systems at Customer Sites*.

Attachment F - NFPA 55 Public Inputs

17.3 Cryogenic Fluid Central Supply Systems Operation.

17.3.1

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

(1) Fill connection

(2) Top and bottom fill valves

(3) Hose purge valve

(4) Vent valve

(5) Full trycock valve

(6) Liquid level indicator

(7) Tank pressure indicator

17.3.2

Cryogenic fluid central supply systems shall consist of the following:

(1) One or more main supply vessel, with capacity determined after consideration of the customer usage requirements, delivery schedules, proximity of the facility to alternative supplies, and the emergency plan

(2) A contents gauge on every main vessel

(3) A reserve supply sized for greater than an average day's supply, with the size of vessel or number of cylinders determined after consideration of delivery schedules, proximity of the facility to alternative supplies, and the emergency plan

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

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

17.3.3

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

(1) Where the reserve source is a compressed gas source, the reserve shall be equipped with the following:

  (a) A cylinder manifold having not less than three gas cylinder connections or as otherwise required for an average of one day's gas supply

  (b) A pressure switch to monitor the pressure in the cylinder manifold

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

  (a) An actuating switch or sensor to monitor the internal tank pressure

  (b) A contents gauge to monitor the liquid level

(3) Where 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.

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17.3.4

Bulk cryogenic liquid sources shall include automatic means to provide the following functions:

(1) When the main supply is supplying the system, the reserve supply shall be prevented from supplying the system until the main supply is reduced to a level at or below the reserve activation pressure.

(2) When the main supply cannot supply the system, the reserve supply shall automatically begin to supply the system.

(3) Where there is more than one main supply vessel, the system shall operate as follows for primary, secondary, and reserve operation:

  (a) If provided with two liquid container headers, one cryogenic liquid header shall be the primary and the other shall be the secondary, with either being capable of either role.

  (b) If provided with one liquid container header and one gas cylinder header (i.e., a hybrid arrangement), the liquid container header shall be the primary and the gas cylinder header shall be the secondary.

  (c) When the primary header is supplying the system, the secondary header shall be prevented from supplying the system.

  (d) When the primary header is depleted, the secondary header shall automatically begin to supply the system.

(4) Where there are two or more cryogenic vessels, they shall be permitted to alternate (e.g., on a timed basis) in the roles of primary, secondary, and reserve, provided that an operating cascade (i.e., primary–secondary–reserve) is maintained at all times.

(5) Where a cryogenic vessel is used as the reserve, the reserve vessel shall include a means to conserve the gas produced by evaporation of the cryogenic liquid in the reserve vessel and to discharge the gas into the line upstream of the final line regulator assembly.

17.4 Main Supply System.

The main supply vessel for a cryogenic fluid central supply system shall be a cryogenic storage tank.

17.5 Reserve Supply System.

17.5.1

A CMG reserve supply system shall consist of either of the following:

(1) A secondary cryogenic vessel

(2) A high-pressure compressed gas source

17.5.2

A cryogenic source reserve supply shall have a switch or sensor to monitor the tank pressure.

17.5.3

A compressed gas reserve supply shall meet the following requirements:

(1) It shall be manifolded with no fewer than three gas cylinders.

(2) It shall have a pressure switch or sensor to monitor the contents using manifold pressure.

(3) It shall have a check valve to prevent backflow into the system.

(4) It shall have a check valve at each connection on the cylinder header to minimize loss of gas from the reserve system.

Attachment F - NFPA 55 Public Inputs

17.6 Cryogenic Fill System.

Cryogenic fluid central supply systems shall include a fill mechanism consisting of the following components:

(1) A nonremovable 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 check valve to prevent product backflow from the fill inlet

(4) A fill hose purge valve

(5) Supports that hold the fill piping off the ground

(6) A secure connection between the bulk tank and the fill piping

(7) Supports, as necessary, to hold the fill line in position during all operations associated with the filling procedure

17.7 Vaporizers.

17.7.1

Vaporizers used to convert cryogenic CMG to a gaseous state shall meet the following requirements:

(1) Vaporizers shall be permitted to operate by either ambient heat transfer or external thermal source (e.g., electric heater, hot water, steam).

(2) Vaporizers using a heat source other than ambient air shall be protected in the event of a loss of the energy source.

17.7.2

Vaporizers shall be designed to provide capacity for the customer’s use under the following conditions:

(1) Customer’s average and peak flows

(2) Local conditions (e.g., structures that obstruct air circulation or sunlight)

(3) Seasonal conditions (e.g., freeze periods)

17.7.3

A system design that uses switching vaporizers shall meet all of the following requirements:

(1) Valves shall be permitted to be manual or automatic.

(2) Valves and piping shall allow an operating vaporizer or an operating section of a vaporizer to be switched to a nonoperating condition for deicing.

(3) The system design shall provide continuous flow of CMG to the health care facility during vaporizer switchover.

(4) The system design shall provide continuous flow of CMG to the health care facility if vaporizer switchover fails.

17.7.4

Where a vaporizer uses an external thermal source, the flow of the CMG shall be unaffected by the loss of the external thermal source by one of the following methods:

(1) Reserve ambient heat transfer vaporizers sized for at least one day’s average supply and piped so that the flow of the CMG is unaffected by flow stoppage through the external thermal source vaporizer

(2) A noncryogenic source capable of providing at least one day’s average supply

17.7.5

Where vaporizers are used in the reserve system, they shall be as follows:

(1) Sized by the supplier to provide a source of vaporized CMG from the reserve bulk liquid storage vessel during times when the reserve system is operational

(2) Able to provide a flow rate equal to at least that of the main system vaporizer(s); however, the duration of flow might be different

(3) Indirectly heated by ambient air

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17.7.6

Low-temperature protection systems that interrupt or reduce flow shall not be used on the reserve system of cryogenic fluid central supply systems.

17.8 High-Pressure Manifolds.

17.8.1

Manifold assemblies shall be fit for service and shall have supports that are independent of the cylinders.

17.8.2

Cylinders on the manifold shall be secured against falling.

17.8.3*

Cylinders on the manifold shall have the same service pressure rating or the filled pressure of each cylinder shall not exceed the service pressure rating of the lowest rated cylinder on the manifold.

17.9 Pressure Control Devices.

The final pressure control device assembly or assemblies shall not be fabricated on-site.

17.10 Pressure Relief Devices.

17.10.1

Pressure relief devices (PRDs) shall meet the following requirements:

(1) PRDs shall have a relief pressure setting not higher than the maximum allowable working pressure (MAWP) of the component with the lowest working pressure rating in the portion of the system being protected.

(2) PRDs shall be of brass or bronze construction.

(3) PRDs shall be designed for the specific gas service.

(4) PRDs shall have the discharge protected to prevent the entry of rain or snow.

(5) PRDs shall be designed in accordance with ASME B31.3, *Pressure Process Piping*.

17.10.2

PRDs shall have an identifier that contains the date of manufacture or test.

17.10.3

The final line pressure relief valves shall be approved by a nationally recognized organization and shall have a relief capacity greater than or equal to the maximum throughput of the final line regulator.

17.10.3.1

The pressure relief valve shall be set at 50 percent above the normal working pressure, but no higher than the MAWP, of the health care facility pipeline.

17.10.3.2

The relief valve information shall be permanently identified either on the nameplate of the relief valve or on a permanently attached metal tag.

17.11 Tubing and Valves.

17.11.1

New, hard-drawn Type K or L copper tube shall be used for all process piping.

17.11.1.1

Tubing shall comply with ASTM B819, *Standard Specification for Seamless Copper Tube for Medical Gas Systems*.

17.11.1.2

Tubing shall be capped and bear the marking OXY or MEDICAL or be otherwise packaged and labeled to indicate it is clean for oxygen service according to the supplier’s policy.

17.11.2 Copper Tubing.

17.11.2.1

Instrumentation tubing shall be constructed of annealed copper tubing or seamless stainless steel tubing.

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17.11.2.2

Copper tubing shall comply with ASTM B88, *Standard Specification for Seamless Copper Water Tube*.

17.11.3

Valves of quick-open or quarter-turn designs, such as ball or plug valves, shall not be permitted in the portion of an oxygen piping system operating above 435 psi.

17.11.4 Alternate Materials.

17.11.4.1*

Alternate materials of construction for piping, tubing, valves, and instruments shall be permitted for installation at the request of the health care facility or the supplier.

17.11.4.2

Technical documentation of alternate materials shall be submitted to the health care facility QA representative to demonstrate equivalency.

17.12* Alarms.

The cryogenic fluid central supply system shall have a local signal that visibly indicates the operating status of the equipment and an indicator at all master alarms under the following conditions:

(1) When, or at a predetermined set point before, the main supply reaches an average day's supply, indicating low contents

(2) When, or at a predetermined set point before, the reserve supply begins to supply the system, indicating reserve is in use

(3) When, or at a predetermined set point before, the reserve supply contents fall to one day's average supply, indicating low reserve

(4) 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

(5) Where there is more than one main supply vessel, when, or at a predetermined set point before, the secondary vessel begins to supply the system, indicating changeover

Statement of Problem and Substantiation for Public Input

CGA SA-37 provided methods to deal with increased demand for medical oxygen during the COVID-19 crisis. Some of the recommendations in AS-37 should be considered for addition to NFPA 55 chapter 17 (and later extracted into NFPA 99) so that health care facilities can deal with future increases in demand for medical gases.

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Attachment F - NFPA 55 Public Inputs

Public Input No. 51-NFPA 55-2020 [New Section after 17.2.1]

Update title of 17.2.1 to add an asterisk (17.2.1*) to tag it to a new annex note A.17.2.1.

Create a new annex note:

"A.17.2.1 CGA M-1.1, Guidance for Compressed Medical Gas Cryogenic Fluid Ventral Supply System Training, provides recommendations for establishing and administering a program to train personnel to meet the requirements of CGA M-1."

Statement of Problem and Substantiation for Public Input

CGA M-1.1 provides more details for training personnel and can serve as a model training program.

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Attachment F - NFPA 55 Public Inputs

Public Input No. 55-NFPA 55-2020 [New Section after 17.2.2]

17.2.2 (move current 17.2.2 down)

Initial inspection and testing of the cryogenic fluid central supply system shall be conducted by a party technically competent and experienced in the field of cryogenic fluid systems and meeting the requirements of ASSE 6035, *Professional Qualifications Standard for Bulk Medical Gas Systems Verifiers* , in accordance with the NFPA 99, *Health Care Facilities Code* and the mandatory requirements of CGA M-1, *Standard for Medical Gas Supply Systems at Health Care Facilities* .

Statement of Problem and Substantiation for Public Input

This is to align NFPA 55 with NFPA 99 with regard to testing the cryogenic central supply systems at health care facilities.

Submitter Information Verification

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Attachment F - NFPA 55 Public Inputs

Public Input No. 52-NFPA 55-2020 [Section No. 17.2.3]

17.2.3

Cryogenic fluid central supply systems shall be ~~anchored with foundations in~~ installed in accordance with ANSI/CGA M-1, *Standard for Medical Gas Supply Systems at Health Care Facilities*.

Statement of Problem and Substantiation for Public Input

The existing wording requires only that the system foundation must comply with CGA M-1. CGA M-1 applies to all parts of the system and so should be a requirement for the entire system.

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Attachment F - NFPA 55 Public Inputs

Public Input No. 31-NFPA 55-2020 [New Section after 17.2.4]

TITLE OF NEW CONTENT

Vaporizers shall have a minimum work space clearance of 6 ft. (2m) to allow for maintenance and operation.

Additional Proposed Changes

File Name	Description	Approved
Deicing_Procedure.PDF	Cryoquip defrosting procedure for vaporizers	

Statement of Problem and Substantiation for Public Input

During the recent pandemic, excessive ice build up of the vaporizer due to high use was a concern. Many vaporization systems at health care facilities needed to be defrosted because of the ice build up. The attached document is the defrost procedure from one of the major vaporizer manufactures. Their procedure calls for a minimum of 6 ft (2 m) to allow for defrosting.

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Attachment F - NFPA 55 Public Inputs

Public Input No. 32-NFPA 55-2020 [New Section after 17.7.1]

TITLE OF NEW CONTENT

Vaporizers shall be sized using the calculated expected load for the health care facility that was used to size the main supply line. For non-switching vaporizer system design, the duration of service shall be considered continuous. For switching vaporizer system design the duration of service shall be based on the switching cycle.

Additional Proposed Changes

File Name	Description	Approved
AARC_guidance-document-additional-ventilators-may-pose-a-risk-to-hospital-gas-systems.pdf	AARC Guidance Document	

Statement of Problem and Substantiation for Public Input

Due to the high demands for oxygen during the Covid-19 pandemic many health care facilities experienced problems related to the vaporization systems of their bulk oxygen systems. There is currently no requirements in NFPA 55 for the sizing of vaporization systems at health care facilities. The current practice is to base the design on a previously installed system or a guess on how much oxygen will be used at a new facility. With out guidance from the code you can have inconsistent flow requirements provided to the bulk system designers. While this practice has somewhat worked in the past because poor design wasn't evident, the unexpected loads that were placed on the health care facilities oxygen systems during this pandemic brought a serious problem to light across the country.

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Attachment F - NFPA 55 Public Inputs

Public Input No. 87-NFPA 55-2020 [Section No. A.1.1.2(11)]

A.1.1.2(11)

NFPA 55 ~~is~~ was initially used as one of the many source document for the ~~fundamental~~ requirements for compressed hydrogen gas (GH_2), or liquefied hydrogen gas (LH_2) system installations ~~. Correlation between NFPA 55 and NFPA 2 is the responsibility of the two technical committees involved. The installation requirements~~ in NFPA 2. NFPA 2 has completed consolidation of all requirements for bulk GH_2 or LH_2 ~~are viewed as fundamental provisions. On the other hand,~~ and the use-specific requirements for ~~designated~~ hydrogen applications such as vehicular fueling ~~are not resident in NFPA 55 and are under the purview of the NFPA 2 Technical Committee. Where there are specific provisions or controls included in NFPA 55, the specific controls of NFPA 55 will govern except that modifications made to provisions that have been extracted can be followed when the modifications have been made within NFPA's extract procedure as indicated in the~~ ~~*Manual of Style for NFPA Technical Committee Documents*~~ , fuel cells, hydrogen generators, special atmospheres, repair garages, etc. in accordance with the HYG committee scope. NFPA 2 is now the primary document regarding hydrogen in accordance with scopes of the HYG and IMG committees .

Statement of Problem and Substantiation for Public Input

The text of A.1.1.2(11) was out of date and not consistent with HYG and IMG committee scopes.

Note: Per the committee scope statements the HYD Committee has "primary responsibility for documents on the storage, transfer, production, and use hydrogen" and the IMG "Committee shall coordinate the material on gaseous and liquid hydrogen storage and use with the Hydrogen Technology Committee."

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 70-NFPA 55-2020 [Section No. 1.1.2]	Annex A text for 1.1.2.

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Attachment F - NFPA 55 Public Inputs

Public Input No. 88-NFPA 55-2020 [Section No. A.1.4.1]

A.1.4.1

It is generally not necessary to modify systems to meet code requirements that were not in effect at the time of installation as long as the system met the then-current standard and remains in its original location and condition. When the system is upgraded or moved to a new location, the current code requirements generally take effect. Normal maintenance and replacement of parts are not considered an upgrade to the system.

Typically, the code changes are in the nature of exposure distances. Where a system is closer to an exposure than the current code allows, but the system met the code in effect at the time of installation, the system is generally allowed to stay in place if no upgrades are made to the system. Once upgrades are made or the system is relocated, the current separation distances are applicable. When newer exposures are added, they must meet the current code separation distances and not the distances that were in effect at the time of installation.

An upgrade is considered as one of the following:

(1) An equipment change that would materially affect the original exposure distances

(2) Installation of new hazards and exposures adjacent to the existing installation

Changing of regulators, controls, or piping systems normally would not be considered an upgrade. The replacement of a bulk vessel with one of the same nominal size is not considered an upgrade.

~~For example, liquid hydrogen systems installed per the 2010 and later editions of NFPA 55 must have a minimum horizontal separation distance of 15 ft (4.6 m) from overhead piping containing hazardous materials. Previous editions of NFPA 55 mandated only that the hazardous material piping not be over the liquid hydrogen system. A system that was installed in 2005 and has a horizontal separation of 10 ft (3.0 m) from overhead hazardous materials piping met the 2005 edition of NFPA 55 and generally does not need changing. However, the existing hazardous materials piping is not allowed to be moved closer to the hydrogen system because that action is a change to the system. Similarly, if a new hazardous materials pipeline is installed, it must meet the current 15 ft (4.6 m) minimum separation distance because it is a change to the system.~~

Statement of Problem and Substantiation for Public Input

The example is for a hydrogen system that is the scope of NFPA 2 and should be deleted or replaced with an example more appropriate for an NFPA 55 application.

Note: Per the committee scope statements the HYD Committee has "primary responsibility for documents on the storage, transfer, production, and use hydrogen" and the IMG "Committee shall coordinate the material on gaseous and liquid hydrogen storage and use with the Hydrogen Technology Committee."

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Attachment F - NFPA 55 Public Inputs

Public Input No. 89-NFPA 55-2020 [Section No. A.3.3.48]

A.3.3.48 Flammable Liquid (Class I).

Materials that boil at a temperature of less than 68°F (20°C) are compressed gases. Users are cautioned that the use of the definitions found in NFPA 30 can result in the misclassification of certain liquefied compressed gases as flammable liquids (Class IA). Liquefied hydrogen is classed as a flammable compressed gas by the U.S. Department of Transportation ~~. It is regulated as a cryogenic fluid within this code~~ and is addressed in NFPA 2 .

Statement of Problem and Substantiation for Public Input

The storage, use, handling, and many other aspects of hydrogen are addressed by NFPA 2. The simplest, least error prone way for NFPA 55 to coordinate with NFPA 2 regarding hydrogen gas is to just refer the user to NFPA 2.

Note: Per the committee scope statements the HYD Committee has "primary responsibility for documents on the storage, transfer, production, and use hydrogen" and the IMG "Committee shall coordinate the material on gaseous and liquid hydrogen storage and use with the Hydrogen Technology Committee."

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Attachment F - NFPA 55 Public Inputs

Public Input No. 117-NFPA 55-2020 [Section No. A.3.3.90]

A.3.3.90 Source Valve.

The source valve is located at a point downstream of a bulk gas supply system and used as the defined point of termination of the bulk supply. It is a point that differentiates between the ~~“supplier” side of the~~ bulk storage system and ~~what is commonly referred to as the “user” or “customer”~~ the use side of the system.

Statement of Problem and Substantiation for Public Input

The terms "supplier" and "user" or "customer" are not relevant in fire safety. These terms may be relevant in certain business models for gas suppliers, but not all. They are contractual in nature and conflict with the scope of a fire code which is to assure reasonable fire safety on both sides of the source valve, regardless of business models, liability demarcation points or typical operational protocols. The term "source valve" is used throughout NFPA 55 as the end point for a bulk storage system. this change is consistent with that usage.

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Attachment F - NFPA 55 Public Inputs

Public Input No. 106-NFPA 55-2020 [Section No. A.3.3.95.9]

~~**A.3.3.95.9** Gaseous Hydrogen System.~~

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

Statement of Problem and Substantiation for Public Input

The storage, use, handling, and many other aspects of hydrogen are addressed by NFPA 2. The simplest, least error prone way for NFPA 55 to coordinate with NFPA 2 regarding hydrogen gas is to just refer the user to NFPA 2. This is best accomplished in in 7.6.1.2 and 8.1.4. This nullifies the need for Chapter 10 and thus for these definitions and the associated Annex A text.

Note: Per the committee scope statements the HYD Committee has "primary responsibility for documents on the storage, transfer, production, and use hydrogen" and the IMG "Committee shall coordinate the material on gaseous and liquid hydrogen storage and use with the Hydrogen Technology Committee."

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 103-NFPA 55-2020 [Section No. 3.3.95.9]	This is Annex A text for 3.3.95.9.

Submitter Information Verification

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Committee: IMG-AAA

Attachment F - NFPA 55 Public Inputs

Public Input No. 107-NFPA 55-2020 [Section No. A.3.3.95.9.1]

Attachment F - NFPA 55 Public Inputs

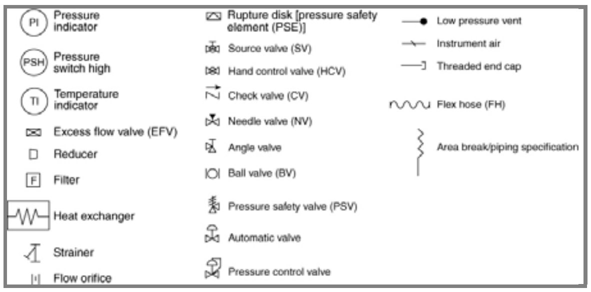
~~**A.3.3.95.9.1** Bulk Hydrogen Compressed Gas System.~~

Attachment F - NFPA 55 Public Inputs

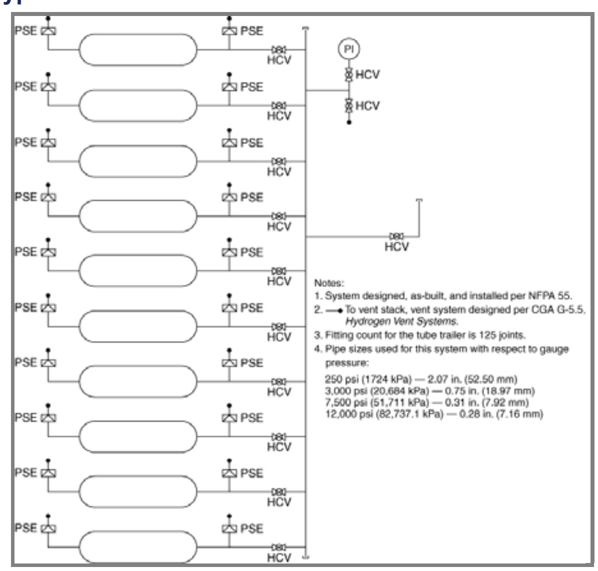
~~The bulk system terminates at the source valve, which is the point where the gas supply, at service pressure, first enters the supply line, or at a piece of equipment that utilizes the hydrogen gas, such as a hydrogen dispenser. The containers are either stationary or movable, and the source gas for the system is stored as a compressed gas.~~

~~Bulk hydrogen compressed gas systems can include a bulk storage source, transfer piping and manifold system, compression system, and other components. The gaseous source can include a tube trailer, tube bank, or other high pressure storage vessels used to serve the piping system that transports hydrogen to the end user. Compressors can be installed downstream of the storage supply to boost the pressure of the source gas, and intermediate high pressure storage might be present. This is done where the end use requires hydrogen at a pressure higher than that of the bulk supply. In these instances, there may be intermediate storage vessels used to store the gas at elevated pressures. It is not uncommon for the bulk supply as delivered to be furnished at nominal gauge pressure of 3000 psi (20,684 kPa), and the intermediate high pressure storage to be stored at gauge pressures up to 15,000 psi (103,421 kPa). See Figure A.3.3.95.9.1(a) through Figure A.3.3.95.9.1(f) .~~

~~Figure A.3.3.95.9.1(a) Symbol Legend for Figure A.3.3.94.9.1(b) through Figure A.3.3.94.9.1(f).~~

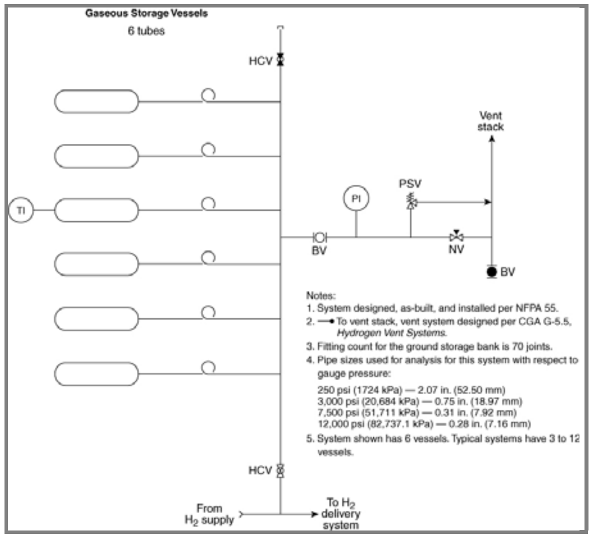


~~Figure A.3.3.95.9.1(b) Typical Tube Trailer.~~

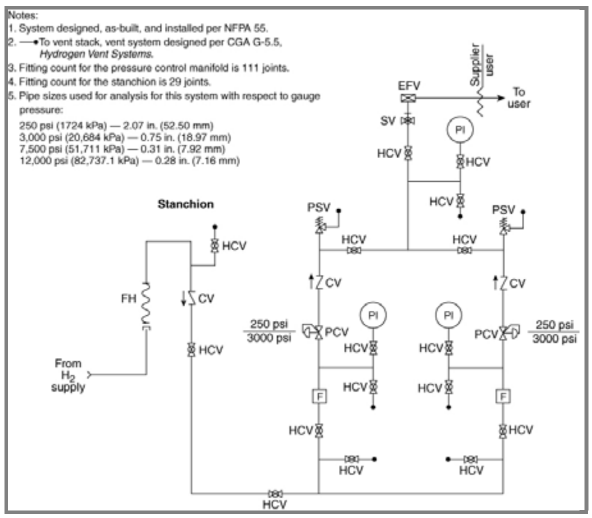


~~Figure A.3.3.95.9.1(c) Typical Bulk Compressed Gaseous Storage System.~~

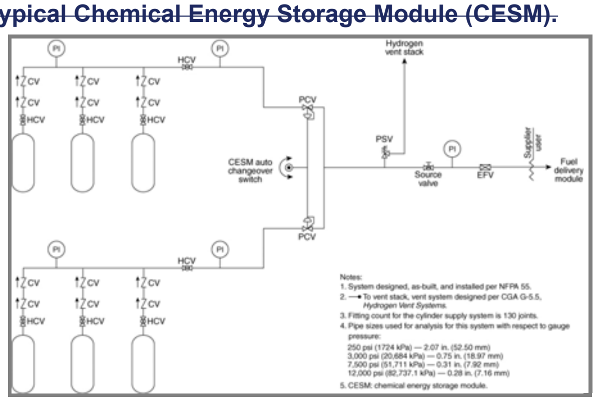
Attachment F - NFPA 55 Public Inputs



~~Figure A.3.3.95.9.1(d) Typical Tube Trailer Discharge Stanchion and Pressure Control Manifold.~~

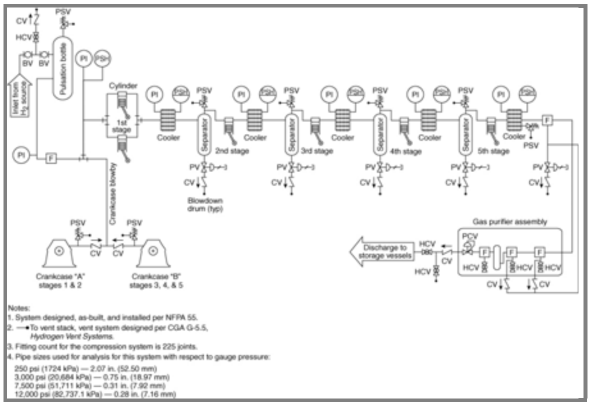


~~Figure A.3.3.95.9.1(e) Typical Chemical Energy Storage Module (CESM).~~



~~Figure A.3.3.95.9.1(f) Typical Compressor Module.~~

Attachment F - NFPA 55 Public Inputs



Statement of Problem and Substantiation for Public Input

The storage, use, handling, and many other aspects of hydrogen are addressed by NFPA 2. The simplest, least error prone way for NFPA 55 to coordinate with NFPA 2 regarding hydrogen gas is to just refer the user to NFPA 2. This is best accomplished in in 7.6.1.2 and 8.1.4. This nullifies the need for Chapter 10 and thus for these definitions and the associated Annex A text.

Note: Per the committee scope statements the HYD Committee has "primary responsibility for documents on the storage, transfer, production, and use hydrogen" and the IMG "Committee shall coordinate the material on gaseous and liquid hydrogen storage and use with the Hydrogen Technology Committee."

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 103-NFPA 55-2020 [Section No. 3.3.95.9]	This is Annex A text for 3.3.95.9.

Submitter Information Verification

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Attachment F - NFPA 55 Public Inputs

Public Input No. 108-NFPA 55-2020 [Section No. A.3.3.95.10.1]

~~**A.3.3.95.10.1** Bulk Liquefied Hydrogen 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 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. For systems that are composed of combined gaseous and liquefied hydrogen storage systems and have separate source valves for both systems, the system can be viewed as having two source valves for determining minimum separation distances for bulk storage systems in accordance with 10.4.2.2 and 11.3.2.2 . Identifying two source valves means that each portion of the system is subject to its respective minimum separation distances in accordance with 10.4.2.2 or 11.3.2.2 .~~

Statement of Problem and Substantiation for Public Input

The storage, use, handling, and many other aspects of hydrogen are addressed by NFPA 2. The simplest, least error prone way for NFPA 55 to coordinate with NFPA 2 regarding hydrogen gas is to just refer the user to NFPA 2. This is best accomplished in in 7.6.1.2 and 8.1.4. This nullifies the need for Chapter 11 and thus for these definitions and the associated Annex A text.

Note: Per the committee scope statements the HYD Committee has "primary responsibility for documents on the storage, transfer, production, and use hydrogen" and the IMG "Committee shall coordinate the material on gaseous and liquid hydrogen storage and use with the Hydrogen Technology Committee."

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 104-NFPA 55-2020 [Section No. 3.3.95.10]	This is Annex A text for 3.3.95.10.

Submitter Information Verification

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Attachment F - NFPA 55 Public Inputs

Public Input No. 9-NFPA 55-2020 [New Section after A.5.1.1]

A6.3.1.1 Maximum Allowable Quatitity

Table 6.3.1.1 allows for a 100 percent increase in the MAQ for quantities stored in approved cabinets or other specified control, a combination of storage both inside and outside approved cabinets in the control area is permitted. Storage amounts up to the MAQ are allowed outside of cabinets where the 100 percent increase is applied. Footnotes (d) and (e) allows quantities to be increased by an additional 100 percent where sprinklers are installed throughout the building.

Example: The following table shows the MAQ for oxidizing gas with various control scenarios.

Controls	Max allowed outside cabinets (scf)	Max total allowable (scf)
No Cabinets, No Sprinklers	1500	1500
No Cabinets, Fully Sprinklered	3000	3000
Cabinets, No Sprinklers	1500	3000
Cabinets, Fully Sprinklered	3000	6000

Statement of Problem and Substantiation for Public Input

Statement of Problem and Substantiation for Public Input

The doubling allowance associated with cabinet storage has been interpreted several different ways over the years and this annex material will provide guidance to facilitate consistent interpretation. This interpretation lines up directly with annex material found in NFPA 400.

NFPA 400 -2019

Table 5.2.1.1.3 Maximum Allowable Quantities (MAQ) of Hazardous Materials per Control Area includes quantities extracted from NFPA 55 for gases

A.5.2.1.5.3 The MAQ is an amount of material generally felt to represent a reasonable risk, or an amount that does not represent a significant risk when a specific control has been applied.

Where Table 5.2.1.1.3 allows for a 100 percent increase in the MAQ for quantities stored in approved cabinets or another specified control, a combination of storage both inside and outside approved cabinets in the control area is permitted. Storage amounts up to the MAQ are allowed outside of cabinets where the 100 percent increase is applied.

Example: The MAQ for storage of a Class 2 oxidizer is 250 lb (113 kg). The MAQ is allowed to be increased 100 percent to 500 lb (226 kg) per control area where stored in approved cabinets. Because the MAQ allows for 250 lb (113 kg) of Class 2 oxidizers outside of cabinets, only 250 lb (113 kg) of the 500 lb (226 kg) is required to be confined to cabinets.

Similarly, where Table 5.2.1.1.3 allows for a 100 percent increase for both cabinets and building sprinklers, storage outside of cabinets is permitted in the control area up to the MAQ for sprinklered buildings even after the cabinet increase is applied.

Example: The MAQ for storage of a Class 2 oxidizer is 250 lb (113 kg). The MAQ is allowed to be increased 100 percent to 500 lb (226 kg) in buildings equipped throughout with an approved sprinkler system. The MAQ is also allowed to be increased 100 percent where stored in approved storage cabinets. Because both increases are allowed and the sprinklered building increase allows for storage of 500 lb (226 kg) outside of cabinets, only 500 lb (226 kg) of the 1000 lb (454 kg) aggregate storage amount allowed is required to be confined to cabinets.

This input has been developed in collaboration with Rob Early, Tony Lachawiec, Richard Palluzi, Eugene Nga, and Jef Frick.

Submitter Information Verification

Attachment F - NFPA 55 Public Inputs

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Committee:	IMG-AAA

Attachment F - NFPA 55 Public Inputs

Public Input No. 90-NFPA 55-2020 [Section No. A.6.6]

~~A.6.6~~

~~Bulk hydrogen compressed gas systems terminate at the source valve. In cylinder filling or packaging operations, cylinders located on filling manifolds located downstream of the source valve are not considered to be part of the bulk gas system. For definitions of source valve and bulk hydrogen compressed gas system, see 3.3.90 and 3.3.95.9.1 . Additional requirements for source valves can be found in Section 6.20 . The 15,000 scf (425 Nm ^{3}) threshold only applies to the supply and not to cylinders being filled from the system. An example of an individual bulk hydrogen system would be supply containers manifolded together into an individual system, such as a bundle or a tube trailer that exceeds 15,000 scf and which is intended to feed a process.~~

Statement of Problem and Substantiation for Public Input

The storage, use, handling, and many other aspects of hydrogen are addressed by NFPA 2. The simplest, least error prone way for NFPA 55 to coordinate with NFPA 2 regarding hydrogen gas is to just refer the user to NFPA 2.

Note: Per the committee scope statements the HYD Committee has "primary responsibility for documents on the storage, transfer, production, and use hydrogen" and the IMG "Committee shall coordinate the material on gaseous and liquid hydrogen storage and use with the Hydrogen Technology Committee."

Also, some aspects of this Annex A text does not make sense. If cylinders are being filled with hydrogen, the cylinders and associated piping system need to meet safety requirements as well. It is irresponsible to imply that they do not.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 76-NFPA 55-2020 [Section No. 6.6]	This Annex A text is for 6.6.

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Attachment F - NFPA 55 Public Inputs

Public Input No. 91-NFPA 55-2020 [Section No. A.6.17.4.3]

A.6.17.4.3

Examples of gases that are lighter than air include, but are not limited to, hydrogen, helium, and methane.

Hydrogen has many unique properties in addition to being lighter than air; see NFPA 2 for more information and requirements regarding hydrogen.

Statement of Problem and Substantiation for Public Input

Hydrogen has many unique properties and requirements and the user should be directed to NFPA 2 for more information.

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Attachment F - NFPA 55 Public Inputs

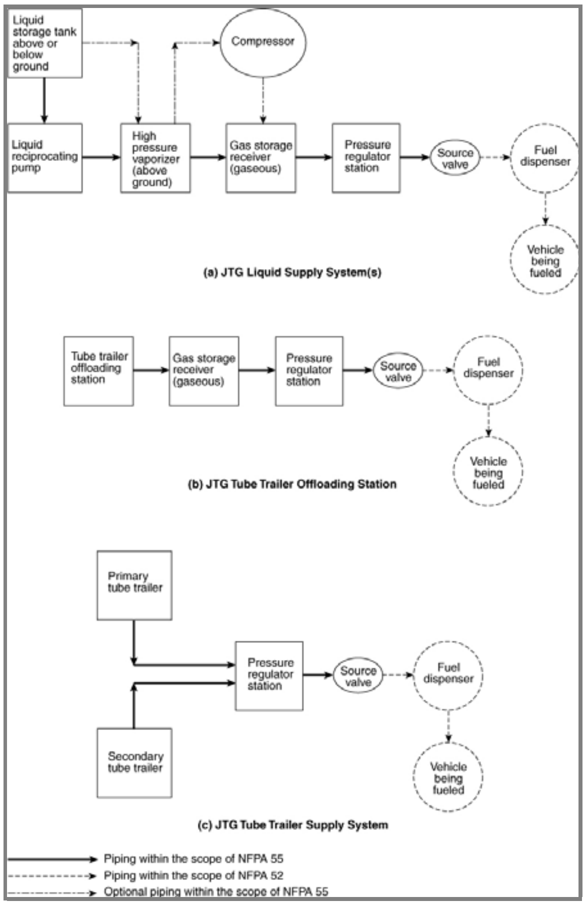
Public Input No. 105-NFPA 55-2020 [Section No. A.6.20]

A.6.20

Figure A.6.20 shows three possible locations of the source valve.

Figure A.6.20 Three Examples of Source Valve Locations.

Change "Piping within scope of NFPA52" to "Piping within scope of NFPA 2 and NFPA 52"



Statement of Problem and Substantiation for Public Input

The drawing should be updated to include NFPA2 because it also applies to hydrogen stations.

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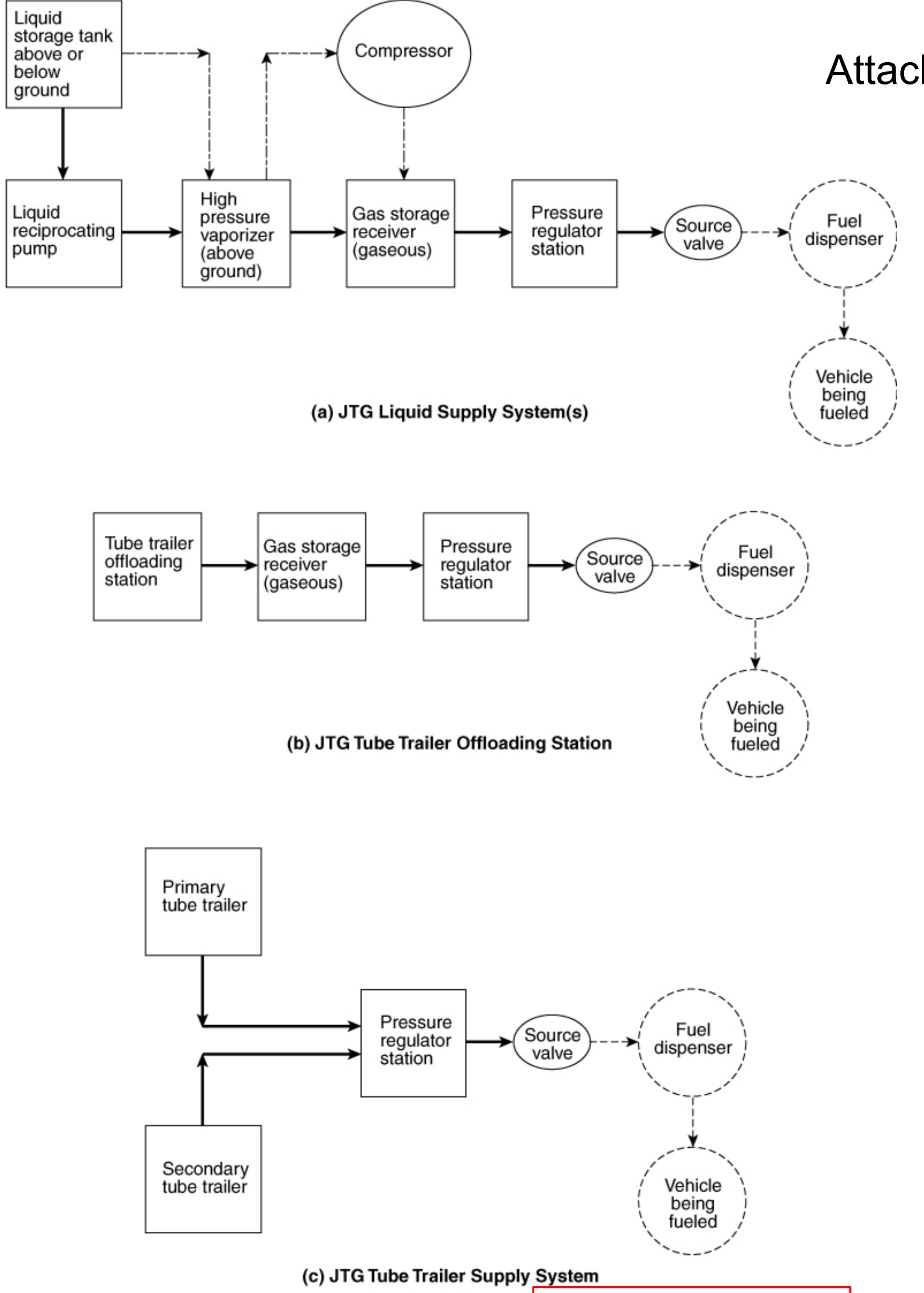
Attachment F - PI105 (Figure A.6.20)



Piping within the scope of NFPA 55

~~Piping within the scope of NFPA 52~~

Optional piping within the scope of NFPA 55

Production: Change language to "Piping within scope of NFPA 2 and NFPA 52"

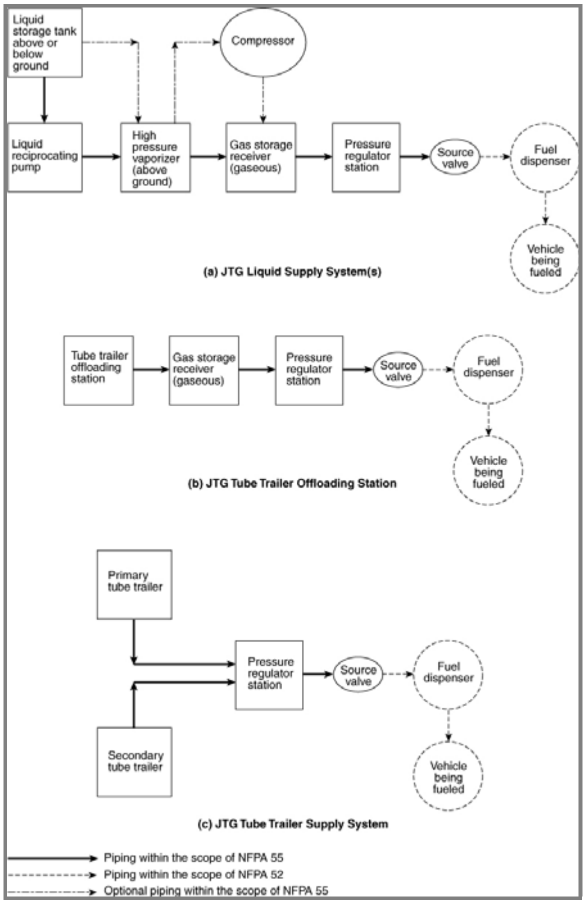
Attachment F - NFPA 55 Public Inputs

Public Input No. 54-NFPA 55-2020 [Section No. A.6.20]

A.6.20

Figure A.6.20 shows three possible locations of the source valve.

Figure A.6.20 Three Examples of Source Valve Locations.



Update figure A.6.20:

(1) remove "JTG" from title in (a), (b), and (c)

(2) change "Piping within the scope of NFPA 52" to "Piping within the scope of NFPA 2" in piping key

Statement of Problem and Substantiation for Public Input

(1) "JTG" is not defined in the code and is probably an acronym used by the CGA company who provided these figures a few cycles ago.

(2) NFPA 52 no longer covers hydrogen applications and use piping. That scope is now assigned to NFPA 2.

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Attachment F - NFPA 55 Public Inputs

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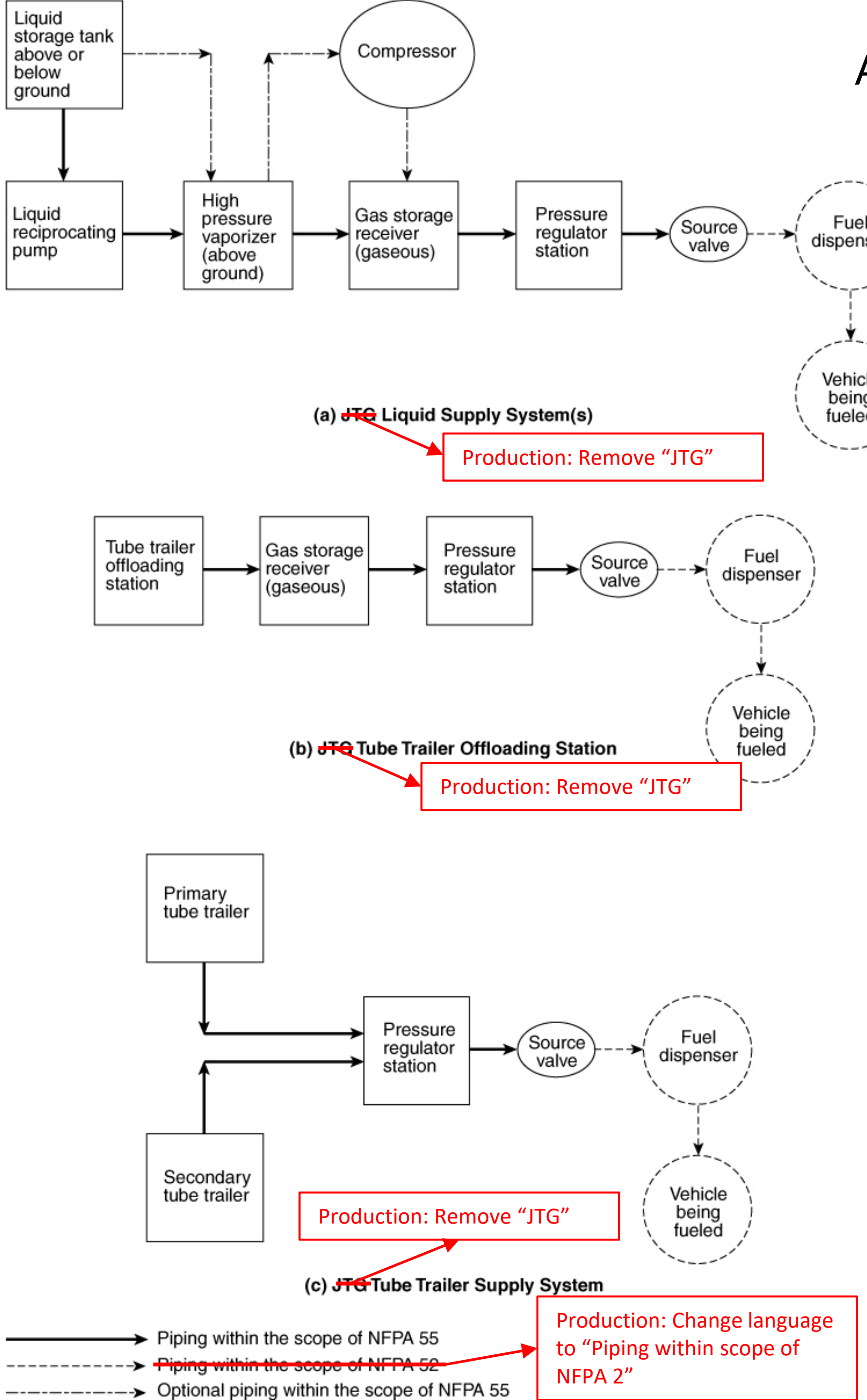
Attachment F - PI54 (Figure A.6.20)



Attachment F - NFPA 55 Public Inputs

Public Input No. 17-NFPA 55-2020 [New Section after A.7.1.10.2]

Separation of Compatible Gases (Annex Material)

The NFPA Fire Protection Guide to Hazardous Materials may be used for guidance on compatibility. Additionally, the Safety Data Sheets and other sources such as the Hazardous Materials Expert Assistant (HMEX) provide information about the compatibility of chemicals.

Statement of Problem and Substantiation for Public Input

This change is associated with Public Input 16, see related input for an explanation of the change.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 16-NFPA 55-2020 [New Section after 7.1.10.2.2]	Code change and related annex material

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Attachment F - NFPA 55 Public Inputs

Public Input No. 92-NFPA 55-2020 [Section No. A.8.12.2.6.4.1]

A.8.12.2.6.4.1

The intent of these provisions is to make certain that the cryogenic installation is not exposed to the potential of a pool fire from the release of flammable or combustible liquids. ~~Cryogenic fluids are not diked in order that they are allowed to dissipate should leakage occur. Studies conducted by NASA (NSS 1740.16, *Safety Standard for Hydrogen and Hydrogen Systems* , 1997) show that the use of dikes around liquid hydrogen storage facilities serves to prolong ground-level flammable cloud travel and that the dispersion mechanism is enhanced by vaporization-induced turbulence. The travel of spilled or leaked cryogenic fluid to distances greater than a few feet (meters) from the source given the nature of the typical leak is considered to be implausible due to the character of cryogenic fluids and their ability to quickly absorb heat from the surrounding environment.~~

Statement of Problem and Substantiation for Public Input

This Annex A text is very confusing.
The subject of 8.12.2.6 is drainage (for cryogenic storage).
And, 8.12.2.6.4 gives the requirement for the length of the grade (of the drainage): 50 ft
And, 8.12.2.6.4.1 requires the use of diversion curbs, etc.to direct flammable or combustible liquids away from the cryogenic storage and for at least 50 ft.
But, the Annex A text says don't use dikes (same thing as a curb?) and that fluids won't travel more than a few feet.
The Annex A texts appears to be saying that there is no way to meet the requirement.

Also, liquid hydrogen is both a cryogenic and flammable liquid.
It can't be kept separate from itself so, what is the requirement?

Recommend simplifying the Annex A text to only the part that helps explain the intent and delete the rest; especially the part about liquid hydrogen.

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Attachment F - NFPA 55 Public Inputs

Public Input No. 93-NFPA 55-2020 [Section No. A.8.12.2.7.2]

A.8.12.2.7.2

The placement of stationary containers is limited with respect to exposure hazards. Table 8.6.2 establishes the minimum separation distance between a building and any stationary tank at 1 ft (0.3 m). Additional limitations are placed on wall openings, air intakes, and other exposures. The material-specific tables ~~for liquid hydrogen and liquid oxygen specify increased~~ for liquid oxygen and flammable cyrogenic liquids specify increased distances according to the type of construction adjacent to the tank. A problem arises when courtyards are configured so as to interrupt the free movement of air around a tank where an asphyxiation hazard, a flammable hazard, or an oxygen-enriched environment can be created.

Placement of stationary containers proximate to the wall of the building served is allowable, provided the minimum separation distances for exposure hazards are met. When additional walls encroach on the installation to form a court, the focus of concern shifts away from the exposure hazards associated with the building itself to the hazards associated with personnel due to hazardous atmospheres that can be created due to the lack of free air movement and ventilation.

By specifying the minimum distance between the tank and the encroaching walls that form the court, the circulation of adequate air is ensured. Placing the tank at not less than the height of two of the three encroaching walls results in creating an opening such that the angular dimension between the top of two of the three encroaching walls and the point over which the tank is placed is not greater than 45 degrees, thereby allowing the circulation of air through the space in which the tank is installed.

Statement of Problem and Substantiation for Public Input

These limitations should apply to any flammable cryogenic fluid not just hydrogen.

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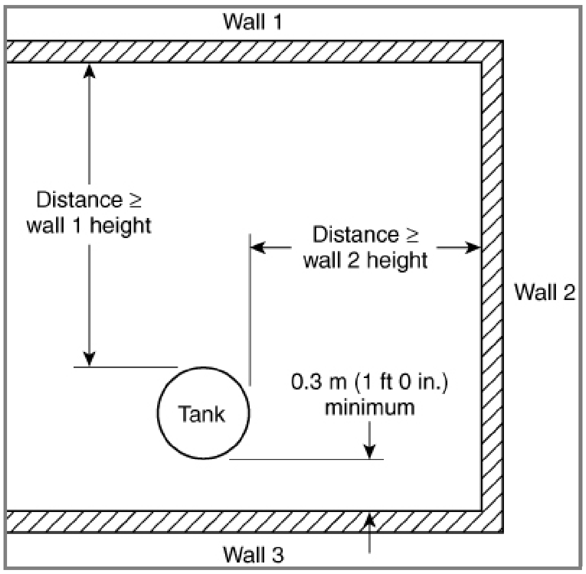
Attachment F - NFPA 55 Public Inputs

Public Input No. 94-NFPA 55-2020 [Section No. A.8.12.2.7.2.1]

A.8.12.2.7.2.1

The separation distances shown in Figure A.8.12.2.7.2.1 are required to provide for ventilation in the space in order to avoid creating a confined space. Chapter 8 is a generic chapter used to establish minimum requirements for all cryogens. Material-specific requirements for oxygen, ~~hydrogen~~ flammable , or other gases might require greater separation distances based on the type of construction or the related exposure. For example, wall number 3 shown in Figure A.8.12.2.7.2.1 could be an exterior building wall, and the gas could be ~~hydrogen~~ LNG . Refer to Table 8.6.2, Table 9.3.2, ~~Table 11.3.2.2 , Table~~ able 13.10.1, and Table 16.2 for specific details regarding building walls, wall openings, air intakes, and similar conditions.

Figure A.8.12.2.7.2.1 Bulk Cryogenic System Located in a Courtyard.



Statement of Problem and Substantiation for Public Input

There are other flammable cryogens besides hydrogen; statement should be expanded to include them all and a different example should be used.

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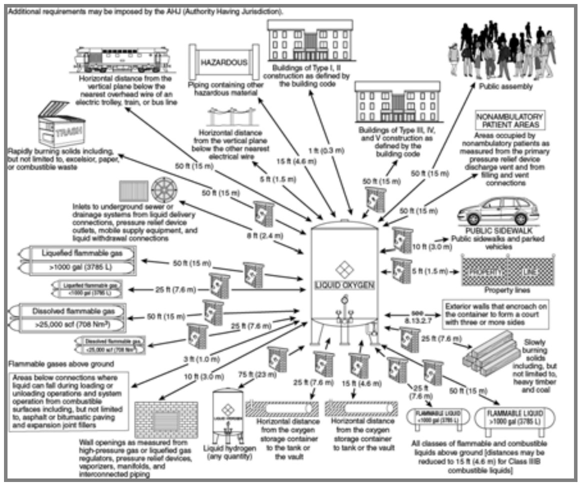
Attachment F - NFPA 55 Public Inputs

Public Input No. 110-NFPA 55-2020 [Section No. A.9.3.2]

A.9.3.2

Figure A.9.3.2 serves to illustrate the separation distances between bulk oxygen systems and exposures.

Figure A.9.3.2 Distances Between Bulk Oxygen Systems and Exposures.



These distances do not apply where fire barriers having a minimum fire resistance rating of 2 hours interrupt the line of sight between uninsulated portions of the bulk oxygen storage installation and the exposure. The fire barriers protect uninsulated oxygen storage containers or supports, control equipment, and system piping (or parts thereof) from external fire exposure. Liquid oxygen storage containers are insulated. Such containers can provide line-of-sight protection for uninsulated system components. Interruption of the line of sight means that an "eye" on any part of the uninsulated portion of the bulk oxygen storage installation cannot "see" any part of the exposure.

Line 12 of Table 9.3.2 defines the exposure distances to flammable gas storage systems as a function of type and quantity of stored flammable gases. Line 18 defines the exposure distance to flammable gas in a piping system, which is not always associated with a storage system. An example is a flammable gas pipeline. The pipeline could be aboveground, below ground, or transition between above and below ground. The exposure distance applies to the parts of the flammable gas piping system, including the piping and inline components, that are located aboveground. The exposure distance does not apply to the underground portion of the pipeline.

Statement of Problem and Substantiation for Public Input

It doesn't matter what type of flammable gas is being stored; it all needs to be kept away from oxygen. (With oxygen everything is a fuel.) There is no justification for different types of flammable gases to be different distances from oxygen. Figure A.9.3.2 should be updated to reflect this.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 84-NFPA 55-2020 [Section No. 9.3.2 [Excluding any Sub-Sections]]	This Annex A text for 9.3.2.

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Attachment F - NFPA 55 Public Inputs

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Committee:	IMG-AAA

Attachment F - NFPA 55 Public Inputs

Public Input No. 95-NFPA 55-2020 [Sections A.10.1.3, A.10.2.2, A.10.2.8, A.10.2.9, A.10.4.2.2...]

~~**Sections A.10.1.3, A.10.2.2, A.10.2.8, A.10.2.9, A.10.4.2.2.1, A.10.4.2.2.1.2, A.10.4.2.2.2.1, A.10.4.2.2.3, A.10.4.2.2.4,**~~

~~**A.10.1.3**~~ —

~~ANSI/CGA H-5, *Standard for Bulk Hydrogen Supply Systems* , provides guidance on designing, installing, testing, starting up, and removing bulk hydrogen supply systems.~~

~~**A.10.2.2**~~ —

~~Any reference to listed or approved equipment in the noted sections of the IFGC is within the context of ASME B31.12, *Hydrogen Piping and Pipelines* , and describes a material or component that conforms to the specifications integral to ASME B31.12.~~

~~**A.10.2.8**~~ —

~~The compressed gas system equipment referenced is intended to include fuel cell applications, generation of hydrogen from portable or transportable hydrogen generation equipment, batteries, and similar devices and equipment that utilize hydrogen for the purpose of power generation. It does not include hydrogen production facilities intended to produce hydrogen used for distribution or repackaging operations operated by gas producers, distributors, and repackagers.~~

~~**A.10.2.9**~~ —

~~Numerous metal hydrides are currently being tested for gaseous hydrogen storage applications. While certain Class D extinguishing agents have been effective on some metal hydride materials, they have not been tested on the wide range of hydrides. It is crucial to understand any adverse chemical reactions between the hydride and the agent prior to using the fire suppressant. Additionally, it is important to understand that the application should be limited to small incipient stage fires. Larger fires would require the use of personal protective equipment in the application of the extinguishing agent.~~

Attachment F - NFPA 55 Public Inputs

~~A.10.4.2.2.1~~ —

Attachment F - NFPA 55 Public Inputs

~~The exposures integral to Table 10.4.2.2.1(a), Table 10.4.2.2.1(b), and Table 10.4.2.2.1(c) have been arranged into groups based on similar risks. The estimated leak area was changed from 3 percent to 1 percent of the pipe diameter to evaluate separation distances. The 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 1500 Btu/hr/ft^2 (4732 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 an 8 percent mole fraction (i.e., volume fraction) of hydrogen, whichever is greater. In all cases, the distance required to achieve an 8 percent mole fraction was the greater distance and was used to establish the requirements.~~

(2) ~~*Group 2 Exposures.* The distances specified are those required to reduce the radiant heat flux level to 1500 Btu/hr/ft^2 (4732 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 6340 Btu/hr/ft^2 (20,000 W/m^2) or the visible flame length for combustible materials, or a radiant heat flux level of 8000 Btu/hr/ft^2 (25,237 W/m^2) or the visible flame length for noncombustible equipment. In both cases, the visible flame length was used to establish the requirements.~~

~~A 50 percent safety factor was added to all resulting separation distance values.~~

~~*Table 10.4.2.2.1(a) Exposures Group 1 (a).* Lot lines (i.e., 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 can result in an encroachment that will necessitate relocation of the hydrogen system at the system user's expense.~~

~~Where the property on the other side of a property line is determined to be unbuildable or unoccupiable due to natural features, including, but not limited to, waterways, terrain, wetlands, or similar features encroachment by the hydrogen system on the property line can be acceptable with the approval of the authority having jurisdiction. Should the property that is encroached upon become buildable or otherwise occupiable, the hydrogen system location should be reevaluated by the system user and the AHJ notified of the results.~~

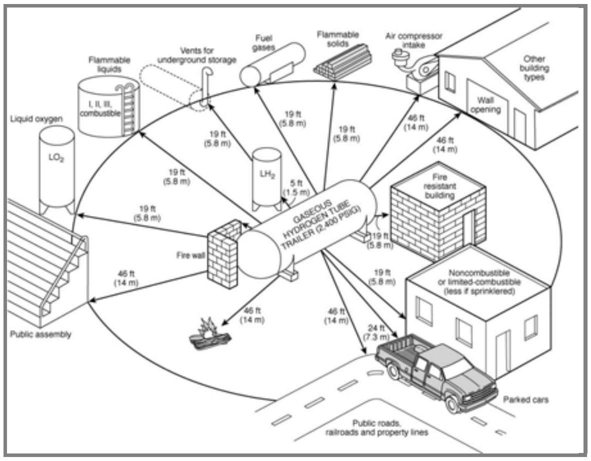
~~*Table 10.4.2.2.1(a) Exposure Group 2(a).* The exposed persons of concern are non-work-related persons or members of the public who are not involved with servicing the system, because these persons typically are neither trained nor knowledgeable in the operation of the system, but are on the premises. By comparison, service personnel or those involved with servicing the system are trained and engaged in activities related to the system operation including, but not limited to, inspecting, monitoring system inventory, delivering product, maintenance, or similar functions. Administrative controls, engineering controls, or construction features are typically used to restrict persons other than service personnel from being within the zone of potential exposure. The permit holder is responsible for managing and administering the controls to restrict access. Examples of such controls could include painted lines or signs or a physical barrier such as a fence.~~

~~See Figure A.10.4.2.2.1 for a graphical representation of separation distances from bulk hydrogen systems.~~

~~CGA PS-48, *Clarification of Existing Hydrogen Setback Distances and Development of New Hydrogen Setback Distances in NFPA 55*, provides guidance and clarification on types of exposures as well as applications of the separation distances.~~

~~**Figure A.10.4.2.2.1 Distances Between Bulk Hydrogen Systems and Exposures.**~~

Attachment F - NFPA 55 Public Inputs



~~A.10.4.2.2.1.2~~

~~The vent stack begins at the downstream side of a pressure relief device or vent valve.~~

~~A.10.4.2.2.2.1~~

~~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 5000 scf (141.6 Nm ^{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 psi (20,684 kPa) storage system that supplies a 6000 psi (41,369 kPa) compressor that directly feeds a process with less than 5000 scf (141.6 Nm ^{3}) of intervening storage at a pressure of 6000 psi (41,369 kPa) or less is considered a 3000 psi (20,684 kPa) system. Conversely, a system with the primary storage of 3000 psi (20,684 kPa) might supply a compressor that in turn delivers hydrogen to intermediate storage with a quantity of greater than 5000 scf (141.6 Nm ^{3}). 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 piping and instrumentation drawings (P&IDs) shown in Figure A.3.3.95.9.1(a) through Figure A.3.3.95.9.1(f) for additional information in this regard.~~

~~The use of Table 10.4.2.2.1(b) and Table 10.4.2.2.1(c) 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.~~

~~A.10.4.2.2.3~~

~~The methodology used to determine the distances listed in Table 10.4.2.2.1(b) and Table 10.4.2.2.1(c) has been evaluated for piping up to and including internal diameters of approximately 3 in. (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 .~~

~~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 5000 scf (141.6 Nm ^{3}) 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 5000 scf (141.6 Nm ^{3}) of intervening storage at a pressure of 6000 psig (41,369 kPa) or less is considered a 3000 psig (20,684 kPa) system.~~

Attachment F - NFPA 55 Public Inputs

~~**A.10.4.2.2.4**~~ —

~~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. Distances to assumed lot lines can be disregarded in the application of Table 10.4.2.2.1(a), Table 10.4.2.2.1(b), and Table 10.4.2.2.1(c). The lot lines described under item (a) of Group 1 Exposures in Table 10.4.2.2.1(a) 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.~~

~~**A.10.4.2.2.4.1**~~ —

~~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.~~

~~**A.10.4.2.2.4.1(6)**~~ —

~~See Figure A.8.12.2.7.2.1, 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, provided the distances to walls constructed as fire barrier walls for exposure protection are not less than that required by Table 10.4.2.2.1(a), Table 10.4.2.2.1(b), or Table 10.4.2.2.1(c).~~

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~~**A.10.4.2.2.4.2**~~ —

~~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 shutdown, 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. 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.~~

(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. [**72:** A.17.8.2]~~

~~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.17.8.2]~~

~~**A.10.4.2.2.6**~~ —

~~Compressed hydrogen gas storage systems are permitted to be installed adjacent to other flammable gas storage systems with no defined minimum separation distance between them. The intent of a minimum separation distance is to prevent the escalation of a fire if a leak occurs. If a fire were to start at one flammable gas storage system, the separation distance would prevent its spread to another flammable gas storage system. Yet a separation distance is not required between two systems storing the same flammable gas. Hydrogen has been stored safely in single- and multi-tube assemblies for over 60 years. As long as sound engineering practice is used, storing different flammable gases in adjacent tubes is an equally safe practice. A compressed hydrogen gas storage system is permitted to be installed adjacent to another flammable gas storage system with no defined minimum separation distance between them.~~

~~**A.10.4.3.1.1.1**~~ —

~~Fracture mechanic methods given in recognized standards such as API RP 579, *Fitness-for-Service* , or BS 7910, *Guide to Methods for Assessing the Acceptability of Flaws in Metallic Structures* , can be used. Additional information is provided in BS 7910.~~

~~**A.10.4.3.1.4**~~ —

~~Straight threads alone are not considered to be a seal.~~

~~**A.10.4.3.1.6.6**~~ —

~~Buried utilities include electrical, sewer, water, gas, storm drains, and similar services. A greater distance may be required by the service provided. For example, public utility easements might dictate greater distances.~~

~~**A.10.4.3.1.9**~~ —

~~Flood hazard areas are typically identified on either (1) the special flood hazard area shown on the flood insurance rate map or (2) the area subject to flooding during the design flood and shown on a jurisdiction's flood hazard map, or are otherwise legally designated.~~

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~~**A.10.4.5.1.2**~~ —

~~Hydrogen fires should not be extinguished until the supply of hydrogen has been shut off because of the danger of re-ignition or explosion. In the event of fire, large quantities of water should be sprayed on adjacent equipment to cool the equipment and prevent involvement in the fire. Combination fog and solid stream nozzles are preferred, to permit widest adaptability in fire control. Small hydrogen fires can be extinguished with dry chemical extinguishers or with carbon dioxide, nitrogen, and steam. Re-ignition can occur if a heated surface adjacent to the flame is not cooled with water or other means.~~

~~**A.10.4.5.2.3**~~ —

~~For guidance in these construction techniques, see NFPA 68.~~

~~**A.10.4.6.1**~~ —

~~The basis of this requirement is to prevent unauthorized personnel or those unfamiliar with gas storage systems from tampering with the equipment. Where the GH_2 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 the supplier and the user personnel. Where 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 can still mandate that the system be fenced, as determined by the supplier and the user.~~

Statement of Problem and Substantiation for Public Input

The storage, use, handling, and many other aspects of hydrogen are addressed by NFPA 2. Per the committee scope statements the HYD Committee has "primary responsibility for documents on the storage, transfer, production, and use hydrogen" and the IMG "Committee shall coordinate the material on gaseous and liquid hydrogen storage and use with the Hydrogen Technology Committee." The simplest, least error prone way for NFPA 55 to coordinate with NFPA 2 regarding hydrogen gas is to just refer the user to NFPA 2. This is best accomplished in in 7.6.1.2 and 8.1.4. This nullifies the need for Chapter 10 and the associated Annex A text.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 85-NFPA 55-2020 [Chapter 10]	These Annex A texts are related to Chapter 10.

Submitter Information Verification

Submitter Full Name: Stephen Goyette
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Submittal Date: Sun Jun 28 18:49:40 EDT 2020
Committee: IMG-AAA

Attachment F - NFPA 55 Public Inputs

Public Input No. 109-NFPA 55-2020 [Section No. A.10.4.2.2.1]

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A.10.4.2.2.1

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The exposures integral to Table 10.4.2.2.1(a), Table 10.4.2.2.1(b), and Table 10.4.2.2.1(c) have been arranged into groups based on similar risks. The estimated leak area was changed from 3 percent to 1 percent of the pipe diameter to evaluate separation distances. The 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 1500 Btu/hr/ft^2 (4732 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 an 8 percent mole fraction (i.e., volume fraction) of hydrogen, whichever is greater. In all cases, the distance required to achieve an 8 percent mole fraction was the greater distance and was used to establish the requirements.

(2) *Group 2 Exposures.* The distances specified are those required to reduce the radiant heat flux level to 1500 Btu/hr/ft^2 (4732 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 6340 Btu/hr/ft^2 (20,000 W/m^2) or the visible flame length for combustible materials, or a radiant heat flux level of 8000 Btu/hr/ft^2 (25,237 W/m^2) or the visible flame length for noncombustible equipment. In both cases, the visible flame length was used to establish the requirements.

A 50 percent safety factor was added to all resulting separation distance values.

Table 10.4.2.2.1(a) Exposures Group 1 (a). Lot lines (i.e., 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 can result in an encroachment that will necessitate relocation of the hydrogen system at the system user's expense.

Where the property on the other side of a property line is determined to be unbuildable or unoccupiable due to natural features, including, but not limited to, waterways, terrain, wetlands, or similar features encroachment by the hydrogen system on the property line can be acceptable with the approval of the authority having jurisdiction. Should the property that is encroached upon become buildable or otherwise occupiable, the hydrogen system location should be reevaluated by the system user and the AHJ notified of the results.

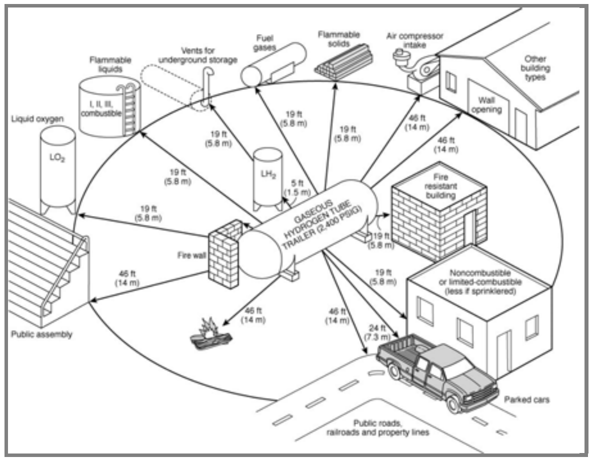
Table 10.4.2.2.1(a) Exposure Group 2(a). The exposed persons of concern are non-work-related persons or members of the public who are not involved with servicing the system, because these persons typically are neither trained nor knowledgeable in the operation of the system, but are on the premises. By comparison, service personnel or those involved with servicing the system are trained and engaged in activities related to the system operation including, but not limited to, inspecting, monitoring system inventory, delivering product, maintenance, or similar functions. Administrative controls, engineering controls, or construction features are typically used to restrict persons other than service personnel from being within the zone of potential exposure. The permit holder is responsible for managing and administering the controls to restrict access. Examples of such controls could include painted lines or signs or a physical barrier such as a fence.

~~See Figure A.10.4.2.2.1 for a graphical representation of separation distances from bulk hydrogen systems.~~

CGA PS-48, *Clarification of Existing Hydrogen Setback Distances and Development of New Hydrogen Setback Distances in NFPA 55*, provides guidance and clarification on types of exposures as well as applications of the separation distances.

~~**Figure A.10.4.2.2.1 Distances Between Bulk Hydrogen Systems and Exposures.**~~

Attachment F - NFPA 55 Public Inputs



Statement of Problem and Substantiation for Public Input

Figure A.10.4.2.2.1 is very misleading and should be revised or deleted. The relative distances between the hydrogen storage and the exposures are inaccurate, inconsistent, and wrong. For example it shows the open fire (46 ft) INSIDE the circle that mostly has a radius of 19 ft. And, it shows the parked vehicle (24 ft) further away than the road (46 ft). And, it shows the fire resistant building right next to the storage but with text indicating a distance the same as the other building (19 ft). It also does not show the reduced distance permitted by the fire wall. And, the distance to liquid oxygen contradicts Chapter 9 (see also Figure A.9.3.2).

Submitter Information Verification

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Attachment F - NFPA 55 Public Inputs

Public Input No. 96-NFPA 55-2020 [Sections A.11.1, A.11.1.1, A.11.2.3, A.11.2.3.2, A.11.2.3.6...]

~~**Sections**~~
~~**A.11.1, A.11.1.1, A.11.2.3, A.11.2.3.2, A.11.2.3.6, A.11.2.4.2.2.1, A.11.2.4.2.2.2, A.11.2.5.1, A.11.2.5.2, A.11.2**~~

~~**A.11.1**~~ —

~~For information on gaseous hydrogen systems, see Chapter 10 .~~

~~**A.11.1.1**~~ —

~~ANSI/CGA H-5, *Standard for Bulk Hydrogen Supply Systems* , provides guidance for designing, installing, testing, starting up, and removing bulk hydrogen supply systems.~~

~~**A.11.2.3**~~ —

~~Some materials acceptable for liquefied hydrogen temperature include austenitic chromium–nickel alloys, certain copper alloys, and aluminum, which retain ductility and do not become brittle at the temperature of liquefied hydrogen.~~

~~**A.11.2.3.2**~~ —

~~Piping and tubing used for liquid hydrogen and cold gas hydrogen (such as venting from a liquid hydrogen tank or a liquid hydrogen line) typically operates at temperatures below −20˚F (−29˚C).~~

~~**A.11.2.3.6**~~ —

~~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, because 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 uninsulated 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.~~

~~**A.11.2.4.2.2.1**~~ —

~~More details about the tank valve arrangements are found in CGA H-3, *Cryogenic Hydrogen Storage* . CGA H-3 requires that these valves be located on the liquid supply line and the gas supply (economizer) line on all sizes of bulk liquid hydrogen tanks. Where other liquid and gas supply lines are provided, such as liquid to a pump and gas return from a pump, these lines also have the remotely operated emergency isolation valves.~~

~~A typical way to operate these valves is to supply an air-operated fail-close automatic valve in the liquid lines and the gas lines. A manual or electric (solenoid) three-way valve supplies instrument air to open the automatic valve. Turning the manual three-way valve or de-energizing the solenoid three-way valve vents the signal from the automatic valve, causing it to close and isolate the tank. The instrument valve must be connected to all automatic emergency isolation valves so that it is necessary to operate only one instrument valve to isolate all tank supply lines. Typically a system will have more than one instrument valve, with one located near the tank fill connection for access at the tank and one located remotely to avoid the necessity of approaching the tank in an emergency situation.~~

~~**A.11.2.4.2.2.2**~~ —

~~The manual valve is used for maintenance of the automatic valve. However, since mechanical joints are not permitted, all connections between the tank and the automatic valve must be welded. This provision is in place to avoid having leaks upstream of the automatic emergency isolation valve, given that such leaks cannot be isolated.~~

~~**A.11.2.5.1**~~ —

~~To be indirect, heat must be transferred by a transfer medium such as air, steam, water, oil, or comparable heat sources. The use of direct-heat transfer media, including electrical sources or flame, presents a potential hazard should the system overheat, resulting in damage to the wall of the tubing used to construct the vaporizer.~~

Attachment F - NFPA 55 Public Inputs

~~**A.11.2.5.2**~~ —

~~The loss of heat or the withdrawal of hydrogen at a rate exceeding the design capacity of the vaporizer presents a circumstance where cryogenic fluid is transported into portions of the piping system that have been designed to contain gaseous — not liquid — hydrogen. Such an event can result in brittle failure of the piping system downstream of the vaporizer. The potential to trap liquid in parts of the system that have not been designed to accommodate liquid can result in a loss of hydrogen and the generation of hazardous conditions.~~

~~**A.11.2.8.5**~~ —

~~Liquid hydrogen supply systems typically store the liquid, a cryogenic fluid, in storage tanks with maximum allowable working pressures (MAWP) that range from 150 psig to 250 psig. The majority of tanks are limited to 150 psig MAWP. Liquid hydrogen is piped from the tank to a vaporizer that serves as a heat exchanger and to convert the fluid from the liquid to the gaseous state in order to provide a supply of gaseous hydrogen to the user. The gaseous hydrogen supply pressure for such systems is limited to a maximum pressure below that of the storage tank MAWP.~~

~~When gaseous or liquid hydrogen is required to be supplied at pressures higher than the storage tank MAWP, either pumps or compressors are added to the system to raise the delivered pressure. Pumps are used for delivering hydrogen in the liquid state, while compressors deliver hydrogen in the gaseous state. Additional details on system arrangement and piping systems can be found in CGA H-5,~~ ~~*Installation Standards for Bulk Hydrogen Supply Systems*~~ ~~.~~

~~**A.11.3.1.2**~~ —

~~When locating liquefied hydrogen storage containers in proximity to all classes of aboveground flammable and combustible liquid storage or liquid oxygen storage, the liquefied hydrogen container should be on ground higher than all classes of flammable and combustible liquid storage or liquid oxygen storage, because spilled material will quickly vaporize, thereby mitigating the potential exposure hazard to the other fluids.~~

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~~**A.11.3.2.2**~~

~~The Occupational Safety and Health Administration (OSHA) established requirements for hydrogen systems in 29 CFR 1910.103. The tabular distances in Annex G reflect those values published in the July 1, 2006 edition of the CFR. The criteria established in Table G.2(a) and Table G.2(b) are based on the 1969 edition of NFPA 50A which superseded the 1963 edition. Subsequent editions were adopted in 1973, 1978, 1984, 1989, 1994, and 1999. In 2003, the document was integrated into NFPA 55 because the committee believed that one standard covering storage and use of all compressed gases and cryogenic fluids was needed. NFPA 55 was revised in 2005 as the requirements for compressed gases and cryogenic fluids were broadened.~~

~~Throughout those eight revision cycles, the distances were subject to revision as the technology in the use of hydrogen advanced. However, the distances listed in the OSHA tables remain based on the 1969 data. It is important to recognize that the OSHA tables represent the current statutory requirements. While the tables might be accurate, it should be recognized that the OSHA tables in some cases lack clarity, and in other cases hazards recognized by the ongoing evolution of the separation tables have not been acknowledged.~~

~~For an example of clarity, consider row 1, "Building or structure," of Table 11.3.2.2 . The OSHA table refers to buildings by construction types, including wood frame, heavy timber, ordinary, and fire resistive. The current construction types are now designated as Types I through V with variations to address the elements of construction, including the supporting structure as well as the construction of the roof and exterior walls. Although one can guess as to the original intent, there is no clear correlation between the construction types designated in the OSHA tables and the types in either NFPA 220 or the building code.~~

~~Other examples where hazards are not addressed include the fact that there are no prescribed distances for separation from property lines, public sidewalks, and parked vehicles. A close comparison between the OSHA table and the distance tables in the 2005 edition of NFPA 55 reveals a number of discrepancies. As the 2010 edition of NFPA 55 was being developed, a collective effort was undertaken by a joint task group established between the NFPA Industrial and Medical Gases Committee and the NFPA Hydrogen Technology Committee. The scope of the Hydrogen Technology Committee's work was to review and verify the separation distances for exposures integral to the distance tables found in NFPA 55. Research on separation distances funded by the U.S. Department of Energy (DOE) and undertaken by Sandia National Laboratories in 2007 focused on the effects of fire and potential explosion due to an inadvertent release of hydrogen. The initial work had as its focus the use of hydrogen as an alternative vehicle fuel; however, the data produced present the case for separation based on radiant heat flux from hydrogen jet flames and flammability envelopes from unintended releases of hydrogen. The work was based on modeling that was then validated against Sandia National Laboratories and SRI International experiments.~~

~~As the work continued, it became apparent to the group that a risk-informed approach to separation distance could be developed. At that juncture, the committee developed consequence-based tables for separation as well as a set of risk-informed tables. The consequence-based tables present the hazard without regard to probability or frequency. However, there are variables that have not previously been considered in the evolution of the tabular distances.~~

~~On the other hand, the risk-informed tables consider the cumulative frequency of accidents and the distance required to prevent an undesired consequence across a spectrum of varying pressures.~~

~~Additionally, the fundamental requirements of NFPA 55 prescribe a minimum set of engineering controls and construction features. As the work evolved, it became clear that with mitigation methodology, an unintended release could be minimized or eliminated. The developmental work was focused on using a scientific method to obtain separation distances to verify or revise the tabular distances accordingly.~~

~~The OSHA tables are provided to inform the code user of the minimum requirements as they currently exist under 29 CFR and the federal OSHA program. It is incumbent on installers and property owners to recognize the limitations of OSHA based on the precedent requirements established with the use of the 1969 edition of NFPA 50A. The use of alternative approaches to distance as now embodied within the body of the code is subject to approval on a location-by-location basis. The typical AHJ has traditionally been the fire official who might not be the only official that exercises regulatory control for installations of this nature.~~

~~**A.11.3.2.2.1**~~

~~CGA PS-48, *Clarification of Existing Hydrogen Setback Distances and Development of New Hydrogen Setback Distances in NFPA 55* , provides guidance and clarification on types of exposures and applications of the separation distances.~~

~~**A.11.3.2.2.2**~~

~~The vent stack begins at the downstream side of a pressure relief device or vent valve.~~

Attachment F - NFPA 55 Public Inputs

~~**A.11.3.2.2.4**~~

~~See NFPA 259. Separation distances to exposures in Table 11.3.2.2 should be measured in a direct line of sight or horizontally in the shortest path along the outside of buildings. The 5 ft (1.5 m) distance in Table 11.3.2.2 facilitates maintenance and enhances ventilation.~~

~~*Table 11.3.2.2 Item 1. Lot Lines.* 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 that will necessitate relocation of the hydrogen system at the system user's expense.~~

~~Where the property on the other side of a property line is determined to be unbuildable or unoccupiable due to natural features including, but not limited to, waterways, terrain, wetlands, or similar features encroachment by the hydrogen system on the property line can be acceptable with the approval of the authority having jurisdiction. Should the property that is encroached upon become buildable or otherwise occupiable, the hydrogen system location should be reevaluated by the system user and the AHJ notified of the results.~~

~~**A.11.3.2.2.6.1**~~

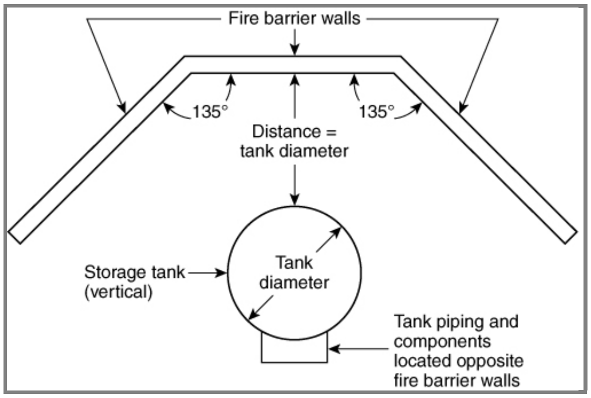
~~See Figure A.8.12.2.7.2.1, which addresses bulk cryogenic systems located in a courtyard. This figure also applies to the case where any or all of the three walls are constructed as fire barrier walls, provided the distances to walls constructed as fire barrier walls for exposure protection is not less than that required by Table 11.3.2.1.~~

Attachment F - NFPA 55 Public Inputs

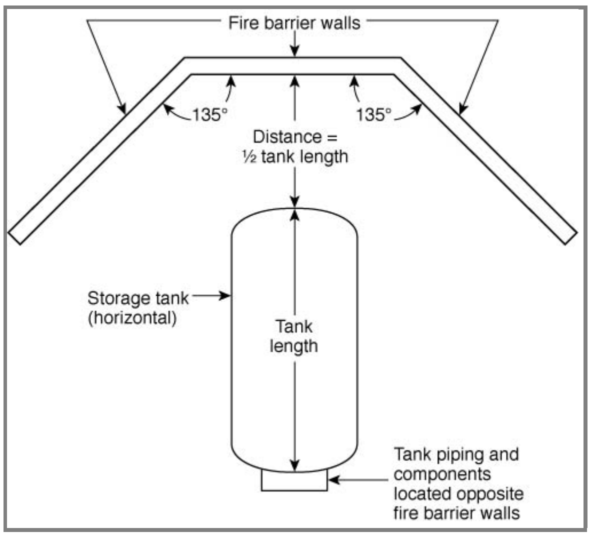
~~**A.11.3.2.2.6.2**~~

~~Figures A.11.3.2.2.6.2(a) and A.11.3.2.2.6.2(b) illustrate wall enclosures for a hydrogen storage system. The geometry of the three-sided enclosure should not contain any hydrogen release that would be enough to create a significant hazard.~~

~~**Figure A.11.3.2.2.6.2(a) Schematic of Three-Sided Fire Barrier Wall Enclosure for a Vertical Hydrogen Storage System.**~~



~~**Figure A.11.3.2.2.6.2(b) Schematic of Three-Sided Fire Barrier Wall Enclosure for a Horizontal Hydrogen Storage System**~~



Attachment F - NFPA 55 Public Inputs

~~**A.11.3.2.4**~~ —

~~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 shutdown, 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 liquefied system and the exposure. Gas detection systems might 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.~~

(2) ~~*Flame Detection.* Flame detection systems can 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.~~

~~**A.11.4.1.3**~~ —

~~The basis of this requirement is to prevent unauthorized personnel or those unfamiliar with gas storage systems from tampering with the equipment. Where the~~ ~~LH_2~~ ~~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.~~

~~**A.11.4.4.3**~~ —

~~Hydrogen fires should not be extinguished until the supply of hydrogen has been shut off because of the danger of re-ignition or explosion. In the event of fire, large quantities of water will normally be sprayed on adjacent equipment to cool the equipment and prevent involvement in the fire. Combination fog and solid stream nozzles are preferred, to permit the widest adaptability in fire control. Small hydrogen fires have been extinguished with dry chemical extinguishers or with carbon dioxide, nitrogen, and steam. Re-ignition can occur if a metal surface adjacent to the flame is not cooled with water or other means.~~

Statement of Problem and Substantiation for Public Input

The storage, use, handling, and many other aspects of hydrogen are addressed by NFPA 2. Per the committee scope statements the HYD Committee has "primary responsibility for documents on the storage, transfer, production, and use hydrogen" and the IMG "Committee shall coordinate the material on gaseous and liquid hydrogen storage and use with the Hydrogen Technology Committee." The simplest, least error prone way for NFPA 55 to coordinate with NFPA 2 regarding hydrogen gas is to just refer the user to NFPA 2. This is best accomplished in in 7.6.1.2 and 8.1.4. This nullifies the need for Chapter 11 and the associated Annex A text.

Related Public Inputs for This Document

Related Input	Relationship

Attachment F - NFPA 55 Public Inputs

Public Input No. 86-NFPA 55-2020 [Chapter 11]	Annex A text for Chapter 11.

Submitter Information Verification

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Committee: IMG-AAA

Attachment F - NFPA 55 Public Inputs

Public Input No. 30-NFPA 55-2020 [Sections A.11.2.4.2.2.1, A.11.2.4.2.2.2]

Sections A.11.2.4.2.2.1, A.11.2.4.2.2.2

A.11.2.4.2.2.1

More details about the tank valve arrangements are found in CGA H-3, *Cryogenic Hydrogen Storage*. CGA H-3 requires that these valves be located on the liquid supply line and the gas supply (economizer) line on all sizes of bulk liquid hydrogen tanks. Where other liquid and gas supply lines are provided, such as liquid to a pump and gas return from a pump, these lines also have the remotely operated emergency isolation valves.

A typical way to operate these valves is to supply an air-operated fail-close automatic valve in the liquid lines and the gas lines. A manual or electric (solenoid) three-way valve supplies instrument air to open the automatic valve. Turning the manual three-way valve or de-energizing the solenoid three-way valve vents the signal from the automatic valve, causing it to close and isolate the tank. The instrument valve must be connected to all automatic emergency ~~isolation~~ shutoff valves so that it is necessary to operate only one instrument valve to isolate all tank supply lines. Typically a system will have more than one instrument valve, with one located near the tank fill connection for access at the tank and one located remotely to avoid the necessity of approaching the tank in an emergency situation.

A.11.2.4.2.2.2

The manual valve is used for maintenance of the automatic valve. However, since mechanical joints are not permitted, all connections between the tank and the automatic valve must be welded. This provision is in place to avoid having leaks upstream of the automatic emergency ~~isolation~~ shutoff valve, given that such leaks cannot be isolated.

Statement of Problem and Substantiation for Public Input

The defined term in 3.3.38 is for an Emergency Shutoff Valve not an Emergency Isolation Valve.

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Public Input No. 15-NFPA 55-2020 [Section No. A.11.3.2.2]

A.11.3.2.2

The Occupational Safety and Health Administration (OSHA) established requirements for hydrogen systems in 29 CFR 1910.103. The tabular distances in Annex G reflect those values published in the July 1, 2006 edition of the CFR. The criteria established in Table G.2(a) and Table G.2(b) are based on the 1969 edition of NFPA 50A which superseded the 1963 edition. Subsequent editions were adopted in 1973, 1978, 1984, 1989, 1994, and 1999. In 2003, the document was integrated into NFPA 55 because the committee believed that one standard covering storage and use of all compressed gases and cryogenic fluids was needed. NFPA 55 was revised in 2005 as the requirements for compressed gases and cryogenic fluids were broadened.

Throughout those eight revision cycles, the distances were subject to revision as the technology in the use of hydrogen advanced. However, the distances listed in the OSHA tables remain based on the 1969 data. It is important to recognize that the OSHA tables represent the current statutory requirements. While the tables might be accurate, it should be recognized that the OSHA tables in some cases lack clarity, and in other cases hazards recognized by the ongoing evolution of the separation tables have not been acknowledged.

For an example of <u>lack of</u> clarity, consider row 1, “Building or structure,” of Table ~~11~~ <u>G</u> .~~3.~~ 2(<u>a</u>) <u>.</u> ~~2.~~ The OSHA table refers to buildings by construction types, including wood frame, heavy timber, ordinary, and fire resistive. The current construction types are now designated as Types I through V with variations to address the elements of construction, including the supporting structure as well as the construction of the roof and exterior walls. Although one can guess as to the original intent, there is no clear correlation between the construction types designated in the OSHA tables and the types in either NFPA 220 or the building code.

Other examples where hazards are not addressed include the fact that there are no prescribed distances for separation from property lines, public sidewalks, and parked vehicles. A close comparison between the OSHA table and the distance tables in the 2005 edition of NFPA 55 reveals a number of discrepancies. As the 2010 edition of NFPA 55 was being developed, a collective effort was undertaken by a joint task group established between the NFPA Industrial and Medical Gases Committee and the NFPA Hydrogen Technology Committee. The scope of the Hydrogen Technology Committee’s work was to review and verify the separation distances for exposures integral to the distance tables found in NFPA 55. Research on separation distances funded by the U.S. Department of Energy (DOE) and undertaken by Sandia National Laboratories in 2007 focused on the effects of fire and potential explosion due to an inadvertent release of hydrogen. The initial work had as its focus the use of hydrogen as an alternative vehicle fuel; however, the data produced present the case for separation based on radiant heat flux from hydrogen jet flames and flammability envelopes from unintended releases of hydrogen. The work was based on modeling that was then validated against Sandia National Laboratories and SRI International experiments.

As the work continued, it became apparent to the group that a risk-informed approach to separation distance could be developed. At that juncture, the committee developed consequence-based tables for separation as well as a set of risk-informed tables. The consequence-based tables present the hazard without regard to probability or frequency. However, there are variables that have not previously been considered in the evolution of the tabular distances.

On the other hand, the risk-informed tables consider the cumulative frequency of accidents and the distance required to prevent an undesired consequence across a spectrum of varying pressures.

Additionally, the fundamental requirements of NFPA 55 prescribe a minimum set of engineering controls and construction features. As the work evolved, it became clear that with mitigation methodology, an unintended release could be minimized or eliminated. The developmental work was focused on using a scientific method to obtain separation distances to verify or revise the tabular distances accordingly.

The OSHA tables are provided to inform the code user of the minimum requirements as they currently exist under 29 CFR and the federal OSHA program. It is incumbent on installers and property owners to recognize the limitations of OSHA based on the precedent requirements established with the use of the 1969 edition of NFPA 50A. The use of alternative approaches to distance as now embodied within the body of the code is subject to approval on a location-by-location basis. The typical AHJ has traditionally been the fire official who might not be the only official that exercises regulatory control for installations of this nature.

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This refers to row 1 of Table 11.3.2.2 as "building or structure" but row (exposure) 1 of Table 11.3.2.2 is "lot lines."

This language appears to have been taken from Annex Section G.1, which reads: "For an example of lack of clarity, consider row 1 of Table G.2(a) (Building or structure)." Row 1 of Table G.2(a) is indeed "building or structure."

Therefore, the proposed change adds the "lack of" wording before "clarity" to match the Annex G.1 language, and should also change the reference to refer to Table G.2(a) rather than Table 11.3.2.2.

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Public Input No. 50-NFPA 55-2020 [Section No. A.16.3.3.3]

A.16.3.3.3

~~See~~ As an alternate to compliance with ASTM E84 or ANSI/UL 723 , ~~*Standard Test Method for Surface Burning Characteristics of Building Materials*~~ a foam plastic insulation material that complies with the requirements for interior wall and ceiling finish materials tested in accordance with NFPA 286 shown in NFPA1 is acceptable for this application.

Also: add NFPA 286, Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth, into the section on informational NFPA referenced documents .

Statement of Problem and Substantiation for Public Input

The companion PI recommends placing the reference to ASTM E84 in the body of the document, meaning that this is unnecessary. However, some insulation materials are being tested to NFPA 286 (a room-corner test) instead of to ASTM E84 and that is a more meaningful test. Therefore, a material that has already been tested to NFPA 286 (and meets the criteria in NFPA 1, which are the same as those in NFPA 101 or 5000, or the IBC) should be allowed to be used. This PI does not require testing to NFPA 286 but offers it as an alternate.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 45-NFPA 55-2020 [Section No. 16.3.3]	

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Public Input No. 97-NFPA 55-2020 [Chapter C]

~~**Annex C** – Physical Properties of Hydrogen~~

~~*This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.*~~

~~**C.1** – Physical Properties.~~

~~Hydrogen is a flammable gas. It is colorless, odorless, tasteless, and nontoxic. It is the lightest gas known, having a specific gravity of 0.0695 (air = 1.0). Hydrogen diffuses rapidly in air and through materials not normally considered porous.~~

~~**C.1.1** –~~

~~Hydrogen burns in air with a pale blue, almost invisible flame. At atmospheric pressure, the ignition temperature of hydrogen–air mixtures has been reported by the U.S. Bureau of Mines to be as low as 932°F (500°C). The flammable limits of hydrogen–air mixtures depend on pressure, temperature, and water vapor content. At atmospheric pressure, the flammable range is approximately 4 percent to 75 percent by volume of hydrogen in air.~~

~~**C.1.2** –~~

~~Hydrogen remains a gas even at high pressures. It is liquefied when cooled to its boiling point of −423°F (−253°C).~~

~~**C.1.3** –~~

~~Hydrogen is nontoxic, but it can cause anoxia (asphyxiation) when it displaces the normal 21 percent oxygen in a confined area without ventilation that will maintain an oxygen content exceeding 19.5 percent. Because hydrogen is colorless, odorless, and tasteless, its presence cannot be detected by the human senses.~~

~~**C.2** – Physical Properties.~~

~~Liquefied hydrogen is transparent, odorless, and not corrosive or noticeably reactive. The boiling point at atmospheric pressure is −423°F (−253°C). It is only $^{1}/_{14}$ as heavy as water. Liquefied hydrogen converted to gaseous hydrogen at standard conditions expands approximately 850 times.~~

Statement of Problem and Substantiation for Public Input

The storage, use, handling, and many other aspects of hydrogen including the physical properties are addressed by NFPA 2. Per the committee scope statements the HYD Committee has "primary responsibility for documents on the storage, transfer, production, and use hydrogen" and the IMG "Committee shall coordinate the material on gaseous and liquid hydrogen storage and use with the Hydrogen Technology Committee." The simplest, least error prone way for NFPA 55 to coordinate with NFPA 2 regarding hydrogen gas is to just refer the user to NFPA 2. This is best accomplished in in 7.6.1.2 and 8.1.4. This nullifies the need for Annex C. And, and the presence of Annex C in NFPA 55 causes confusion regarding whether NFPA 2 or NFPA 55 applies.

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Public Input No. 66-NFPA 55-2020 [Chapter E]

~~**Annex E** – Explanation of Methodology Utilized to Develop Separation Distances~~

~~*This annex is not part of the requirements of this NFPA document but is included for informational purposes only.*~~

~~**E.1** – Separation Distances Tables Methodology History.~~

~~The evaluation of separation distances for bulk gaseous hydrogen systems was the subject of study of a joint task group that comprised members of NFPA's Hydrogen Technology Technical Committee and the Industrial and Medical Gases Technical Committee. The task of the group was to examine the exposure distances published in Table 10.3.2.2.1 of the 2005 edition of NFPA 55 for the purpose of validation or revision based on a scientific approach that could be substantiated either through testing or through generally accepted scientific means for the 2010 edition of NFPA 55.~~

~~In the 2016 edition of NFPA 55, exposures were grouped in 10.4.2.2.1(a) based upon the rationale for determining the associated hazard, as shown in Table E.1(a) and Table E.1(b) . Table E.1(a) is cross-referenced to Table 10.4.2.2.1(a) by exposure group number and row letter. Notes are provided to indicate the specific rationale considered for each of the exposures listed. The notes are then cross-referenced to specific hazard scenarios further defined in Table E.1(b) . The performance criteria and design scenarios have been extracted from NFPA 1 as indicated in the extracts provided. [1] For each exposure, the effects of a release were considered within the context of hazard scenarios developed in the performance approach foundational to determining the design scenarios outlined in the performance-based option in NFPA 1.~~

~~In the event alternative materials or methods are to be employed when bulk systems are installed, code users should be aware of the specific hazard scenarios used to analyze each exposure.~~

~~Studies by Houf and Schefer of Sandia National Laboratories (Sandia) predicted the radiative heat flux at various distances resulting from the ignition of turbulent jet releases of hydrogen from systems at various pressures. In addition, the concentrations of an unignited hydrogen jet in the surrounding air and the envelope where the concentration falls below the lower flammability limit for hydrogen were determined. [2] Understanding the consequences of release in terms of thermal flux or the boundaries of the unignited cloud were then used to determine distances that were believed to be appropriate based on the consequence of a release. The consequence approach is referred to as a deterministic approach because distances are determined based on consequence alone. Another consequence-based approach, found in a project sponsored by NFPA's Fire Protection Research Foundation, to determine appropriate separation distances for certain installations of bulk gaseous hydrogen systems was also reviewed by the task group, and comparisons were made to the existing requirements in the 2005 edition of NFPA 55. [3]~~

~~As the group evaluated the impact of the deterministic tables, it became apparent that the probability of occurrence of events should have a bearing on determining a reasonable level of safety.~~

~~The work of the task group integrated the efforts of Sandia's risk and reliability department, as part of the U.S. Department of Energy Hydrogen, Fuel Cells & Infrastructure Technologies Program.~~

~~Researchers at Sandia developed benchmark experiments and a defensible analysis strategy for risk and consequence assessment of unintended releases from gaseous hydrogen systems. This work included experimentation and modeling to understand the fluid mechanics and dispersion of hydrogen for different release scenarios, including investigations of hydrogen combustion and subsequent heat transfer from hydrogen flames. The resulting technical information was incorporated into engineering models that were used for assessment of different hydrogen release scenarios and for input into quantitative risk assessments (QRA) of hydrogen facilities.~~

~~The QRAs were used to identify and quantify scenarios for the unintended release of hydrogen, identify the significant risk contributors at different types of hydrogen facilities, and to identify potential accident prevention and mitigation strategies to reduce the risk to acceptable levels. [4]~~

~~To evaluate risk, the history of leakage data from high-pressure compressed gas systems was needed. Hydrogen-specific leak data were provided by one of the major suppliers through the use of a 5-year documented collection of leak data from both industrial and fueling uses. These data were augmented with data from other sources after being reviewed for applicability, and representative values were selected. The source documents considered in augmentation of hydrogen-specific data included the following publications:~~

(1) ~~"Determination of Safety Distances," European Industrial Gases Association, IGC Doc 75/07/E, 2007~~

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(2) ~~A. W. Cox, F. P. Lees, and M. L. Ang, "Classification of Hazardous Locations," Institution of Chemical Engineers, May 2003~~

(3) ~~C. H. Blanton and S. A. Eide, "Savannah River Site Generic Data Base Development," WSRC-TR-93-262, Westinghouse Savannah River Company, June 30, 1993~~

(4) ~~J. Spouge, "New Generic Leak Frequencies for Process Equipment," *Process Safety Progress* (Vol. 24, No. 4), December 2005~~

~~A hierarchy was developed that gave hydrogen-specific data the highest priority, followed by non-gas-specific data where available for high pressure components. Piping and instrumentation drawings (P&IDs) were then prepared to define a standard bulk supply system in terms of modules that might be found in the typical system. The P&IDs can be found in A.3.3.95.9.1 . The P&IDs were reviewed by suppliers and the typical nature verified.~~

~~Frequency and size of leaks encountered were evaluated across a number of systems, including both industrial and fueling operations. The leak/failure data were then applied to "typical" fitting counts (i.e., components) integral to each of the modules identified in the P&IDs for each of the components. The failure data were based on the most recent 5-year history for high-pressure systems. Hydrogen-specific data were provided by Compressed Gas Association (CGA) representatives. These data were augmented by failure data from other resources obtained by researchers from Sandia and combined to quantify a probability for failure on a component-by-component basis [e.g., hoses (pigtails), valves, instruments, joints, pipe]. The analysis resulted in a probability for failure being developed for each component, which could then be wrapped into failures expected across the spectrum of the various modules included in the array of P&IDs developed.~~

~~A Bayesian approach to the determination of probability was used in the analysis of data by researchers at Sandia. The technical approach and supporting details can be found in the articles listed in Annex H and informational articles found in I.2 . The advantage of the Bayesian approach is that it can combine data from different sources to include uncertainty. This approach is contrary to what has been done in other sources. For example, judgment can be used as a means to determine risk; however, that method does not provide for uncertainty. Such methods are qualitative at best. By comparison, the use of specific leak data results in a quantitative approach.~~

~~The tables developed for inclusion in Chapter 10 of the 2010 edition of NFPA 55 are said to be *risk informed* , not *risk based* , the difference being that integral to the risk tables is a series of decisions based on the applicability of various factors. For example, with respect to thermal flux, one could use a series of exposures from *no harm* to *fatality* , and those exposures could then be taken from the point of various receptors (workers, people on the property where the installation is located, people off the property, etc.). One of the primary decisions made by the group was that in the final analysis the risk presented for the typical GH_2 installation (either industrial or fueling applications) should present no greater risk to the public in terms of fatalities or injuries than does an existing gasoline service station. The average frequency of a fatality associated with the operation of a single gasoline station has been reported to be approximately 2E-5/yr. [5] Other key decisions of the group included the parameters given in Sections E.2 through E.5 .~~

~~Table E.1(a) Hazard Scenario~~

~~Row Group 1 Exposures greater of a or b Hazard Scenario Rationale [c] (a) Lot lines 1, 2, 3, 4, 5 (b) Air intakes (HVAC, compressors, other) 1 (c) Operable openings in buildings and structures 1, 2 (d) Ignition sources such as open flames and welding 3, 5 **Row Group 2 Exposures [d] Hazard Scenario Rationale [c]** (a) Exposed persons other than those involved in servicing of the system 4 (b) Parked cars 4 **Row Group 3 Exposures [e] Hazard Scenario Rationale [c]** (a) Buildings of noncombustible non-fire-rated construction 2 (b) Buildings of combustible construction 2 - - - (c) Flammable gas storage systems above or below ground 2 (d) Hazardous materials storage systems above or below ground 6, 7, 8, 9 (e) Heavy timber, coal, or other slow-burning combustible solids 2 (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 2 (g) Unopenable openings in buildings and structures 1, 2 - - - - - - (h) Encroachment by overhead utilities (horizontal distance from the vertical plane below the nearest overhead electrical wire of building service) 2, 10 (i) Piping containing other hazardous materials 6, 7, 8, 9 (j) Flammable gas metering and regulating stations such as natural gas or propane 6, 7, 8, 9 -~~

~~[a] Unignited jet concentration decay distance to 4 percent mole fraction (volume fraction) hydrogen.~~

~~[b] D_{rad} — radiation heat flux level of 1577 W/m^2 .~~

~~[c] See Table E.1(b) for explanation of notes.~~

~~[d] D_{rad} for heat flux level of 4732 W/m^2 exposure to employees for a maximum of 3 minutes.~~

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~~e The greater of D_{rad} for combustible heat flux level of 20,000 W/m^2 or the visible flame length.~~

~~Table E.1(b) Hazard Scenario Rationale Notes to Table E.1(a)~~

~~Note Number Statement Performance Criteria Hazardous Materials~~

~~Design Scenario 1 Gas release and subsequent entrainment or accumulation by the receptor **Explosion Conditions.** The facility design shall provide an acceptable level of safety for occupants and for individuals immediately adjacent to the property from the effects of unintentional detonation or deflagration. [**1:** 5.2.2.2] **Hazardous Materials Design Scenario 1.** Hazardous Materials Design Scenario 1 involves an unauthorized release of hazardous materials from a single control area. This design scenario shall address the concern regarding the spread of hazardous conditions from the point of release. [**1:** 5.4.4.1] 2 Fire spread to or from adjacent equipment or structure **Property Protection.** The facility design shall limit the effects of all required design scenarios from causing an unacceptable level of property damage. [**1:** 5.2.2.4] **Hazardous Materials Design Scenario 2.** Hazardous Materials Design Scenario 2 involves an exposure fire on a location where hazardous materials are stored, used, handled, or dispensed. This design scenario shall address the concern regarding how a fire in a facility affects the safe storage, handling, or use of hazardous materials. [**1:** 5.4.4.2] 3 Gas explosion hazard on site or affecting adjacent property **Explosion Conditions.** The facility design shall provide an acceptable level of safety for occupants and for individuals immediately adjacent to the property from the effects of unintentional detonation or deflagration. [**1:** 5.2.2.2] **Hazardous Materials Design Scenario 1.** Hazardous Materials Design Scenario 1 involves an unauthorized release of hazardous materials from a single control area. This design scenario shall address the concern regarding the spread of hazardous conditions from the point of release. [**1:** 5.4.4.1] 4 Threat of injuries on site or adjacent property **Hazardous Materials Exposure.** The facility design shall provide an acceptable level of safety for occupants and for individuals immediately adjacent to the property from the effects of an unauthorized release of hazardous materials or the unintentional reaction of hazardous materials. [**1:** 5.2.2.3] **Hazardous Materials Design Scenario 2.** Hazardous Materials Design Scenario 2 involves an exposure fire on a location where hazardous materials are stored, used, handled, or dispensed. This design scenario shall address the concern regarding how a fire in a facility affects the safe storage, handling, or use of hazardous materials. [**1:** 5.4.4.2] **Hazardous Materials Design Scenario 4.** Hazardous Materials Design Scenario 4 involves an unauthorized discharge with each protection system independently rendered ineffective. This set of design hazardous materials scenarios shall address concern regarding each protection system or protection feature, considered individually, being unreliable or becoming unavailable. [**1:** 5.4.4.4.1] 5 Ignition of an unignited release/vented hydrogen **Explosion Conditions.** The facility design shall provide an acceptable level of safety for occupants and for individuals immediately adjacent to the property from the effects of unintentional detonation or deflagration. [**1:** 5.2.2.2] **Hazardous Materials Design Scenario 1.** Hazardous Materials Design Scenario 1 involves an unauthorized release of hazardous materials from a single control area. This design scenario shall address the concern regarding the spread of hazardous conditions from the point of release. [**1:** 5.4.4.1] 6 Damage to exposed components of underground system that are exposed above ground **Property Protection.** The facility design shall limit the effects of all required design scenarios from causing an unacceptable level of property damage. [**1:** 5.2.2.4] **Hazardous Materials Design Scenario 1.** Hazardous Materials Design Scenario 1 involves an unauthorized release of hazardous materials from a single control area. This design scenario shall address the concern regarding the spread of hazardous conditions from the point of release. [**1:** 5.4.4.1] 7 Damage to aboveground system due to function of explosion control system used to vent underground vault or structure **Property Protection.** The facility design shall limit the effects of all required design scenarios from causing an unacceptable level of property damage. [**1:** 5.2.2.4] **Hazardous Materials Design Scenario 3.** Hazardous Materials Design Scenario 3 involves the application of an external factor to the hazardous material that is likely to result in a fire, explosion, toxic release, or other unsafe condition. This design scenario shall address the concern regarding the initiation of a hazardous materials event by the application of heat, shock, impact, or water onto a hazardous material being stored, used, handled, or dispensed in the facility. [**1:** 5.4.4.3] **Explosion Conditions.** The facility design shall provide an acceptable level of safety for occupants and for individuals immediately adjacent to the property from the effects of unintentional detonation or deflagration. [**1:** 5.2.2.2] 8 Fire or explosion in other hazardous materials resulting in release of hydrogen **Hazardous Materials Exposure.** The facility design shall provide an acceptable level of safety for occupants and for individuals immediately adjacent to the property from the effects of an unauthorized release of hazardous materials or the unintentional reaction of hazardous materials. [**1:** 5.2.2.3] **Hazardous Materials Design Scenario 3.** Hazardous Materials Design Scenario 3 involves the application of an external factor to the hazardous material that is likely to result in a fire, explosion, toxic release, or other unsafe condition. This design scenario shall address the concern regarding the initiation of a hazardous materials event by the application of heat, shock, impact, or water onto a hazardous material being stored, used, handled, or dispensed in the facility. [**1:** 5.4.4.3] 9 Fire or explosion in hydrogen system resulting in release of other hazardous materials **Hazardous Materials Exposure.** The facility design shall provide an acceptable~~

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~~level of safety for occupants and for individuals immediately adjacent to the property from the effects of an unauthorized release of hazardous materials or the unintentional reaction of hazardous materials. [**1:** 5.2.2.3] **Hazardous Materials Design Scenario 2.** Hazardous Materials Design Scenario 2 involves an exposure fire on a location where hazardous materials are stored, used, handled, or dispensed. This design scenario shall address the concern regarding how a fire in a facility affects the safe storage, handling, or use of hazardous materials. [**1:** 5.4.4.2] 10 Failure of equipment exposing hydrogen system to electrical hazard, physical, or health hazard; failure of system exposing utilities to failure **Property Protection.** The facility design shall limit the effects of all required design scenarios from causing an unacceptable level of property damage. [**1** :5.2.2.4] **Hazardous Materials Design Scenario 3.** Hazardous Materials Design Scenario 3 involves the application of an external factor to the hazardous material that is likely to result in a fire, explosion, toxic release, or other unsafe condition.~~

~~This design scenario shall address the concern regarding the initiation of a hazardous materials event by the application of heat, shock, impact, or water onto a hazardous material being stored, used, handled, or dispensed in the facility. [**1:** 5.4.4.3] **Public Welfare.** For facilities that serve a public welfare role as defined in 4.1.5 of NFPA 1, the facility design shall limit the effects of all required design scenarios from causing an unacceptable interruption of the facility's mission. [**1:** 5.2.2.5]~~

~~**E.2** Lower Flammable Limit — 4 Percent H_2 by Volume.~~

~~In scenarios where the concern is that a plume of unignited GH_2 from a release might reach an ignition source, the separation distance was determined using a computational fluid dynamics (CFD) model to determine the distance required to reduce the GH_2 concentration to 4 percent by volume. A concentration of 4 percent hydrogen in air has been shown to be the lower bounds of an ignitible mixture under ideal conditions for burning. As such, 4 percent is the established lower flammable limit for hydrogen mixtures in air.~~

~~**E.3** Use of 3 Percent of Internal Pipe Diameter (ID) as Leak Size.~~

~~A detailed description of the process used and the results achieved are provided in a technical article included in Annex H . [6] This process follows guidance by the Fire Protection Research Foundation published in March 2007 that encourages NFPA Technical Committees to use risk concepts in their decision-making process. [7] The risk-informed approach included two considerations: the frequency of hydrogen system leakage and the risk from leakage events.~~

~~Component leak frequencies as a function of leak size were generated for several hydrogen components. The hydrogen-specific leakage rates were used to estimate the leakage frequency for four example systems used as the basis for the risk evaluation used in the study. The cumulative probability for different leak sizes was then calculated to determine what range of leaks represents the most likely leak sizes. The results of this analysis indicated that leaks less than 0.1 percent of the component flow areas represent 95 percent of the leakage frequency for the example systems. Leak areas less than 10 percent of the flow area are estimated to result in 99 percent of the leaks that could occur based on the results of the analysis.~~

~~The risks resulting from different size leaks were also evaluated for four standard gas storage configurations. The risk evaluations indicate that the use of 0.1 percent of the component flow area as the basis for determining separation distances results in risk estimates that significantly exceed the 2×10^{-5} /yr risk guideline selected by the NFPA separation distance working group, particularly for the 7500 psig and 15,000 psig systems. On the other hand, use of a leak size equal to between 1 percent and 10 percent of the component flow area results in risk estimates that are reasonably close to the risk guideline. The fact that the risk estimates are a factor of 2 higher than the risk guideline for the 7500 psig and 15,000 psig example systems was weighed against the uncertainties in the QRA models, most of which result in conservative risk estimates.~~

~~Based on the results of both the system leakage frequency evaluation and the associated risk assessment, a diameter of 3 percent of the flow area corresponding to the largest internal pipe downstream of the highest pressure source in the system is used in the model. The use of a 3 percent leak area results in capturing an estimated 98 percent of the leaks that have been determined to be probable based on detailed analysis of the typical systems employed.~~

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~~**E.4** – Selected Heat Flux Values.~~

~~The values for heat flux used in development of the separation distance tables are as follows:~~

(1) ~~1,577 W/m^2 (500 Btu/hr-ft^2)~~

(2) ~~4,732 W/m^2 (1,500 Btu/hr-ft^2)~~

(3) ~~20,000 W/m^2 (6,340 Btu/hr-ft^2)~~

(4) ~~25,237 W/m^2 (8,000 Btu/hr-ft^2)~~

~~The basis for using each value is as follows:~~

(1) ~~1,577 W/m^2 (500 Btu/hr-ft^2) is used as the "no harm" value. This heat flux is defined by API 521, *Pressure Relieving and Depressuring Systems* , as the heat flux threshold to which personnel with appropriate clothing can be continuously exposed. [10] This value is slightly less than what the Society of Fire Protection Engineers determined to be the "no harm" heat flux threshold (540 Btu/hr-ft^2), that is, the maximum heat flux to which people can be exposed for prolonged periods of time without experiencing pain. [11]~~

(2) ~~4,732 W/m^2 (1,500 Btu/hr-ft^2) is defined by API 521 as the heat flux threshold in areas where emergency actions lasting several minutes might be required by personnel without shielding but with appropriate clothing. [10] It is also defined by the *International Fire Code* as the threshold for exposure to employees for a maximum of 3 minutes. [12]~~

(3) ~~20,000 W/m^2 (6,340 Btu/hr-ft^2) is generally considered the minimum heat flux for the nonpiloted ignition of combustible materials, such as wood. [13]~~

(4) ~~25,237 W/m^2 (8,000 Btu/hr-ft^2) is the threshold heat flux imposed by the *International Fire Code* for noncombustible materials. [12]~~

~~**E.5** – Pressure as a Controlling Parameter in Lieu of Volume.~~

~~The traditional approach of using volume as a determinant in the establishment of distance was revised in favor of using pressure as the determinate factor. The work of Houf and Schefer demonstrated that the flame radiation heat flux and flame length varied with the pressure of gas released across a given orifice. [2] In cases where the high pressure leak of hydrogen was unignited, a turbulent jet is formed and the area of the flammable envelope can be calculated.~~

~~Peak flows were used as a means to determine acceptable distances, and comparisons were made to contents. It was determined that once the threshold for a bulk supply had been exceeded, gas pressure, not volume, was the determining factor in establishing the radiant flux or the unignited jet concentration. Detailed analysis over a series of tank pressures of 18.25 bar (250 psig), 207.85 bar (3000 psig), 518.11 bar (7500 psig), and 1035.21 bar (15,000 psig) over a range of leak diameters were examined.~~

~~Transient effects varying the quantity and pressure decay over time were ruled out as controlling parameters. Volume was then considered to be at its worst case, which assumed that pressure was constant due to the volume contained. This is especially true for large systems typically encountered in commercial applications. Small systems using small-diameter tubing were accounted for by the use of tables that allow the user to calculate the benefit from the use of small-diameter systems.~~

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~~**E.6** – Updates to the Separation Distances Tables.~~

~~Since the publication of the two codes, several hydrogen storage systems have been installed in accordance with the risk-informed separation distances. These recent installations have provided an opportunity to examine how these requirements work in actual project applications. The project applications have been reviewed and found to meet an acceptable level of safety such that conservative assumptions made in the previous analysis could be reexamined. In addition, there was interest from the committees to perform a similar risk-based process to calculate separation distances for liquid bulk hydrogen storage systems. In 2014, the NFPA 2 and NFPA 55 Technical Committees created a task group with the following objectives:~~

(1) ~~Evaluate the risk criteria used to develop the separation distances for bulk gaseous hydrogen storage and make recommendations for changes in these distances based on the revised criteria.~~

(2) ~~Develop revised separation distances for bulk liquefied hydrogen storage based on a risk-informed methodology parallel to the process used in the previous update of the gaseous requirements.~~

~~Objective one is discussed in Section E.7 and objective two is discussed in Section E.8 .~~

~~**E.7** – Updates to the Gaseous Hydrogen Separation Distance Tables.~~

~~For each of the exposures listed in Table E.1(a) , potential hazard scenarios associated with ignited and unignited hydrogen jets were identified. Harm criteria, including heat flux levels and a 4% mole fraction of hydrogen which represents the potential for a flash fire given delayed ignition, were chosen depending on the scenario. Three risk criteria thresholds that were used in the 2010 edition of NFPA 55 were reexamined: lower flammable limit, leak size, and heat flux levels.~~

~~*Lower Flammable Limit — 8 Percent H2 by Volume* .~~

~~The task group reviewed the hydrogen concentration threshold. Based on work done at Sandia National Laboratories Combustion Research Facility, the Group concluded that there would not be sustained ignition at hydrogen concentrations of 8% or less. [16] There could be localized hydrogen ignition, but it would not develop into sustained combustion.~~

~~*Use of 1 Percent of Internal Pipe Diameter (ID) as Leak Size*~~

~~The cumulative probability for different leak sizes was calculated to determine what range of leaks represents the most likely leak sizes, as discussed in Section E.3 . The system leakage frequency corresponds to the largest internal pipe downstream of the highest pressure source in the system. The results of this analysis indicated that leaks less than 0.1 percent of the component flow areas represent 95 percent of the leakage frequency for the example systems, however the risk resulting from this small leak size significantly exceeded the~~ 2×10^{-5} ~~/yr risk guideline set by the task group. At the same time, the use of a leak size between 1 percent and 10 percent of the component flow area results in risk estimates that are reasonably close to the risk guideline.~~

~~Based on the results of both the system leakage frequency evaluation and the associated risk assessment, the task group decided that adjusting to a diameter of 1 percent value, instead of a 3 percent, would remove excess conservatism from the input assumption to the model. The 1 percent value still accounts for 95 percent of the leakage frequency from the example systems and does not exceed the~~ 2×10^{-5} ~~/year risk guideline established in the previous analysis. This results in more permissive separation distance requirements with no change in risk.~~

~~*Selected Heat Flux Values*~~

~~The task group reviewed the heat flux values discussed in Section E.4 and determined that the use of a "no harm" criteria was overly conservative. This heat flux assumes exposed persons will not take protective actions, such as moving away from the fire scene. The task group deemed it reasonable to assume that exposed personnel will relocate away from a fire scene within a few minutes and therefore the "no harm" criteria is not appropriate for establishing separation distances. Exposures that were analyzed based on this heat flux value were updated to reflect the harm distance for a radiation heat flux level of~~ 4.7 kW/m^2 ~~. The task group decided not to change the three other heat flux values.~~

~~Table E.7 shows the revised separation distances for the four storage pressure ranges based on the task group's recommended changes in risk criteria and exposures grouped by the harm criteria that the distance is based upon. The safety distances in the table are rounded to the nearest whole number and a safety factor of 1.5 has been added to the values. The significance of these potential changes can be shown in the high pressure column for the Group 1 Exposures. The reduction in separation distances from 34 feet to 16 feet for bulk gaseous systems would allow these systems to be placed in more locations, including existing gasoline fueling stations and other space constrained locations.~~

~~Table E.7 Updated Values to 2016 NFPA 2 and NFPA 55 Tables with 1.5 Safety Factor~~

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~~Separation Distance Exposures >0.10 to 1.7 MPa (>15 to 250 psig) >1.7 to 20.7 MPa (>250 to 3000 psig) >20.7 to 51.7 MPa (>3000 to 7500 psig) 51.7 to 103.4 MPa (7500 to 15000 psig) Group 1 2010 edition 12 m (40 ft.) 14 m (46 ft.) 9 m (29 ft.) 10 m (34 ft.) 2019 edition 5 m (16 ft.) 6 m (20 ft.) 4 m (13 ft.) 5 m (16 ft.) Group 2 2010 edition 6 m (20 ft.) 7 m (24 ft.) 4 m (13 ft.) 5 m (16 ft.) 2019 edition 5 m (16 ft.) 6 m (20 ft.) 3 m (10 ft.) 4 m (13 ft.) Group 3 2010 edition 5 m (17 ft.) 6 m (19 ft.) 4 m (12 ft.) 4 m (14 ft.) 2019 edition 4 m (13 ft.) 5 m (16 ft.) 3 m (10 ft.) 4 m (13 ft.)~~

~~Notes:~~

~~Group 1 Exposures include: lot lines, air intakes, operable openings in buildings and structures, and ignition sources. Group 1 separation distances are based on the higher value of radiation heat flux of 4.7 kW/m ^{2} or the unignited jet concentration decay distance of 8% hydrogen volume fraction concentration. In this instance, the separation distance is higher for the concentration value than the heat flux value.~~

~~Group 2 Exposures include: parked cars, exposed persons other than those servicing the system. Group 2 separation distances are based on the higher value of the incident radiation heat flux of 4.7 kW/m ^{2} exposure to employees for a maximum of 3 minutes or the visible flame length.~~

~~Group 3 Exposures includes everything else (e.g., buildings of combustible construction, ordinary combustibles, openings in buildings and structures). Group 3 separation distances are based on the higher value of the radiant heat flux for noncombustible equipment of 25.2 kW/m ^{2} or the visible flame length.~~

~~**E.8** – Updates to the Liquid Hydrogen Separation Distance Tables.~~

~~The joint NFPA 55 and NFPA 2 task group was also formed to develop a scientific basis for the separation distances for bulk liquefied hydrogen storage systems. The task group has the following objectives:~~

(1) ~~Define a representative bulk liquefied hydrogen storage system.~~

(2) ~~Perform a risk analysis on the system to determine the release scenarios with the highest risk.~~

(3) ~~Evaluate the risk criteria for each of the highest risk release scenarios by using a scientific model that predicts the extent of specific hydrogen concentrations and heat fluxes.~~

(4) ~~Acquire leak frequency data from the discharge points from the highest risk release scenarios.~~

(5) ~~Perform an integrated analysis of releases and leak frequencies to estimate the system separation distances using the risk threshold of 2 x 10 $^{-5}$ fatalities/yr.~~

~~The task group decided to use the liquefied hydrogen system described in the Compressed Gas Association, Inc. (CGA) P-28, OSHA Process Safety Management and EPA Risk Management Plan Guidance Document for Bulk Liquid Hydrogen Systems, as the representative system. The representative system contains a liquid hydrogen storage tank, a pressure buildup circuit and economizer, vaporizer, and pump. CGA P-28 also contained a representative hazard and operability study (HAZOP) that was performed on the representative bulk liquid hydrogen system. The process was divided into seven segments, called nodes, which were as follows:~~

(1) ~~Delivery trailer, hose, and fill line to the storage vessel~~

(2) ~~Storage tank~~

(3) ~~Pressure buildup circuit and economizer~~

(4) ~~Hydrogen line — liquid through the vaporizer to the final line~~

(5) ~~Hydrogen pump~~

(6) ~~Vent stacks~~

(7) ~~General items~~

~~In CGA P-28, each node was examined based on deviations from normal operating parameters that could have potentially hazardous consequences. The task group started with this division of the system and analyzed each node deviation to come up with event likelihood and hazard severity. Event likelihood was the annual probability that the deviation may occur for each node, with the highest level expecting the deviation to occur once per year or more and the lowest level expected to occur once per 10,000 years, documented in Table E.8(a) . Hazard severity classified the consequence from the node deviation. The hazard severity ranged from negligible to catastrophic, documented in Table E.8(b) . The task group estimated the event likelihood and severity based on industry experience and subject matter expertise and had to agree with the levels given to each node deviation.~~

~~Table E.8(a) Event Likelihood Classification Table~~

~~Level Annual Probability Probability Description 1 Frequent > 1.0 Expected to occur once per year or more frequently. 2 Reasonably probable 1.0 to 0.1 Expected to occur once per 10 years. 3 Occasional~~

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~~0.01 to 0.1 Expected to occur once per 100 years. 4 Remote 0.001 to 0.01 Expected to occur once per 1000 years. 5 Extremely remote 0.0001 to 0.001 Expected to occur once per 10,000 years. 6 Improbable < 0.0001 Expected to occur less than once per 10,000 years. Extremely unlikely to occur~~

~~Table E.8(b) Hazard Severity Classification Table~~

~~Level Description Potential Consequences 1 Catastrophic Could cause fatality to nonassociated members of the public 2 Critical Could cause severe injury to nonassociated members of the public, fatality or serious injury to works of the public, fatality or serious injury to workers of persons conducting business at a refueling site or significant damage to equipment/facilities 3 Marginal Could cause minor injury, or minor system damage 4 Negligible Will not result in injury or system damage~~

~~Based on the level of likelihood and severity, the node deviation was given a risk ranking, documented in Figure E.8 . A few assumptions were made for this analysis. First, the task group assumed an NFPA 55 and a CGA H-5 code-complaint system. The scenarios would only have a single failure, and cascading failures would not be analyzed. The current setback distances did not provide any credit during this analysis and tornadoes were not included in the natural disaster considerations.~~

~~**Figure E.8 Risk Ranking Table.**~~

		Likelihood					
		1	2	3	4	5	6
Severity	1	1	1	1	2	3	4
	2	1	1	2	3	3	4
	3	2	2	3	3	4	4
	4	4	4	4	4	4	4

1: High risk
2: Moderate risk
3: Low risk
4: Routine risk

~~After the task group had prioritized all 102 node deviations, the risk-ranked results were reviewed and discussed. Two scenarios were added, based on feedback from the task group, which analyzed high and normal flow from a trailer vent stack. In total, the task group chose nine scenarios with the highest risk to analyze further. The first six scenarios listed occur during liquid hydrogen (LH_2) transfer operations from a tanker truck to the bulk LH_2 storage tank. The two scenarios that the task group added are included in this list. The other three scenarios occur during normal system operations. For each of the scenarios, the task group decided upon the inputs to liquid hydrogen models and the risk criteria for analysis.~~

~~Sandia developed a cryogenic hydrogen integral jet and plume model, called COLDPLUME, which is intended to be used to predict release characteristics from various real-world hydrogen storage states. [17] Sandia is also developing a network flow model that accounts for internal system flows from the storage vessel to the release plane, called NETFLOW, which will be suitable for liquid and multiphase cryogen flows. [18] These models are currently under development and experimental validation. Once modeling results are available, the hydrogen exposure risk criteria used for the bulk gaseous separation distances will be used to develop the new liquid separation distance table. [See Table E.8(c) .]~~

~~Table E.8(c) HAZOP Scenarios and Modeling Notes~~

~~- HAZOP Number and Description Modeling Notes Separation Distance Driver Release scenarios during liquid transfer to bulk storage tank 1.18 High-flow gaseous hydrogen from trailer vent stack due to venting excess pressure after LH_2 transfer Sandia's NETFLOW and COLDPLUME models will characterize the temperature and concentration from the trailer vent stack. The task group would like to model an estimate of up to 50 kg of cold, gaseous hydrogen. - - 1.19 Normal flow from trailer vent stack due to venting excess pressure after LH_2 transfer Sandia's NETFLOW and COLDPLUME models will characterize the temperature and concentration from the trailer vent stack. The task group would like to model an estimate of up to 50 kg of cold, gaseous hydrogen. Modeling results will be used to calculate~~

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~~separation distance from air intakes and overhead utilities because this is the highest frequency release and the release point is in closest proximity to these exposures. - 1.6 High flow from line rupture, valve or component failure during transfer process Sandia's NETFLOW and COLDPLUME models will characterize the temperature and concentration from the release to the air. A model is needed to characterize pooling and evaporation effects. - - 1.4 High temperature caused by external fire will cause high flow venting through tank vent stack Sandia's NETFLOW and COLDPLUME models will characterize the temperature and concentration from the trailer vent stack. This is the worst case venting scenario from the pressure relief device to a high ambient temperature. - - 1.8 Reverse flow during transfer process caused by human error and pressure mismanagement Sandia's NETFLOW and COLDPLUME models will characterize the temperature and concentration from the release to the air. A model is needed to characterize pooling and evaporation effects. - - 1.16 Loss of containment from external impacts, consider all causes The task group postulated a vehicle crash into the tanker during transfer. This causes a transfer hose rupture with NETFLOW and COLDPLUME models characterizing the release to the air. A model is needed to characterize pooling and evaporation effects. - Release scenarios during normal system operation 4.15 Loss of containment from pipe leading from tank to vaporizer or vaporizer itself caused by thermal cycles or ice falling from vaporizers Sandia's NETFLOW and COLDPLUME models will characterize the temperature and concentration from the release to the air. A model is needed to characterize pooling and evaporation effects. Modeling results of hydrogen concentration plume and heat flux from a subsequent fire will be used for all other separation distance exposures because this is the highest risk priority during normal operations. - 6.15 Misdirected flow caused by operator error resulting in large low-level release of cold gaseous hydrogen through bottom drain valve of vent stack during normal tank venting process Sandia's NETFLOW model will capture how much gas is going out of the drain vent and vent stack. Sandia's COLDPLUME model can characterize the temperature and concentrations from the releases to the air. A model is needed to characterize pooling and evaporation effects. - - 2.1 High pressure because of a leak in inner vessel allowing hydrogen into the vacuum area Sandia's NETFLOW and COLDPLUME models can characterize the flow out of the casing vent (a large hole instead of a pipe orifice). -~~

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~~**E.9** – References.~~

(1) ~~NFPA 1, *Fire Code* , 2018 edition.~~

(2) ~~W. Houf and R. Schefer, "Predicting Radiative Heat Fluxes and Flammability Envelopes from Unintended Releases of Hydrogen," *International Journal of Hydrogen Energy* , Elsevier Publishing, 2007, Vol. 32, pp. 136–151.~~

(3) ~~J. Floyd, *Siting Requirements for Hydrogen Supplies Serving Fuel Cells in Non-Combustible Enclosures* , Hughes Associates, Inc., 3610 Commerce Drive, Suite 817, Baltimore, MD 21227, HAI Project #3250-000, November 30, 2006.~~

(4) ~~J. LaChance, *Risk-Informed Separation Distances for Hydrogen Refueling Stations* , Risk and Reliability Department, Sandia National Laboratories, Albuquerque, NM, May 2007. (Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under Contract DE-AC04-94-AL85000.)~~

(5) ~~Ibid, p. 11, reference to *Fires in or at Service Stations and Motor Vehicle Repair and Paint Shops,* NFPA, April 2002.~~

(6) ~~J. LaChance, W. Houf, B. Middleton (all of Sandia National Laboratories), and L. Fluer (of Fluer, Inc.), "Analyses to Support Development of Risk-Informed Separation Distances for NFPA Hydrogen Codes and Standards," SAND 2009-0874, Sandia National Laboratories, Albuquerque, NM 87185, and Livermore, CA 94550, March 2009.~~

(7) ~~S. E. Rose, S. Flamberg, and F. Leverenz, "Guidance Document for Incorporating Risk Concepts into NFPA Codes and Standards," Fire Protection Research Foundation, March 2007.~~

(8) ~~"Determination of Safety Distances," European Industrial Gases Association, IGC Doc. 75/07/E, 2007.~~

(9) ~~C. L. Atwood, J. L. LaChance, H. F. Martz, D. J. Anderson, M. Englehardt, D. Whitehead, and T. Wheeler, "Handbook of Parameter Estimation for Probabilistic Risk Assessment," NUREG/CR-6823, U.S. Nuclear Regulatory Commission, Washington, DC, 2003.~~

(10) ~~API Recommended Practice 521, *Guide for Pressure Relieving and Depressuring Systems* , 4th edition, March 1997, API Publishing Services, 1220 L. St. N.W., Washington, DC 20005, Table 8, p. 41.~~

(11) ~~"Predicting 1st and 2nd Degree Skin Burns from Thermal Radiation," *SFPE Engineering Guide* , Society of Fire Protection Engineers, Bethesda, MD 20814, March 2000, p. 8.~~

(12) ~~ICC, *International Fire Code* ™, 2006 edition, International Code Council, 4051 West Flossmoor Road, Country Club Hills, IL 60478-5795, Table 2209.5.4.3.6(1), p. 210.~~

(13) ~~V. Babrauskas, "Ignition of Wood: A Review of the State of the Art," Interflam 2001, Interscience Communications Ltd., London, 2001, pp. 71–88.~~

(14) ~~J. LaChance, J. Phillips, and W. Houf, "Risk Associated with the Use of Barriers in Hydrogen Refueling Stations," National Hydrogen Association Conference & Expo, Long Beach, CA, May 3–6, 2010.~~

(15) ~~W. Houf, R. Schefer, G. Evans, E. Merilo, and M. Groethe, "Evaluation of Barrier Walls for Mitigation of Unintended Releases of Hydrogen," *International Journal of Hydrogen Energy* , Vol. 35, Issue 10, May 2010, pp. 4758–4775.~~

(16) ~~R. W., Schefer, G. H., Evans, J. Zhang, A. J., Ruggles, and R. Grief. "Ignitability limits for combustion of unintended hydrogen releases: Experimental and theoretical result," *International Journal of Hydrogen Energy* , Vol. 36, 2011.~~

(17) ~~W. Houf, R. Schefer, "Analytical experimental investigation of small-scale unintended releases of hydrogen," *International Journal of Hydrogen Energy* , Vol. 33, 2008, pp. 1435-44.~~

(18) ~~Winters, W. S., "A New Approach to Modeling Fluid/Gas Flows in Networks." SAND2001-8422, Sandia National Laboratories, July 2001.~~

(1) ~~**Delete Annex E**~~

Statement of Problem and Substantiation for Public Input

Annex E is dated in that it refers to 3% leak sizes, 400 SCF for a bulk system, and 4% flammability range. Since this is an external paper, it's not appropriate to change these values.

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As a result, this annex adds confusion since it's inconsistent with the current Standard and other Annex material. Add a reference to this document as background information in Annex A for historical context, but not in it's entirety as it is in Annex E.

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Public Input No. 98-NFPA 55-2020 [Chapter E]

~~**Annex E** – Explanation of Methodology Utilized to Develop Separation Distances~~

~~*This annex is not part of the requirements of this NFPA document but is included for informational purposes only.*~~

~~**E.1** – Separation Distances Tables Methodology History.~~

~~The evaluation of separation distances for bulk gaseous hydrogen systems was the subject of study of a joint task group that comprised members of NFPA's Hydrogen Technology Technical Committee and the Industrial and Medical Gases Technical Committee. The task of the group was to examine the exposure distances published in Table 10.3.2.2.1 of the 2005 edition of NFPA 55 for the purpose of validation or revision based on a scientific approach that could be substantiated either through testing or through generally accepted scientific means for the 2010 edition of NFPA 55.~~

~~In the 2016 edition of NFPA 55, exposures were grouped in 10.4.2.2.1(a) based upon the rationale for determining the associated hazard, as shown in Table E.1(a) and Table E.1(b) . Table E.1(a) is cross-referenced to Table 10.4.2.2.1(a) by exposure group number and row letter. Notes are provided to indicate the specific rationale considered for each of the exposures listed. The notes are then cross-referenced to specific hazard scenarios further defined in Table E.1(b) . The performance criteria and design scenarios have been extracted from NFPA 1 as indicated in the extracts provided. [1] For each exposure, the effects of a release were considered within the context of hazard scenarios developed in the performance approach foundational to determining the design scenarios outlined in the performance-based option in NFPA 1.~~

~~In the event alternative materials or methods are to be employed when bulk systems are installed, code users should be aware of the specific hazard scenarios used to analyze each exposure.~~

~~Studies by Houf and Schefer of Sandia National Laboratories (Sandia) predicted the radiative heat flux at various distances resulting from the ignition of turbulent jet releases of hydrogen from systems at various pressures. In addition, the concentrations of an unignited hydrogen jet in the surrounding air and the envelope where the concentration falls below the lower flammability limit for hydrogen were determined. [2] Understanding the consequences of release in terms of thermal flux or the boundaries of the unignited cloud were then used to determine distances that were believed to be appropriate based on the consequence of a release. The consequence approach is referred to as a deterministic approach because distances are determined based on consequence alone. Another consequence-based approach, found in a project sponsored by NFPA's Fire Protection Research Foundation, to determine appropriate separation distances for certain installations of bulk gaseous hydrogen systems was also reviewed by the task group, and comparisons were made to the existing requirements in the 2005 edition of NFPA 55. [3]~~

~~As the group evaluated the impact of the deterministic tables, it became apparent that the probability of occurrence of events should have a bearing on determining a reasonable level of safety.~~

~~The work of the task group integrated the efforts of Sandia's risk and reliability department, as part of the U.S. Department of Energy Hydrogen, Fuel Cells & Infrastructure Technologies Program.~~

~~Researchers at Sandia developed benchmark experiments and a defensible analysis strategy for risk and consequence assessment of unintended releases from gaseous hydrogen systems. This work included experimentation and modeling to understand the fluid mechanics and dispersion of hydrogen for different release scenarios, including investigations of hydrogen combustion and subsequent heat transfer from hydrogen flames. The resulting technical information was incorporated into engineering models that were used for assessment of different hydrogen release scenarios and for input into quantitative risk assessments (QRA) of hydrogen facilities.~~

~~The QRAs were used to identify and quantify scenarios for the unintended release of hydrogen, identify the significant risk contributors at different types of hydrogen facilities, and to identify potential accident prevention and mitigation strategies to reduce the risk to acceptable levels. [4]~~

~~To evaluate risk, the history of leakage data from high-pressure compressed gas systems was needed. Hydrogen-specific leak data were provided by one of the major suppliers through the use of a 5-year documented collection of leak data from both industrial and fueling uses. These data were augmented with data from other sources after being reviewed for applicability, and representative values were selected. The source documents considered in augmentation of hydrogen-specific data included the following publications:~~

(1) ~~"Determination of Safety Distances," European Industrial Gases Association, IGC Doc 75/07/E, 2007~~

(2) ~~A. W. Cox, F. P. Lees, and M. L. Ang, "Classification of Hazardous Locations," Institution of Chemical Engineers, May 2003~~

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(3) ~~C. H. Blanton and S. A. Eide, "Savannah River Site Generic Data Base Development," WSRC-TR-93-262, Westinghouse Savannah River Company, June 30, 1993~~

(4) ~~J. Spouge, "New Generic Leak Frequencies for Process Equipment," *Process Safety Progress* (Vol. 24, No. 4), December 2005~~

~~A hierarchy was developed that gave hydrogen-specific data the highest priority, followed by non-gas-specific data where available for high pressure components. Piping and instrumentation drawings (P&IDs) were then prepared to define a standard bulk supply system in terms of modules that might be found in the typical system. The P&IDs can be found in A.3.3.95.9.1 . The P&IDs were reviewed by suppliers and the typical nature verified.~~

~~Frequency and size of leaks encountered were evaluated across a number of systems, including both industrial and fueling operations. The leak/failure data were then applied to "typical" fitting counts (i.e., components) integral to each of the modules identified in the P&IDs for each of the components. The failure data were based on the most recent 5-year history for high-pressure systems. Hydrogen-specific data were provided by Compressed Gas Association (CGA) representatives. These data were augmented by failure data from other resources obtained by researchers from Sandia and combined to quantify a probability for failure on a component-by-component basis [e.g., hoses (pigtails), valves, instruments, joints, pipe]. The analysis resulted in a probability for failure being developed for each component, which could then be wrapped into failures expected across the spectrum of the various modules included in the array of P&IDs developed.~~

~~A Bayesian approach to the determination of probability was used in the analysis of data by researchers at Sandia. The technical approach and supporting details can be found in the articles listed in Annex H and informational articles found in I.2 . The advantage of the Bayesian approach is that it can combine data from different sources to include uncertainty. This approach is contrary to what has been done in other sources. For example, judgment can be used as a means to determine risk; however, that method does not provide for uncertainty. Such methods are qualitative at best. By comparison, the use of specific leak data results in a quantitative approach.~~

~~The tables developed for inclusion in Chapter 10 of the 2010 edition of NFPA 55 are said to be *risk informed* , not *risk based* , the difference being that integral to the risk tables is a series of decisions based on the applicability of various factors. For example, with respect to thermal flux, one could use a series of exposures from *no harm* to *fatality* , and those exposures could then be taken from the point of various receptors (workers, people on the property where the installation is located, people off the property, etc.). One of the primary decisions made by the group was that in the final analysis the risk presented for the typical GH~~ $_2$ ~~installation (either industrial or fueling applications) should present no greater risk to the public in terms of fatalities or injuries than does an existing gasoline service station. The average frequency of a fatality associated with the operation of a single gasoline station has been reported to be approximately 2E-5/yr. [5] Other key decisions of the group included the parameters given in Sections E.2 through E.5 .~~

~~Table E.1(a) Hazard Scenario~~

~~Row Group 1 Exposures greater of a or b Hazard Scenario Rationale c (a) Lot lines 1, 2, 3, 4, 5 (b) Air intakes (HVAC, compressors, other) 1 (c) Operable openings in buildings and structures 1, 2 (d) Ignition sources such as open flames and welding 3, 5~~ **~~Row Group 2 Exposures d Hazard Scenario Rationale c~~** ~~(a) Exposed persons other than those involved in servicing of the system 4 (b) Parked cars 4~~ **~~Row Group 3 Exposures e Hazard Scenario Rationale c~~** ~~(a) Buildings of noncombustible non-fire-rated construction 2 (b) Buildings of combustible construction 2 - - - (c) Flammable gas storage systems above or below ground 2 (d) Hazardous materials storage systems above or below ground 6, 7, 8, 9 (e) Heavy timber, coal, or other slow-burning combustible solids 2 (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 2 (g) Unopenable openings in buildings and structures 1, 2 - - - - - - (h) Encroachment by overhead utilities (horizontal distance from the vertical plane below the nearest overhead electrical wire of building service) 2, 10 (i) Piping containing other hazardous materials 6, 7, 8, 9 (j) Flammable gas metering and regulating stations such as natural gas or propane 6, 7, 8, 9 -~~

~~a Unignited jet concentration decay distance to 4 percent mole fraction (volume fraction) hydrogen.~~

~~b~~ D_{rad} ~~— radiation heat flux level of 1577~~ W/m^2 ~~.~~

~~c See Table E.1(b) for explanation of notes.~~

~~d~~ D_{rad} ~~for heat flux level of 4732~~ W/m^2 ~~exposure to employees for a maximum of 3 minutes.~~

~~e The greater of~~ D_{rad} ~~for combustible heat flux level of 20,000~~ W/m^2 ~~or the visible flame length.~~

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~~Table E.1(b) Hazard Scenario Rationale Notes to Table E.1(a)~~

~~Note Number Statement Performance Criteria Hazardous Materials~~

~~Design Scenario 1 Gas release and subsequent entrainment or accumulation by the receptor **Explosion Conditions.** The facility design shall provide an acceptable level of safety for occupants and for individuals immediately adjacent to the property from the effects of unintentional detonation or deflagration. [**1:** 5.2.2.2] **Hazardous Materials Design Scenario 1.** Hazardous Materials Design Scenario 1 involves an unauthorized release of hazardous materials from a single control area. This design scenario shall address the concern regarding the spread of hazardous conditions from the point of release. [**1:** 5.4.4.1] 2 Fire spread to or from adjacent equipment or structure **Property Protection.** The facility design shall limit the effects of all required design scenarios from causing an unacceptable level of property damage. [**1:** 5.2.2.4] **Hazardous Materials Design Scenario 2.** Hazardous Materials Design Scenario 2 involves an exposure fire on a location where hazardous materials are stored, used, handled, or dispensed. This design scenario shall address the concern regarding how a fire in a facility affects the safe storage, handling, or use of hazardous materials. [**1:** 5.4.4.2] 3 Gas explosion hazard on site or affecting adjacent property **Explosion Conditions.** The facility design shall provide an acceptable level of safety for occupants and for individuals immediately adjacent to the property from the effects of unintentional detonation or deflagration. [**1:** 5.2.2.2] **Hazardous Materials Design Scenario 1.** Hazardous Materials Design Scenario 1 involves an unauthorized release of hazardous materials from a single control area. This design scenario shall address the concern regarding the spread of hazardous conditions from the point of release. [**1:** 5.4.4.1] 4 Threat of injuries on site or adjacent property **Hazardous Materials Exposure.** The facility design shall provide an acceptable level of safety for occupants and for individuals immediately adjacent to the property from the effects of an unauthorized release of hazardous materials or the unintentional reaction of hazardous materials. [**1:** 5.2.2.3] **Hazardous Materials Design Scenario 2.** Hazardous Materials Design Scenario 2 involves an exposure fire on a location where hazardous materials are stored, used, handled, or dispensed. This design scenario shall address the concern regarding how a fire in a facility affects the safe storage, handling, or use of hazardous materials. [**1:** 5.4.4.2] **Hazardous Materials Design Scenario 4.** Hazardous Materials Design Scenario 4 involves an unauthorized discharge with each protection system independently rendered ineffective. This set of design hazardous materials scenarios shall address concern regarding each protection system or protection feature, considered individually, being unreliable or becoming unavailable. [**1:** 5.4.4.4.1] 5 Ignition of an unignited release/vented hydrogen **Explosion Conditions.** The facility design shall provide an acceptable level of safety for occupants and for individuals immediately adjacent to the property from the effects of unintentional detonation or deflagration. [**1:** 5.2.2.2] **Hazardous Materials Design Scenario 1.** Hazardous Materials Design Scenario 1 involves an unauthorized release of hazardous materials from a single control area. This design scenario shall address the concern regarding the spread of hazardous conditions from the point of release. [**1:** 5.4.4.1] 6 Damage to exposed components of underground system that are exposed above ground **Property Protection.** The facility design shall limit the effects of all required design scenarios from causing an unacceptable level of property damage. [**1:** 5.2.2.4] **Hazardous Materials Design Scenario 1.** Hazardous Materials Design Scenario 1 involves an unauthorized release of hazardous materials from a single control area. This design scenario shall address the concern regarding the spread of hazardous conditions from the point of release. [**1:** 5.4.4.1] 7 Damage to aboveground system due to function of explosion control system used to vent underground vault or structure **Property Protection.** The facility design shall limit the effects of all required design scenarios from causing an unacceptable level of property damage. [**1:** 5.2.2.4] **Hazardous Materials Design Scenario 3.** Hazardous Materials Design Scenario 3 involves the application of an external factor to the hazardous material that is likely to result in a fire, explosion, toxic release, or other unsafe condition. This design scenario shall address the concern regarding the initiation of a hazardous materials event by the application of heat, shock, impact, or water onto a hazardous material being stored, used, handled, or dispensed in the facility. [**1:** 5.4.4.3] **Explosion Conditions.** The facility design shall provide an acceptable level of safety for occupants and for individuals immediately adjacent to the property from the effects of unintentional detonation or deflagration. [**1:** 5.2.2.2] 8 Fire or explosion in other hazardous materials resulting in release of hydrogen **Hazardous Materials Exposure.** The facility design shall provide an acceptable level of safety for occupants and for individuals immediately adjacent to the property from the effects of an unauthorized release of hazardous materials or the unintentional reaction of hazardous materials. [**1:** 5.2.2.3] **Hazardous Materials Design Scenario 3.** Hazardous Materials Design Scenario 3 involves the application of an external factor to the hazardous material that is likely to result in a fire, explosion, toxic release, or other unsafe condition. This design scenario shall address the concern regarding the initiation of a hazardous materials event by the application of heat, shock, impact, or water onto a hazardous material being stored, used, handled, or dispensed in the facility. [**1:** 5.4.4.3] 9 Fire or explosion in hydrogen system resulting in release of other hazardous materials **Hazardous Materials Exposure.** The facility design shall provide an acceptable level of safety for occupants and for individuals immediately adjacent to the property from the effects of an unauthorized release of hazardous materials or the unintentional reaction of hazardous materials. [**1:** 5.2.2.3] **Hazardous Materials Design Scenario 2.** Hazardous Materials Design Scenario 2~~

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~~involves an exposure fire on a location where hazardous materials are stored, used, handled, or dispensed. This design scenario shall address the concern regarding how a fire in a facility affects the safe storage, handling, or use of hazardous materials. [**1:** 5.4.4.2] 10 Failure of equipment exposing hydrogen system to electrical hazard, physical, or health hazard; failure of system exposing utilities to failure **Property Protection.** The facility design shall limit the effects of all required design scenarios from causing an unacceptable level of property damage. [**1** :5.2.2.4] **Hazardous Materials Design Scenario 3.** Hazardous Materials Design Scenario 3 involves the application of an external factor to the hazardous material that is likely to result in a fire, explosion, toxic release, or other unsafe condition.~~

~~This design scenario shall address the concern regarding the initiation of a hazardous materials event by the application of heat, shock, impact, or water onto a hazardous material being stored, used, handled, or dispensed in the facility. [**1:** 5.4.4.3] **Public Welfare.** For facilities that serve a public welfare role as defined in 4.1.5 of NFPA 1, the facility design shall limit the effects of all required design scenarios from causing an unacceptable interruption of the facility's mission. [**1:** 5.2.2.5]~~

~~**E.2** Lower Flammable Limit — 4 Percent H_2 by Volume.~~

~~In scenarios where the concern is that a plume of unignited GH_2 from a release might reach an ignition source, the separation distance was determined using a computational fluid dynamics (CFD) model to determine the distance required to reduce the GH_2 concentration to 4 percent by volume. A concentration of 4 percent hydrogen in air has been shown to be the lower bounds of an ignitible mixture under ideal conditions for burning. As such, 4 percent is the established lower flammable limit for hydrogen mixtures in air.~~

~~**E.3** Use of 3 Percent of Internal Pipe Diameter (ID) as Leak Size.~~

~~A detailed description of the process used and the results achieved are provided in a technical article included in Annex H . [6] This process follows guidance by the Fire Protection Research Foundation published in March 2007 that encourages NFPA Technical Committees to use risk concepts in their decision-making process. [7] The risk-informed approach included two considerations: the frequency of hydrogen system leakage and the risk from leakage events.~~

~~Component leak frequencies as a function of leak size were generated for several hydrogen components. The hydrogen-specific leakage rates were used to estimate the leakage frequency for four example systems used as the basis for the risk evaluation used in the study. The cumulative probability for different leak sizes was then calculated to determine what range of leaks represents the most likely leak sizes. The results of this analysis indicated that leaks less than 0.1 percent of the component flow areas represent 95 percent of the leakage frequency for the example systems. Leak areas less than 10 percent of the flow area are estimated to result in 99 percent of the leaks that could occur based on the results of the analysis.~~

~~The risks resulting from different size leaks were also evaluated for four standard gas storage configurations. The risk evaluations indicate that the use of 0.1 percent of the component flow area as the basis for determining separation distances results in risk estimates that significantly exceed the 2×10^{-5} /yr risk guideline selected by the NFPA separation distance working group, particularly for the 7500 psig and 15,000 psig systems. On the other hand, use of a leak size equal to between 1 percent and 10 percent of the component flow area results in risk estimates that are reasonably close to the risk guideline. The fact that the risk estimates are a factor of 2 higher than the risk guideline for the 7500 psig and 15,000 psig example systems was weighed against the uncertainties in the QRA models, most of which result in conservative risk estimates.~~

~~Based on the results of both the system leakage frequency evaluation and the associated risk assessment, a diameter of 3 percent of the flow area corresponding to the largest internal pipe downstream of the highest pressure source in the system is used in the model. The use of a 3 percent leak area results in capturing an estimated 98 percent of the leaks that have been determined to be probable based on detailed analysis of the typical systems employed.~~

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~~**E.4** – Selected Heat Flux Values.~~

~~The values for heat flux used in development of the separation distance tables are as follows:~~

(1) ~~1,577 W/m^2 (500 Btu/hr-ft^2)~~

(2) ~~4,732 W/m^2 (1,500 Btu/hr-ft^2)~~

(3) ~~20,000 W/m^2 (6,340 Btu/hr-ft^2)~~

(4) ~~25,237 W/m^2 (8,000 Btu/hr-ft^2)~~

~~The basis for using each value is as follows:~~

(1) ~~1,577 W/m^2 (500 Btu/hr-ft^2) is used as the "no harm" value. This heat flux is defined by API 521, *Pressure Relieving and Depressuring Systems*, as the heat flux threshold to which personnel with appropriate clothing can be continuously exposed. [10] This value is slightly less than what the Society of Fire Protection Engineers determined to be the "no harm" heat flux threshold (540 Btu/hr-ft^2), that is, the maximum heat flux to which people can be exposed for prolonged periods of time without experiencing pain. [11]~~

(2) ~~4,732 W/m^2 (1,500 Btu/hr-ft^2) is defined by API 521 as the heat flux threshold in areas where emergency actions lasting several minutes might be required by personnel without shielding but with appropriate clothing. [10] It is also defined by the *International Fire Code* as the threshold for exposure to employees for a maximum of 3 minutes. [12]~~

(3) ~~20,000 W/m^2 (6,340 Btu/hr-ft^2) is generally considered the minimum heat flux for the nonpiloted ignition of combustible materials, such as wood. [13]~~

(4) ~~25,237 W/m^2 (8,000 Btu/hr-ft^2) is the threshold heat flux imposed by the *International Fire Code* for noncombustible materials. [12]~~

~~**E.5** – Pressure as a Controlling Parameter in Lieu of Volume.~~

~~The traditional approach of using volume as a determinant in the establishment of distance was revised in favor of using pressure as the determinate factor. The work of Houf and Schefer demonstrated that the flame radiation heat flux and flame length varied with the pressure of gas released across a given orifice. [2] In cases where the high pressure leak of hydrogen was unignited, a turbulent jet is formed and the area of the flammable envelope can be calculated.~~

~~Peak flows were used as a means to determine acceptable distances, and comparisons were made to contents. It was determined that once the threshold for a bulk supply had been exceeded, gas pressure, not volume, was the determining factor in establishing the radiant flux or the unignited jet concentration. Detailed analysis over a series of tank pressures of 18.25 bar (250 psig), 207.85 bar (3000 psig), 518.11 bar (7500 psig), and 1035.21 bar (15,000 psig) over a range of leak diameters were examined.~~

~~Transient effects varying the quantity and pressure decay over time were ruled out as controlling parameters. Volume was then considered to be at its worst case, which assumed that pressure was constant due to the volume contained. This is especially true for large systems typically encountered in commercial applications. Small systems using small-diameter tubing were accounted for by the use of tables that allow the user to calculate the benefit from the use of small-diameter systems.~~

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~~**E.6** – Updates to the Separation Distances Tables.~~

~~Since the publication of the two codes, several hydrogen storage systems have been installed in accordance with the risk-informed separation distances. These recent installations have provided an opportunity to examine how these requirements work in actual project applications. The project applications have been reviewed and found to meet an acceptable level of safety such that conservative assumptions made in the previous analysis could be reexamined. In addition, there was interest from the committees to perform a similar risk-based process to calculate separation distances for liquid bulk hydrogen storage systems. In 2014, the NFPA 2 and NFPA 55 Technical Committees created a task group with the following objectives:~~

(1) ~~Evaluate the risk criteria used to develop the separation distances for bulk gaseous hydrogen storage and make recommendations for changes in these distances based on the revised criteria.~~

(2) ~~Develop revised separation distances for bulk liquefied hydrogen storage based on a risk-informed methodology parallel to the process used in the previous update of the gaseous requirements.~~

~~Objective one is discussed in Section E.7 and objective two is discussed in Section E.8 .~~

~~**E.7** – Updates to the Gaseous Hydrogen Separation Distance Tables.~~

~~For each of the exposures listed in Table E.1(a) , potential hazard scenarios associated with ignited and unignited hydrogen jets were identified. Harm criteria, including heat flux levels and a 4% mole fraction of hydrogen which represents the potential for a flash fire given delayed ignition, were chosen depending on the scenario. Three risk criteria thresholds that were used in the 2010 edition of NFPA 55 were reexamined: lower flammable limit, leak size, and heat flux levels.~~

~~*Lower Flammable Limit — 8 Percent H2 by Volume* .~~

~~The task group reviewed the hydrogen concentration threshold. Based on work done at Sandia National Laboratories Combustion Research Facility, the Group concluded that there would not be sustained ignition at hydrogen concentrations of 8% or less. [16] There could be localized hydrogen ignition, but it would not develop into sustained combustion.~~

~~*Use of 1 Percent of Internal Pipe Diameter (ID) as Leak Size*~~

~~The cumulative probability for different leak sizes was calculated to determine what range of leaks represents the most likely leak sizes, as discussed in Section E.3 . The system leakage frequency corresponds to the largest internal pipe downstream of the highest pressure source in the system. The results of this analysis indicated that leaks less than 0.1 percent of the component flow areas represent 95 percent of the leakage frequency for the example systems, however the risk resulting from this small leak size significantly exceeded the 2 x 10~~ $^{-5}$ ~~/yr risk guideline set by the task group. At the same time, the use of a leak size between 1 percent and 10 percent of the component flow area results in risk estimates that are reasonably close to the risk guideline.~~

~~Based on the results of both the system leakage frequency evaluation and the associated risk assessment, the task group decided that adjusting to a diameter of 1 percent value, instead of a 3 percent, would remove excess conservatism from the input assumption to the model. The 1 percent value still accounts for 95 percent of the leakage frequency from the example systems and does not exceed the 2 × 10~~ $^{-5}$ ~~/year risk guideline established in the previous analysis. This results in more permissive separation distance requirements with no change in risk.~~

~~*Selected Heat Flux Values*~~

~~The task group reviewed the heat flux values discussed in Section E.4 and determined that the use of a "no harm" criteria was overly conservative. This heat flux assumes exposed persons will not take protective actions, such as moving away from the fire scene. The task group deemed it reasonable to assume that exposed personnel will relocate away from a fire scene within a few minutes and therefore the "no harm" criteria is not appropriate for establishing separation distances. Exposures that were analyzed based on this heat flux value were updated to reflect the harm distance for a radiation heat flux level of 4.7 kW/m~~ ^{2} ~~. The task group decided not to change the three other heat flux values.~~

~~Table E.7 shows the revised separation distances for the four storage pressure ranges based on the task group's recommended changes in risk criteria and exposures grouped by the harm criteria that the distance is based upon. The safety distances in the table are rounded to the nearest whole number and a safety factor of 1.5 has been added to the values. The significance of these potential changes can be shown in the high pressure column for the Group 1 Exposures. The reduction in separation distances from 34 feet to 16 feet for bulk gaseous systems would allow these systems to be placed in more locations, including existing gasoline fueling stations and other space constrained locations.~~

~~Table E.7 Updated Values to 2016 NFPA 2 and NFPA 55 Tables with 1.5 Safety Factor~~

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~~Separation Distance Exposures >0.10 to 1.7 MPa (>15 to 250 psig) >1.7 to 20.7 MPa (>250 to 3000 psig) >20.7 to 51.7 MPa (>3000 to 7500 psig) 51.7 to 103.4 MPa (7500 to 15000 psig) Group 1 2010 edition 12 m (40 ft.) 14 m (46 ft.) 9 m (29 ft.) 10 m (34 ft.) 2019 edition 5 m (16 ft.) 6 m (20 ft.) 4 m (13 ft.) 5 m (16 ft.) Group 2 2010 edition 6 m (20 ft.) 7 m (24 ft.) 4 m (13 ft.) 5 m (16 ft.) 2019 edition 5 m (16 ft.) 6 m (20 ft.) 3 m (10 ft.) 4 m (13 ft.) Group 3 2010 edition 5 m (17 ft.) 6 m (19 ft.) 4 m (12 ft.) 4 m (14 ft.) 2019 edition 4 m (13 ft.) 5 m (16 ft.) 3 m (10 ft.) 4 m (13 ft.)~~

~~Notes:~~

~~Group 1 Exposures include: lot lines, air intakes, operable openings in buildings and structures, and ignition sources. Group 1 separation distances are based on the higher value of radiation heat flux of 4.7 kW/m ^{2} or the unignited jet concentration decay distance of 8% hydrogen volume fraction concentration. In this instance, the separation distance is higher for the concentration value than the heat flux value.~~

~~Group 2 Exposures include: parked cars, exposed persons other than those servicing the system. Group 2 separation distances are based on the higher value of the incident radiation heat flux of 4.7 kW/m ^{2} exposure to employees for a maximum of 3 minutes or the visible flame length.~~

~~Group 3 Exposures includes everything else (e.g., buildings of combustible construction, ordinary combustibles, openings in buildings and structures). Group 3 separation distances are based on the higher value of the radiant heat flux for noncombustible equipment of 25.2 kW/m ^{2} or the visible flame length.~~

~~**E.8** – Updates to the Liquid Hydrogen Separation Distance Tables.~~

~~The joint NFPA 55 and NFPA 2 task group was also formed to develop a scientific basis for the separation distances for bulk liquefied hydrogen storage systems. The task group has the following objectives:~~

(1) ~~Define a representative bulk liquefied hydrogen storage system.~~

(2) ~~Perform a risk analysis on the system to determine the release scenarios with the highest risk.~~

(3) ~~Evaluate the risk criteria for each of the highest risk release scenarios by using a scientific model that predicts the extent of specific hydrogen concentrations and heat fluxes.~~

(4) ~~Acquire leak frequency data from the discharge points from the highest risk release scenarios.~~

(5) ~~Perform an integrated analysis of releases and leak frequencies to estimate the system separation distances using the risk threshold of 2 x 10 $^{-5}$ fatalities/yr.~~

~~The task group decided to use the liquefied hydrogen system described in the Compressed Gas Association, Inc. (CGA) P-28, OSHA Process Safety Management and EPA Risk Management Plan Guidance Document for Bulk Liquid Hydrogen Systems, as the representative system. The representative system contains a liquid hydrogen storage tank, a pressure buildup circuit and economizer, vaporizer, and pump. CGA P-28 also contained a representative hazard and operability study (HAZOP) that was performed on the representative bulk liquid hydrogen system. The process was divided into seven segments, called nodes, which were as follows:~~

(1) ~~Delivery trailer, hose, and fill line to the storage vessel~~

(2) ~~Storage tank~~

(3) ~~Pressure buildup circuit and economizer~~

(4) ~~Hydrogen line — liquid through the vaporizer to the final line~~

(5) ~~Hydrogen pump~~

(6) ~~Vent stacks~~

(7) ~~General items~~

~~In CGA P-28, each node was examined based on deviations from normal operating parameters that could have potentially hazardous consequences. The task group started with this division of the system and analyzed each node deviation to come up with event likelihood and hazard severity. Event likelihood was the annual probability that the deviation may occur for each node, with the highest level expecting the deviation to occur once per year or more and the lowest level expected to occur once per 10,000 years, documented in Table E.8(a) . Hazard severity classified the consequence from the node deviation. The hazard severity ranged from negligible to catastrophic, documented in Table E.8(b) . The task group estimated the event likelihood and severity based on industry experience and subject matter expertise and had to agree with the levels given to each node deviation.~~

~~Table E.8(a) Event Likelihood Classification Table~~

~~Level Annual Probability Probability Description 1 Frequent > 1.0 Expected to occur once per year or more frequently. 2 Reasonably probable 1.0 to 0.1 Expected to occur once per 10 years. 3 Occasional~~

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~~0.01 to 0.1 Expected to occur once per 100 years. 4 Remote 0.001 to 0.01 Expected to occur once per 1000 years. 5 Extremely remote 0.0001 to 0.001 Expected to occur once per 10,000 years. 6 Improbable < 0.0001 Expected to occur less than once per 10,000 years. Extremely unlikely to occur~~

~~Table E.8(b) Hazard Severity Classification Table~~

~~Level Description Potential Consequences 1 Catastrophic Could cause fatality to nonassociated members of the public 2 Critical Could cause severe injury to nonassociated members of the public, fatality or serious injury to works of the public, fatality or serious injury to workers of persons conducting business at a refueling site or significant damage to equipment/facilities 3 Marginal Could cause minor injury, or minor system damage 4 Negligible Will not result in injury or system damage~~

~~Based on the level of likelihood and severity, the node deviation was given a risk ranking, documented in Figure E.8 . A few assumptions were made for this analysis. First, the task group assumed an NFPA 55 and a CGA H-5 code-complaint system. The scenarios would only have a single failure, and cascading failures would not be analyzed. The current setback distances did not provide any credit during this analysis and tornadoes were not included in the natural disaster considerations.~~

~~**Figure E.8 Risk Ranking Table.**~~

		Likelihood					
		1	2	3	4	5	6
Severity	1	1	1	1	2	3	4
	2	1	1	2	3	3	4
	3	2	2	3	3	4	4
	4	4	4	4	4	4	4

1: High risk
2: Moderate risk
3: Low risk
4: Routine risk

~~After the task group had prioritized all 102 node deviations, the risk-ranked results were reviewed and discussed. Two scenarios were added, based on feedback from the task group, which analyzed high and normal flow from a trailer vent stack. In total, the task group chose nine scenarios with the highest risk to analyze further. The first six scenarios listed occur during liquid hydrogen (LH_2) transfer operations from a tanker truck to the bulk LH_2 storage tank. The two scenarios that the task group added are included in this list. The other three scenarios occur during normal system operations. For each of the scenarios, the task group decided upon the inputs to liquid hydrogen models and the risk criteria for analysis.~~

~~Sandia developed a cryogenic hydrogen integral jet and plume model, called COLDPLUME, which is intended to be used to predict release characteristics from various real-world hydrogen storage states. [17] Sandia is also developing a network flow model that accounts for internal system flows from the storage vessel to the release plane, called NETFLOW, which will be suitable for liquid and multiphase cryogen flows. [18] These models are currently under development and experimental validation. Once modeling results are available, the hydrogen exposure risk criteria used for the bulk gaseous separation distances will be used to develop the new liquid separation distance table. [See Table E.8(c) .]~~

~~Table E.8(c) HAZOP Scenarios and Modeling Notes~~

~~- HAZOP Number and Description Modeling Notes Separation Distance Driver Release scenarios during liquid transfer to bulk storage tank 1.18 High-flow gaseous hydrogen from trailer vent stack due to venting excess pressure after LH_2 transfer Sandia's NETFLOW and COLDPLUME models will characterize the temperature and concentration from the trailer vent stack. The task group would like to model an estimate of up to 50 kg of cold, gaseous hydrogen. - - 1.19 Normal flow from trailer vent stack due to venting excess pressure after LH_2 transfer Sandia's NETFLOW and COLDPLUME models will characterize the temperature and concentration from the trailer vent stack. The task group would like to model an estimate of up to 50 kg of cold, gaseous hydrogen. Modeling results will be used to calculate separation distance from air intakes and overhead utilities because this is the highest frequency release~~

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~~and the release point is in closest proximity to these exposures. - 1.6 High flow from line rupture, valve or component failure during transfer process Sandia's NETFLOW and COLDPLUME models will characterize the temperature and concentration from the release to the air. A model is needed to characterize pooling and evaporation effects. - - 1.4 High temperature caused by external fire will cause high flow venting through tank vent stack Sandia's NETFLOW and COLDPLUME models will characterize the temperature and concentration from the trailer vent stack. This is the worst case venting scenario from the pressure relief device to a high ambient temperature. - - 1.8 Reverse flow during transfer process caused by human error and pressure mismanagement Sandia's NETFLOW and COLDPLUME models will characterize the temperature and concentration from the release to the air. A model is needed to characterize pooling and evaporation effects. - - 1.16 Loss of containment from external impacts, consider all causes The task group postulated a vehicle crash into the tanker during transfer. This causes a transfer hose rupture with NETFLOW and COLDPLUME models characterizing the release to the air. A model is needed to characterize pooling and evaporation effects. - Release scenarios during normal system operation 4.15 Loss of containment from pipe leading from tank to vaporizer or vaporizer itself caused by thermal cycles or ice falling from vaporizers Sandia's NETFLOW and COLDPLUME models will characterize the temperature and concentration from the release to the air. A model is needed to characterize pooling and evaporation effects. Modeling results of hydrogen concentration plume and heat flux from a subsequent fire will be used for all other separation distance exposures because this is the highest risk priority during normal operations. - 6.15 Misdirected flow caused by operator error resulting in large low-level release of cold gaseous hydrogen through bottom drain valve of vent stack during normal tank venting process Sandia's NETFLOW model will capture how much gas is going out of the drain vent and vent stack. Sandia's COLDPLUME model can characterize the temperature and concentrations from the releases to the air. A model is needed to characterize pooling and evaporation effects. - - 2.1 High pressure because of a leak in inner vessel allowing hydrogen into the vacuum area Sandia's NETFLOW and COLDPLUME models can characterize the flow out of the casing vent (a large hole instead of a pipe orifice). -~~

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~~**E.9** – References.~~

(1) ~~NFPA 1, *Fire Code* , 2018 edition.~~

(2) ~~W. Houf and R. Schefer, "Predicting Radiative Heat Fluxes and Flammability Envelopes from Unintended Releases of Hydrogen," *International Journal of Hydrogen Energy* , Elsevier Publishing, 2007, Vol. 32, pp. 136–151.~~

(3) ~~J. Floyd, *Siting Requirements for Hydrogen Supplies Serving Fuel Cells in Non-Combustible Enclosures* , Hughes Associates, Inc., 3610 Commerce Drive, Suite 817, Baltimore, MD 21227, HAI Project #3250-000, November 30, 2006.~~

(4) ~~J. LaChance, *Risk-Informed Separation Distances for Hydrogen Refueling Stations* , Risk and Reliability Department, Sandia National Laboratories, Albuquerque, NM, May 2007. (Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under Contract DE-AC04-94-AL85000.)~~

(5) ~~Ibid, p. 11, reference to *Fires in or at Service Stations and Motor Vehicle Repair and Paint Shops,* NFPA, April 2002.~~

(6) ~~J. LaChance, W. Houf, B. Middleton (all of Sandia National Laboratories), and L. Fluer (of Fluer, Inc.), "Analyses to Support Development of Risk-Informed Separation Distances for NFPA Hydrogen Codes and Standards," SAND 2009-0874, Sandia National Laboratories, Albuquerque, NM 87185, and Livermore, CA 94550, March 2009.~~

(7) ~~S. E. Rose, S. Flamberg, and F. Leverenz, "Guidance Document for Incorporating Risk Concepts into NFPA Codes and Standards," Fire Protection Research Foundation, March 2007.~~

(8) ~~"Determination of Safety Distances," European Industrial Gases Association, IGC Doc. 75/07/E, 2007.~~

(9) ~~C. L. Atwood, J. L. LaChance, H. F. Martz, D. J. Anderson, M. Englehardt, D. Whitehead, and T. Wheeler, "Handbook of Parameter Estimation for Probabilistic Risk Assessment," NUREG/CR-6823, U.S. Nuclear Regulatory Commission, Washington, DC, 2003.~~

(10) ~~API Recommended Practice 521, *Guide for Pressure Relieving and Depressuring Systems* , 4th edition, March 1997, API Publishing Services, 1220 L. St. N.W., Washington, DC 20005, Table 8, p. 41.~~

(11) ~~"Predicting 1st and 2nd Degree Skin Burns from Thermal Radiation," *SFPE Engineering Guide* , Society of Fire Protection Engineers, Bethesda, MD 20814, March 2000, p. 8.~~

(12) ~~ICC, *International Fire Code* ™, 2006 edition, International Code Council, 4051 West Flossmoor Road, Country Club Hills, IL 60478-5795, Table 2209.5.4.3.6(1), p. 210.~~

(13) ~~V. Babrauskas, "Ignition of Wood: A Review of the State of the Art," Interflam 2001, Interscience Communications Ltd., London, 2001, pp. 71–88.~~

(14) ~~J. LaChance, J. Phillips, and W. Houf, "Risk Associated with the Use of Barriers in Hydrogen Refueling Stations," National Hydrogen Association Conference & Expo, Long Beach, CA, May 3–6, 2010.~~

(15) ~~W. Houf, R. Schefer, G. Evans, E. Merilo, and M. Groethe, "Evaluation of Barrier Walls for Mitigation of Unintended Releases of Hydrogen," *International Journal of Hydrogen Energy* , Vol. 35, Issue 10, May 2010, pp. 4758–4775.~~

(16) ~~R. W., Schefer, G. H., Evans, J. Zhang, A. J., Ruggles, and R. Grief. "Ignitability limits for combustion of unintended hydrogen releases: Experimental and theoretical result," *International Journal of Hydrogen Energy* , Vol. 36, 2011.~~

(17) ~~W. Houf, R. Schefer, "Analytical experimental investigation of small-scale unintended releases of hydrogen," *International Journal of Hydrogen Energy* , Vol. 33, 2008, pp. 1435-44.~~

(18) ~~Winters, W. S., "A New Approach to Modeling Fluid/Gas Flows in Networks." SAND2001-8422, Sandia National Laboratories, July 2001.~~

Statement of Problem and Substantiation for Public Input

The storage, use, handling, and many other aspects of hydrogen including the physical properties are addressed by NFPA 2. Per the committee scope statements the HYD Committee has "primary responsibility for documents on the storage, transfer, production, and use hydrogen" and the IMG "Committee shall coordinate the material on gaseous and liquid hydrogen storage and use with the Hydrogen Technology Committee." The simplest, least error

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prone way for NFPA 55 to coordinate with NFPA 2 regarding hydrogen gas is to just refer the user to NFPA 2. This is best accomplished in in 7.6.1.2 and 8.1.4. This nullifies the need for Chapter 10 and the associated Annex E. And, the presence of Annex E in NFPA 55 causes confusion regarding whether NFPA 2 or NFPA 55 applies.

Note: The title of Annex A does not make it clear that it only applies to hydrogen.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 85-NFPA 55-2020 [Chapter 10]	The separation distances explained in Annex E are from Chapter 10.

Submitter Information Verification

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Public Input No. 99-NFPA 55-2020 [Chapter G]

~~**Annex G** – OSHA Requirements for Hydrogen Systems~~

~~*This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.*~~

~~**G.1** – Introduction.~~

~~The Occupational Safety and Health Administration (OSHA) establishes requirements for hydrogen systems in 29 CFR 1910.103. The tabular distances reflect those values published in the July 1, 2006, edition of the CFR. The criteria established in OSHA's tables of distances are based on the 1969 edition of NFPA 50A, which superseded the 1963 edition. Subsequent editions were adopted in 1973, 1978, 1984, 1989, 1994, and 1999. In 2003, the document was integrated into NFPA 55 because the committee believed that one standard covering storage and use of all compressed gases and cryogenic fluids was needed. NFPA 55 was revised in 2005 because the requirements for compressed gases and cryogenic fluids were broadened.~~

~~Throughout the eight revision cycles of NFPA 55, the tabular distances were revised as the technology in the use of hydrogen advanced. However, the tabular distances listed in the OSHA tables remain based on the 1969 data. It is important to recognize that the OSHA tables represent the current statutory requirements. While the OSHA tables may, in fact, be accurate, it should also be recognized that the OSHA tables in some cases lack clarity and that, in other cases, hazards recognized by the ongoing evolution of the separation tables have not been acknowledged.~~

~~For an example of lack of clarity, consider row 1 of Table G.2(a) (Building or structure). The OSHA table refers to buildings by construction types, including wood frame, heavy timber, ordinary, and fire resistive. Current construction types are now designated as Types I through V, with variations to address the elements of construction, including the supporting structure as well as the construction of the roof and exterior walls. Although one can guess as to the original intent, there is no clear correlation between the construction types designated in the OSHA tables and current editions of either NFPA 220 or *NFPA 5000*.~~

~~Other examples where clarity is needed include rows 3, 4, and 5, which specify separation distance from flammable liquids, raising the question as to whether combustible liquids should be considered or ignored. Examples of hazards not addressed include the fact that there are no prescribed distances for separation from property lines, public sidewalks, and parked vehicles. A close comparison between the OSHA tables and the distance tables found in the 2005 edition of NFPA 55 reveals a number of discrepancies.~~

~~**G.2** – OSHA Tables.~~

~~The OSHA tables [Table G.2(a) and Table G.2(b)] are provided to inform the code user of the minimum requirements as they currently exist under 29 CFR and the federal OSHA program. It is incumbent on installers and property owners to recognize the limitations of OSHA based on the precedent requirements established with the use of the 1969 edition of NFPA 50A. The use of alternative approaches to distance as now embodied within the body of the code is subject to approval on a location-by-location basis. The typical AHJ traditionally has been a fire official, but that person might not be the only official who exercises regulatory control for installations of this nature.~~

~~Table G.2(a) OSHA Table: Minimum Distance from Gaseous Hydrogen Systems to Exposure~~

~~Type of Outdoor Exposure Size of Hydrogen System <3,000 scf (85 Nm^3) - 3,000 to 15,000 scf~~

~~(85 m^3 to 425 Nm^3) - >15,000 scf (425 Nm^3) ft m - ft m - ft m 1. Building or structure - - - - - - - - — Wood frame construction [1] 10 3.1 - 25 7.6 - 50 15.2 — Heavy timber, noncombustible, or ordinary construction [1] 0 0 - 10 3.1 - 25 7.6 — Fire resistive construction [1] 0 0 - 0 0 - 0 0 2. Wall openings - - - - - - - - — Not above any part of a system 10 3.1 - 10 3.1 - 10 3.1 — Above any part of a system 25 7.6 - 25 7.6 - 25 7.6 3. Flammable liquids above ground - - - - - - - - — 0–1000 gal (3785 L) 10 3.1 - 25 7.6 - 25 7.6 — In excess of 1000 gal (3785 L) 25 7.6 - 50 15.2 - 50 15.2 4. Flammable liquids below ground — 0–1000 gal (3785 L) - - - - - - - - — Tank 10 3.1 - 10 3.1 - 10 3.1 — Vent of fill opening of tank 25 7.6 - 25 7.6 - 25 7.6 5. Flammable liquids below ground, in excess of 1000 gal (3785 L) - - - - - - - - — Tank 20 6.1 - 20 6.1 - 20 6.1 — Vent of fill opening of tank 25 7.6 - 25 7.6 - 25 7.6 6. Flammable gas storage, either high pressure or low pressure - - - - - - - - — 0–15,000 scf (425 Nm^3) capacity 10 3.1 - 25 7.6 - 25 7.6 — In excess of 15,000 scf (425 Nm^3) capacity 25 7.6 - 50 15.2 - 50 15.2 7. Oxygen storage - - - - - - - - — 12,000 scf (340 Nm^3) or less [4] - - - - — - - - — More than 12,000 scf~~

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~~(340 Nm^3)[5] - - - - — - - - 8. Fast-burning solids such as ordinary lumber, excelsior, paper 50 15.2 - 50 15.2 - 50 15.2 9. Slow-burning solids such as heavy timber, coal 25 7.6 - 25 7.6 - 25 7.6 10. Open flames and welding 25 7.6 - 25 7.6 - 25[2] 7.6[2] 11. Air compressor intakes or inlets to ventilating or air-conditioning equipment 50 15.2 - 50 15.2 - 50 15.2 12. Concentration of people[3] 25 7.6 - 50 15.2 - 50 15.2~~

~~[1] Refer to NFPA 220 for definitions of various types of construction (1969).~~

~~[2] But not less than one-half the height of adjacent side wall of the structure.~~

~~[3] In congested areas such as offices, lunchrooms, locker rooms, time-clock areas.~~

~~[4] Refer to NFPA 51 (1969).~~

~~[5] Refer to NFPA 566 (1969).~~

~~Table G.2(b) OSHA Table: Minimum Distance (Feet) from Liquefied Hydrogen Systems to Exposure[1,2] Type of Outdoor Exposure Liquefied Hydrogen Storage 39.63–3,500 gal~~

~~(150–13,249 L) - 3,501–15,000 gal~~

~~(13,249–56,780 L) - 15,001–30,000 gal~~

~~(56,780–113,559 L) ft m - ft m - ft m 1. Fire resistive building and fire walls[3] 5 1.5 - 5 1.5 - 5 1.5 2. Noncombustible building[3] 25 7.6 - 50 15.2 - 75 22.9 3. Other buildings[3] 50 15.2 - 75 22.9 - 100 30.5 4. Wall openings, air-compressor intakes, inlets for air-conditioning or ventilating equipment 75 22.9 - 75 22.9 - 75 22.9 5. Flammable liquids (above ground and vent or fill openings if below ground) (See 513 and 514) 50 15.2 - 75 22.9 - 100 30.5 6. Between stationary liquid hydrogen containers 5 1.5 - 5 1.5 - 5 1.5 7. Flammable gas storage 50 15.2 - 75 22.9 - 100 30.5 8. Liquid oxygen storage and other oxiders (See 513 and 514) 100 30.5 - 100 30.5 - 100 30.5 9. Combustible solids 50 15.2 - 75 22.9 - 100 30.5 10. Open flames, smoking and welding 50 15.2 - 50 15.2 - 50 15.2 11. Air compressor intakes or inlets to ventilating or air-conditioning equipment 50 15.2 - 50 15.2 - 50 15.2 12. Concentrations of people[4] 75 22.9 - 75 22.9 - 75 22.9~~

~~[1] The distances in Nos. 2, 3, 5, 7, 9, and 12 may be reduced where protective structures such as fire walls equal to the top of the container, to safeguard the liquefied hydrogen storage system, are located between the liquefied hydrogen installation and the exposure.~~

~~[2] Where protective structures are provided, ventilation and confinement of product should be considered. The 5 ft (1.5 m) distance in Nos. 1 and 6 facilitates maintenance and enhances ventilation.~~

~~[3] Refer to NFPA 220 for definitions of various types of construction (1969).~~

~~[4] In congested areas such as offices, lunchrooms, locker rooms, time-clock areas.~~

Statement of Problem and Substantiation for Public Input

The storage, use, handling, and many other aspects of hydrogen including the physical properties are addressed by NFPA 2. Per the committee scope statements the HYD Committee has "primary responsibility for documents on the storage, transfer, production, and use hydrogen" and the IMG "Committee shall coordinate the material on gaseous and liquid hydrogen storage and use with the Hydrogen Technology Committee." The simplest, least error prone way for NFPA 55 to coordinate with NFPA 2 regarding hydrogen gas is to just refer the user to NFPA 2. This is best accomplished in in 7.6.1.2 and 8.1.4. This nullifies the need for Chapter 10 and the associated Annex G. And, the presence of Annex G in NFPA 55 causes confusion regarding whether NFPA 2 or NFPA 55 applies.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 85-NFPA 55-2020 [Chapter 10]	Separation distances discussed in Annex G are from Chapter 10.

Submitter Information Verification

Attachment F - NFPA 55 Public Inputs

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Committee:	IMG-AAA

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Public Input No. 100-NFPA 55-2020 [Chapter H]

~~**Annex H** – Determination of Separation Distances for Bulk Gaseous Hydrogen Systems~~

~~*This annex is not part of the requirements of this NFPA document but is included for informational purposes only.*~~

~~*This annex is a paper by William Houf and Robert Schefer, "Description of Hazard Models Used in the Development of Separation Distance Tables for NFPA 55 and NFPA 2" (Sandia National Laboratories, P.O. Box 969, Livermore, CA 94551-0969).*~~

~~*This paper has been provided for historical reference to how the separation distance tables for bulk gaseous hydrogen systems were calculated; however, the latest information can be found in Annex H.*~~

~~**H.1** – Introduction.~~

~~Separation distances in NFPA 55 and NFPA 2 are based on the prediction of the characteristics of unignited jets or ignited jet flames from hydrogen leaks. Because the characteristics of hydrogen jets and jet flames depend on the source pressure and effective diameter of the leak the separation distance table for was broken into four pressure ranges. The effective leak diameter for each pressure range was based on a characteristic pipe diameter (I.D. = inside diameter), where the leak flow area was taken to be 3% of the flow area of the pipe (based on I.D. of the pipe). For a round leak the effective diameter of the leak is~~

$$\cancel{d_{leak} = (0.03)^{1/2} d_{pipe(I.D.)}}$$

~~where d_{leak} is the effective leak diameter and $d_{pipe(I.D.)}$ is the inside diameter of the pipe. Table H.1(a) lists the pressure ranges for the separation distances table and the associated inside pipe diameter of the characteristic pipe used to determine the leak effective diameter for each pressure range.~~

~~When using the separation distance table one must first determine the storage pressure. The storage pressure determines what pressure range in the table is to be used in the determination of separation distances. The storage pressure is defined as the maximum pressure of a storage array with volume greater than 400 scf (standard cubic feet) in the system. If the system has more than one storage array with a volume greater than 400 scf then a storage pressure must be determined for each array. The next parameter that must be determined is the largest diameter (I.D.) of the piping within the system or portion of the system downstream of the stored volume. If the largest pipe diameter associated with the storage pressure is less than the characteristic pipe diameter listed in Table H.1(a) for that pressure range, then the values listed in separation distance table may used, or alternately the formulas at the bottom of the table may be applied using the determined value of largest pipe diameter (I.D.).~~

~~If the value of the largest pipe diameter (I.D.) is greater than the characteristic pipe diameter for the storage pressure range of interest then the formulas at the bottom of separation distance table must be used to determine separation distances. These formulas reproduce the numeric values in the separation distance tables for the pipe diameters shown in Table H.1(a).~~

~~The formulas are based on performing curve-fits to hazard distance calculations performed over a range of pipe diameters (assuming 3% flow area leak) and pressures using the hazard models discussed in Section H.2. The formulas are simple enough that they can easily be entered into an Excel spreadsheet program or programmable calculator for computation of separation distances for any value of pipe diameter (I.D.). An Excel spreadsheet based on these formulas was developed and distributed to the NFPA Hydrogen Technology Committee members as part of the development of separation distance tables.~~

~~If a system contains multiple storage arrays (greater than 400 scf) at different pressures then storage pressures and largest pipe diameters must be determined for each storage array in the system. The separation distance table and formula procedure outlined above is then applied to each storage array in the system and the largest separation distance for each storage array defines the value of the separation distance for the overall system.~~

~~A description of the models used to determine the values of the separation distances are discussed in the sections that follow. More detailed descriptions of the models and the experiments used in their development and validation can be found in the publications (Houf and Schefer, 2007, 2008; Schefer et al. 2006, 2007). The models consider either the concentration decay of an unignited high-momentum hydrogen leak or in the case where the mixture ignites, a high-momentum hydrogen jet flame, its visible length, and the radiation heat flux from the flame. Table H.1(b) lists the hazard criteria that were used with the unignited jet and jet flames models to create a risk informed consequence-based separation distance table for NFPA 55 and NFPA 2.~~

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~~Table H.1(a) Pressure Ranges for Separation Distances Table and the Associated System Characteristic Pipe Diameter~~

~~Storage Pressure Range Characteristic Pipe Diameter (I.D.) >103 to ≤ 1724 kPa (gauge) (>15 to ≤250 psig) 52.50 mm (2.067 in) >1724 to ≤ 20684 kPa (gauge) (>250 to ≤3000 psig) 18.97 mm (0.75 in) >20684 ≤ 51711 kPa (gauge) (>3000 to ≤7500 psig) 7.92 mm (0.312 in) >51711 ≤ 103421 kPa (gauge) (>7500 to ≤15000 psig) 7.16 mm (0.282 in)~~

~~Table H.1(b) Hazard Parameters for Separation Distances Tables~~

~~Hydrogen unignited jet Distance to point where concentration has decayed to 4% mole fraction hydrogen in air Hydrogen jet flame Visible flame length Hydrogen jet flame Distance to radiation heat flux level of 1577 W/m ^{2} (500 Btu/hr · ft ^{2}) Hydrogen jet flame Distance to radiation heat flux level of 4732 W/m ^{2} (1500 Btu/hr · ft ^{2}) exposure to employees for a maximum of 3 minutes Hydrogen jet flame Distance to combustible heat flux level of 20,000 W/m ^{2} (6340 Btu/hr · ft ^{2}) Hydrogen jet flame Distance to noncombustible equipment heat flux level of 25,237 W/m ^{2} (8000 Btu/hr · ft ^{2})~~

~~**H.2** – Description of Engineering Hazard Models: Nomenclature.~~

~~See Table H.2 for specification of the parameters used in engineering hazard models.~~

~~Table H.2 Parameters Used in Hazard Models~~

~~b Coefficient for hydrogen in the Abel-Nobel equation of state (7.691 × 10 $^{-3}$ m ^{3}/kg) Btu British thermal unit C* Non-dimensional radiant power CH $_4$ Methane C $_2$ H $_2$ Acetylene C $_2$ H $_4$ Ethylene C $_3$ H $_8$ Propane d $_{eff}$ The effective diameter, m d $_j$ Jet exit diameter, m d* Jet momentum diameter, m D $_{rad}$ Radiation distance, m Fr $_f$ Froude number (dimensionless parameter based on the ratio of momentum effects to buoyancy effects) f_s Mass fraction of fuel at stoichiometric conditions g Acceleration due to gravity (9.8 m/sec ^{2}) H $_2$ Molecular hydrogen hr hour K The entrainment constant K $_c$ The entrainment constant for a round jet L $_{vis}$ Visible flame length, m L* Non-dimensional flame length LFL Lower flammability limit LFL $_{DPF}$ Lower flammability limit for a downward propagating flame LFL $_{UPF}$ Lower flammability limit for an upward propagating flame m $_{fuel}$ Total fuel mass flow rate, kg/sec m $_{fuel}$ ΔH $_c$ Total heat released due to chemical reaction, W p $_j$ The jet exit pressure, bar p $_{supply}$ The pressure in the supply, bar p $_{tank}$ The pressure in the tank, bar p $_\infty$ The ambient pressure, bar q $_{rad}$ (x,r) The radiant heat flux measured at a particular axial location, x, and radial location, r, W/m ^{2} r Radial position, m R $_{H2}$ Gas constant for hydrogen (4124.18 J/kg/K) R $_u$ Universal gas constant (8314.34 J/kmol /K) R $_{max}$ The maximum radial position from the flame centerline for the given heat flux level, m S $_{rad}$ The total emitted radiative power, W T $_{ad}$ Adiabatic flame temperature of hydrogen in air (2390K) u $_j$ Jet exit velocity, m/sec u $_{eff}$ The effective velocity at the end of expansion, m/sec x Axial position, m x $_o$ The virtual origin of the jet, m X(R $_{max}$) The axial location at which the maximum heat flux level occurs, m X $_{rad}$ The radiant fraction or the fraction of the total chemical heat release that is radiated to the surroundings W $_f$ Flame width, m W $_{mix}$ Mean molecular weight of the products of stoichiometric combustion of hydrogen in air (24.54 kg/kmol) Z The compressibility factor [Z = p/(ρRT)] ΔH $_c$ Heat of combustion, J/kg ΔT $_f$ Peak flame temperature rise due to combustion heat release, K π Pi ρ $_f$ Flame density, kg/m ^{3} ρ $_{gas}$ The density of the exiting gas evaluated at ambient temperature and pressure, kg/m ^{3} ρ $_j$ Jet exit density, kg/m ^{3} (ρ $_j$ /ρ $_\infty$) Ratio of jet gas density to ambient gas density ρ $_\infty$ Density of the ambient fluid, kg/m ^{3} $\overline{\eta}_{cl}$ Volume fraction (mole fraction) along the centerline of the jet τ $_f$ Global flame residence time, sec~~

~~The development of an infrastructure for hydrogen utilization requires safety codes and standards that establish guidelines for building the components of this infrastructure. Based on a recent workshop on unintended hydrogen releases, one release case of interest involves leaks from pressurized hydrogen-handling equipment (Schefer et al., 2004). These leaks range from small-diameter, slow-release leaks originating from holes in delivery pipes to larger, high-volume releases resulting from accidental breaks in the tubing from high-pressure storage tanks. In all cases, the resulting hydrogen jet represents a potential fire hazard, and the buildup of a combustible cloud poses a hazard if ignited downstream of the leak.~~

~~A case in which a high-pressure leak of hydrogen is ignited at the source is best described as a classic turbulent-jet flame, shown schematically in Figure H.2 . The distances of importance are the radial distance from the geometrical flame centerline, r, and the distance downstream of the jet exit, x. Other variables of interest are the jet exit diameter, d $_j$, and the jet exit velocity and density, u $_j$ and ρ $_j$, respectively. Schefer et al. (2006, 2007) reported experimental measurements of large-scale hydrogen jet flames and verified that~~

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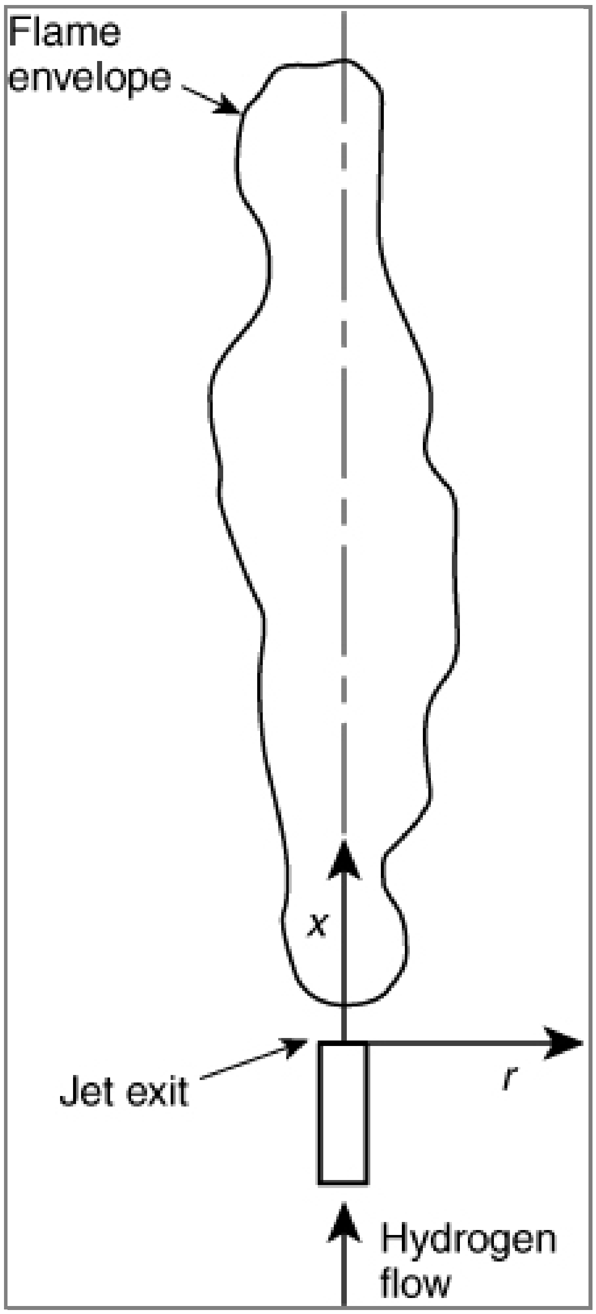
~~measurements of flame length, flame width, radiative heat flux, and radiant fraction are in agreement with non-dimensional flame correlations reported in the literature. This work verifies that such correlations can be used to predict the radiative heat flux from a wide variety of hydrogen flames. The present analysis builds upon this work by incorporating the experimentally verified correlations into an engineering model that predicts flame length, flame width, and the radiative heat flux at an axial position, x, and radial distance, r. The engineering model is then used to predict radiative heat fluxes for hydrogen flames.~~

~~For cases where the high-pressure leak of hydrogen is unignited, a classic high-momentum turbulent jet is formed that can be described using the same coordinate system shown in Figure H.2 . The hydrogen concentration within the jet varies with axial and radial position due to entrainment and turbulent mixing with the ambient air. The concentration contour beyond which the hydrogen-air mixture is no longer ignitable is of importance to hydrogen ignition studies. The present study develops an engineering model for the concentration decay of a high-momentum turbulent jet based on experimentally-measured entrainment rates and similarity scaling laws for turbulent jets. The model is then verified by comparing simulations for high-pressure natural gas leaks with the experimental data of Birch (1984) for the concentration decay of high-pressure natural gas jets. The engineering model is then applied to hydrogen and used to predict unignited jet mean (time-averaged over turbulent fluctuations) concentration contours for high-pressure hydrogen leaks.~~

~~**Figure H.2 Coordinate System for Turbulent Jet Flame and Unignited Jet.**~~



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~~**H.2.1** – Flame Radiation Heat Flux and Flame Length Model.~~

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~~Gaseous flame radiation is the primary heat transfer mechanism from hydrogen flames. The flame radiation heat flux model follows the approach of Sivathanu and Gore (1993) where the flame properties of importance are the visible flame length, L_{vis}, total radiative power emitted from the flame, S_{rad}, and total heat released due to chemical reaction, $m_{fuel}\ \Delta H_c$ where m_{fuel} and ΔH_c are the total fuel mass flow rate and the heat of combustion, respectively. The radiant fraction, X_{rad}, is defined as the fraction of the total chemical heat release that is radiated to the surroundings and is given by an expression of the form~~

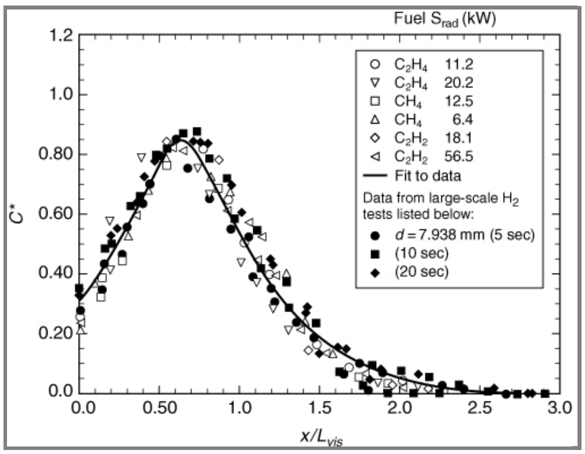
$$X_{rad} = S_{rad} / m_{fuel}\Delta H_c \qquad \text{[H.2.1a]}$$

~~For turbulent-jet flames, the radiative heat flux at an axial position x and radial position r can be expressed in terms of the non-dimensional radiant power, C*, and, S_{rad}, the total emitted radiative power. The radiative heat flux is given by an expression of the form (Sivathanu and Gore, 1993)~~

$$q_{rad}(x, r) = C^*(x/L_{vis})S_{rad}/4\pi r^2 \qquad \text{[H.2.1b]}$$

~~where q_{rad} (x, r) is the radiant heat flux measured at a particular axial location, x, and radial location, r. Experimental data further show that C* may be expressed in non-dimensionalized form as a function of burner diameter, flow rate and fuel type and, for turbulent-jet flames, is dependent only on the normalized axial distance. Figure H.2.1(a) shows typical profiles of C* measured in six different turbulent-jet flames using CH_4, C_2H_2 and C_2H_4 as the fuel (Sivanthanu and Gore, 1993) as well as the measurements of Schefer *et al.* (2006, 2007) for large-scale H_2 jet flames.~~

~~Figure H.2.1(a) Axial Variation of Normalized Radiative Heat Flux.~~



~~The use of Equation H.2.1b to calculate flame radiation heat flux levels requires knowledge of the flame radiant fraction. Turns and Myhr (1991) measured the radiant fraction from turbulent jet flames using four hydrocarbon fuels with a wide variety of sooting tendencies. These fuels included methane, ethylene, propane, and a 57% CO/43% H_2 mixture. A plot of the radiant fraction data from Turns and Myhr (1991) along with the radiant fraction data for large-scale H_2 flames is shown in Figure H.2.1(b). The radiant fraction data, X_{rad}, is plotted versus the global flame residence time where the residence time is given by an expression of the form~~

$$\tau_f = \left(\rho_f W_f^2 L_{vis} f_s\right) / \left(3\rho_j d_j^2 u_j\right) \qquad \text{[H.2.1c]}$$

~~where ρ_f, W_f, and L_{vis} are the flame density, width, and length, and f_s is the mass fraction of hydrogen in a stoichiometric mixture of hydrogen and air. For turbulent-jet flames, the flame width, W_f, is approximately equal to 0.17 L_{vis} (Schefer *et al*., 2006). This definition of residence time takes into account the actual flame density and models the flame as a cone. The flame density, ρ_f, is calculated from the expression $\rho_f = p_\infty W_{mix} / (R_u T_{ad})$, where p_∞ is the ambient pressure, W_{mix} is the mean molecular weight of the stoichiometric products of hydrogen combustion in air, R_u is the universal gas constant, and T_{ad} is the adiabatic flame temperature for hydrogen. The figure suggests that for flames with a lower sooting tendency, there is a well-defined relationship between radiant fraction and global flame residence time. Both methane and the CO/H_2 mixture show a well-behaved dependence on residence time and nearly collapse onto the same curve over the range of conditions studied. Values for the large-scale hydrogen jet flames are approximately a factor of two lower than the hydrocarbon flames for the same flame residence time.~~

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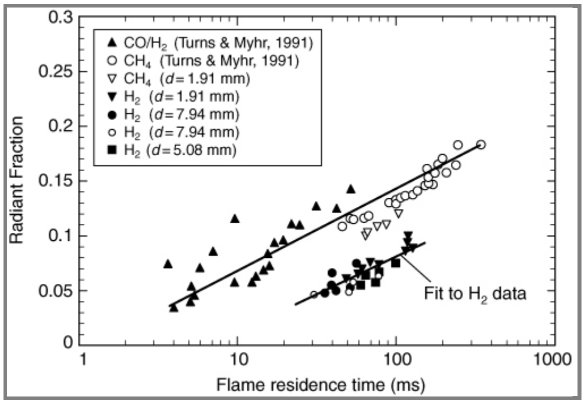
~~**Figure H.2.1(b) Radiant Fraction as a Function of Flame Residence Time (lab H_2 flame data for diameters of 1.905 and 3.75 mm, large-scale H_2 flame test data at diameter of 7.94 mm).**~~



~~The visible flame length, L_{vis}, is required for computing the global flame residence time, τ_f, to determine the flame radiant fraction. Based on an analysis of the transition from momentum-controlled to buoyancy-controlled turbulent jet flame dynamics, Delichatsios (1993) developed a useful correlation for turbulent flame lengths. The correlation is based on a non-dimensional Froude number that measures the ratio of buoyancy to momentum forces in jet flames. Using the nomenclature of Turns (2000) the Froude number is defined as:~~

$$Fr_f = \frac{u_j f_s^{3/2}}{\left(\rho_j / \rho_\infty\right)^{1/4} \left[\frac{\Delta T_f}{T_\infty} g d_j\right]^{1/2}} \qquad \text{[H.2.1d]}$$

~~where u_j is the jet exit velocity, f_s is the mass fraction of fuel at stoichiometric conditions, (ρ_j / ρ_∞) is the ratio of jet gas density to ambient gas density, d_j is the jet exit diameter, and ΔT_f is the peak flame temperature rise due to combustion heat release. Small values of Fr_f correspond to buoyancy-dominated flames while large values of Fr_f correspond to momentum-dominated flames. Note that the parameters known to control turbulent flame length such as jet diameter, flow rate, stoichiometry, and (ρ_j / ρ_∞) are included in Fr_f. Further, a non-dimensional flame length, L*, can be defined as~~

$$L^* = \frac{L_{vis} f_s}{d_j \left(\rho_j / \rho_\infty\right)^{1/2}} = \frac{L_{vis} f_s}{d^*} \qquad \text{[H.2.1e]}$$

~~where L_{vis} is the visible flame length and d* is the jet momentum diameter. Figure H.2.1(c) shows the resulting correlation of flame length data for a range of fuels (H_2, C_3H_8 and CH_4) and inlet flow conditions. In the buoyancy-dominated regime, L* is correlated by the expression~~

$$L^* = \frac{13.5 Fr_f^{2/5}}{\left(1 + 0.07 Fr_f^2\right)^{1/5}} \text{ for } \mathrm{Fr_f} < 5 \qquad \text{[H.2.1f]}$$

~~and in the momentum-dominated regime by the expression~~

$$L^* = 23 \text{ for } \mathrm{Fr_f} > 5 \qquad \text{[H.2.1g]}$$

~~The flame length data of Schefer *et al*. (2006, 2007) for large-scale hydrogen flames is shown on the plot and is found to be in good agreement with the L* correlations given by Eqs. (H.2.1f) and (H.2.1g). For choked flow conditions the concept of a notional expansion and effective source diameter (see next section) was used to reduce the hydrogen flame length measurements for plotting in terms of L* in Figure H.2.1(c). The simulation also uses this same effective diameter approach to recover the visible flame length, L_{vis}, from the values of L* computed from Eqs. (H.2.1f) and (H.2.1g).~~

~~**Figure H.2.1(c) Variation of Dimensionless Visible Flame Length with Flame Froude Number.**~~

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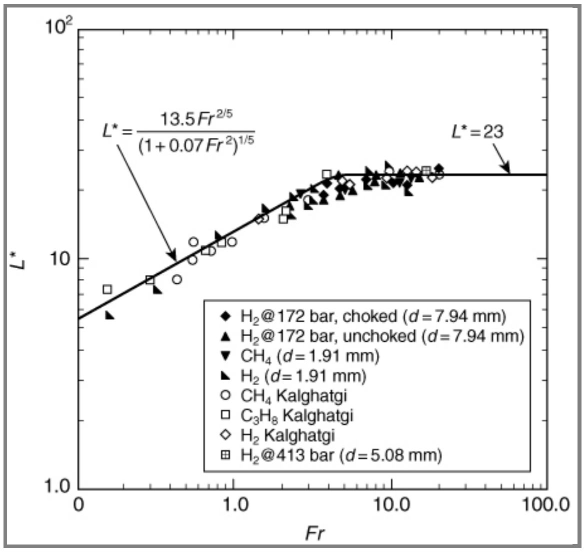

~~If the jet exit velocity and density of a hydrogen flame are known, then Eq. (H.2.1d) can be used to calculate the flame Froude number and Eq. (H.2.1e) and both Eq. (H.2.1f) and Eq. (H.2.1g) can then be used to compute the visible length of the flame, L_{vis} . The flame width, W_f , can be computed from the expression $W_f = 0.17 L_{vis}$ and used in Eq. (H.2.1c) to compute the global flame residence time, τ_f . Knowing the flame residence time, a curve-fit to the hydrogen radiant fraction data in Figure H.2.1(b) can be used to determine the radiant fraction of the hydrogen flame. Knowing the radiant fraction and using a curve-fit to the C* curve shown in Figure H.2.1(a) , Eq. H.2.1b can be used to compute the radiant heat flux from the hydrogen flame at any axial position, x, and radial position r.~~

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~~**H.2.2** – Unignited Jet Concentration Decay Model.~~

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~~For cases where the high-pressure leak of hydrogen is unignited, a classic high-momentum turbulent jet is formed that can be described using the same coordinate system shown in Figure H.2 . The hydrogen concentration within the jet varies with axial position, x, and radial position, r, due to entrainment and turbulent mixing with the ambient air.~~

~~The nature of the concentration field of subsonic, momentum-dominated incompressible turbulent free jets is well documented in the literature (Chen and Rodi, 1980). The decay of the mean volume fraction,~~ $\overline{\eta}_{cl}$ ~~, (or mean mole fraction) along the centerline of the jet is given by an expression of the form~~

$$\eta_{cl}(x) = \frac{Kd_j}{x + x_o}\left(\frac{\rho_\infty}{\rho_{gas}}\right)^{1/2}$$ ~~[H.2.2a]~~

~~where K is the entrainment constant,~~ ρ_∞ ~~is the density of the ambient fluid,~~ ρ_{gas} ~~, is the density of the exiting gas evaluated at ambient temperature and pressure, and~~ x_o ~~is the virtual origin of the jet (Chen and Rodi, 1980).~~

~~For high-pressure leaks of hydrogen, the exit flow chokes at the sonic velocity if the pressure ratio across the leak is greater than the critical pressure ratio (approximately 1.9 for hydrogen). At pressure ratios higher than the critical value, the exit velocity remains locally sonic. For these supercritical releases, the flow leaves the exit to form an underexpanded jet that quickly expands to ambient pressure through a complex flow structure involving one or more shocks. As a result, the concentration field behaves as if it were produced by a larger source than the actual exit diameter and the diameter of this effective source is referred to as the effective diameter,~~ d_{eff} ~~. The work of Birch (1984, 1987) for natural gas jets indicates that the classical laws for concentration decay for turbulent jets in pressure equilibrium [i.e., Eq. (H.2.2a)] can be applied to underexpanded jets resulting from supercritical releases provided that the jet exit diameter,~~ d_j ~~, is replaced by the effective diameter~~ d_{eff} ~~. The reports of Britter (1994, 1995) discuss various approaches for computing effective diameter source models for underexpanded jets.~~

~~The effective source diameter model used in this work is formulated by considering a notional expansion (Birch, 1987) that conserves both mass and momentum while retaining the assumption that the pressure is reduced to ambient pressure at the end of the expansion. Based on the work of Birch (1987), the equation for the effective source diameter is~~

$$d_{eff} = \left(\frac{\rho_j u_j}{\rho_{gas} u_{eff}}\right)^{1/2} d_j$$ ~~[H.2.2b]~~

~~where~~ ρ_j ~~is the jet exit density,~~ u_j ~~is the jet exit velocity,~~ ρ_{gas} ~~is the density of the exiting gas evaluated at ambient pressure and temperature,~~ d_j ~~is the jet exit diameter, and~~ u_{eff} ~~is the velocity at the end of the expansion. The effective velocity at the end of the expansion is given by an expression of the form~~

$$u_{ef} = u_j + \left(P_j - P_\infty\right)/\left(\rho_j u_j\right)$$ ~~[H.2.2c]~~

~~where~~ p_j ~~is the jet exit pressure and~~ p_∞ ~~is the ambient pressure. Equations (H.2.2b) and (H.2.2c) can be used to compute the effective source diameter for supercritical releases and are valid for real gas as well as ideal gas models as long as the jet exit conditions are computed properly. For hydrogen at 200 bar and 300K the compressibility factor Z (where~~ $Z = p/(\rho RT)$ ~~) is approximately 1.12; at a pressure of 800 bar and the same temperature the compressibility factor is approximately 1.51. For an ideal gas, Z is equal to unity.~~

~~For supercritical releases the effective source diameter replaces the jet diameter in Eq. (H.2.2a) and centerline concentration decay equation becomes~~

$$\eta_{cl}(x) = \frac{Kd_{eff}}{x + x_0}\left(\frac{\rho_\infty}{\rho_{gas}}\right)^{1/2}$$ ~~[H.2.2d]~~

~~At each axial position, x, the radial variation of the concentration is computed from the expression~~

$$\eta(x,r) = \eta_{cl}(x)e^{-K_c(r/x+x_o)^2}$$ ~~[H.2.2e]~~

~~where the value of~~ K_c ~~= 57 for a round jet (Chen and Rodi, 1980). Equations (H.2.2b), (H.2.2c), (H.2.2d),~~

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~~and (H.2.2e) can be used to compute the concentration field from a high-momentum turbulent jet resulting from the supercritical release of hydrogen. For the studies performed in this paper, a value of the entrainment coefficient equal to K=5.40 (Birch, 1987) was used for the simulations. The value of the virtual origin,~~ $\cancel{x_o}$ ~~, is typically a small multiple (less than 5) of the jet exit diameter and was set to zero for these studies in accordance with the work of Birch (1987).~~

~~**H.3** – Comparison of Models with Experimental Data.~~

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~~**H.3.1** Flame Radiation Heat Flux and Flame Length Model.~~

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~~The hydrogen flame radiation and flame length models were compared against the large-scale hydrogen jet flame experiments of Schefer *et al.* (2006, 2007). In these experiments, hydrogen gas was released from a "six-pack" of high-pressure cylinders, each connected to a central manifold with a common outlet. Typical pressure in the full cylinders was 137.9 bar (2000 psia) to 172.3 bar (2500 psia).~~

~~To obtain jet exit conditions, a network flow model of the piping and high-pressure cylinders used in the experiment was developed using the Sandia developed Topaz code (Winters, 1984). The network flow model considers the non-ideal gas behavior of hydrogen through an Abel-Nobel equation of state (Chenoweth, 1983) of the form~~

$$p = \frac{\rho R_{H_2} T}{(1-b\rho)} \qquad \text{[H.3.1]}$$

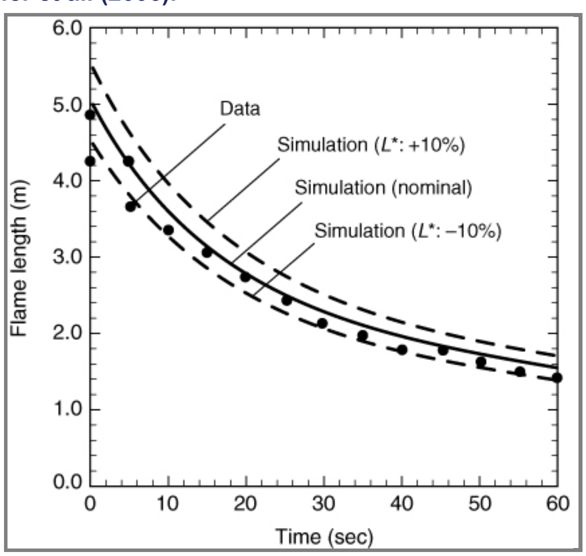
~~where the values of R_{H_2} = 4,124.18 J/kg-K and b = 7.691 × 10^{-3} m^3/kg were used for hydrogen.~~

~~The model can also be used with an ideal-gas equation of state by setting the value b equal to zero.~~

~~The tank blow-down and network flow model was used to predict the flow and pressure drop through the piping leading to the jet exit. These jet exit conditions were then used with the flame length and radiant fraction correlations described in the previous section to predict the hydrogen jet flame characteristics. Comparisons of the measured and predicted pressure history curves in the high-pressure cylinders were used to validate the tank blow-down network flow model (Schefer *et al*., 2006). Simulations with the network flow model indicated that significant pressure drop occurred in the piping of the experiment with the total pressure at the jet exit being approximately 16.4 bar (226 psig) or a static pressure of approximately 13.6 bar (182 psig) at 0.1 second into the blow-down.~~

~~Figure H.3.1(a) shows a comparison of the flame length predictions from the model with the large-scale hydrogen jet flame length data. Because an approximate ±10% scatter occurs in the data around the L* correlation *[see Figure H.2.1(c)]* used in the model, an uncertainty analysis was performed where the L* correlation was increased and then decreased by 10% from its nominal value. Calculations are shown in Figure H.3.1(a) for the nominal L* correlation, and an increase in L* of 10% and a decrease in L* of -10%. Predictions from the model are found to be in good agreement with the measured hydrogen flame lengths.~~

~~Figure H.3.1(a) Comparison of Simulation of Hydrogen Visible Flame Length with the Hydrogen Jet Flame Data of Schefer et al. (2006).~~



~~Figure H.3.1(b) shows a comparison of simulations and measured radiation heat flux data along the axis of a hydrogen jet flame at a radial distance of 1.82 m (6 ft) from the flame centerline at a time 5 seconds into the blow-down of the high-pressure hydrogen cylinders. An approximate ±10% scatter occurs in the data around the L* correlation *[see Figure H.2.1(c)]*, the C* correlation *[see Figure H.2.1(a)]*, and the radiant fraction correlation *[see Figure H.2.1(b)]*, X_{rad}. Hence, an uncertainty analysis was performed where model calculations were performed with the nominal values of these correlations, and an increase of 10% to each of the 3 correlations (upper bound on radiative heat flux), and a decrease of –10% to each of the correlations (lower bound on radiative heat flux). The results of these calculations are shown in Figure H.3.1(b). An additional comparison with data using the same approach is shown in Figure H.3.1(c) at a time of 10 seconds into the blow-down. The range of the calculations with either an increase of 10% or decrease of 10% in each of the correlations for L*, C*, and X_{rad} are able to bound the range of experimental data adequately at both times.~~

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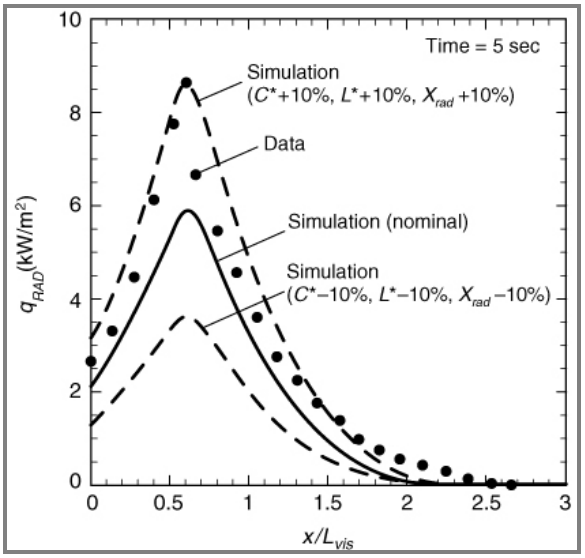
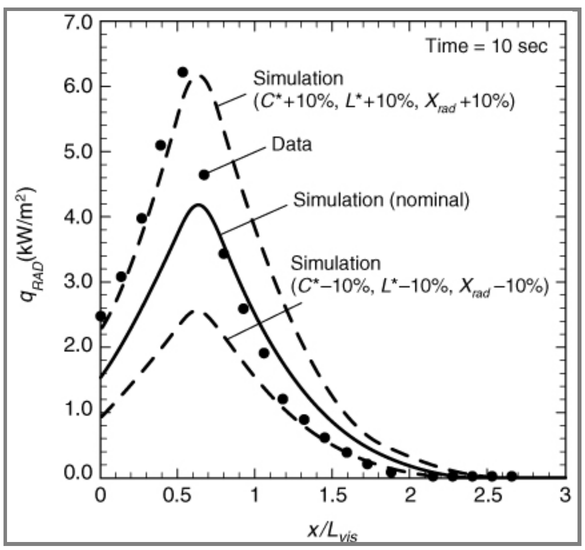
~~**Figure H.3.1(b) Comparison of Simulation of Radiative Heat Flux from a Hydrogen Flame at a Radial Position of r=1.83 m with the Data at 5 Seconds into the Blow-Down.**~~



~~**Figure H.3.1(c) Comparison of Simulation of Radiative Heat Flux from a Hydrogen Flame at a Radial Position of r=1.83 m with the Data at 10 Seconds into the Blow-Down.**~~



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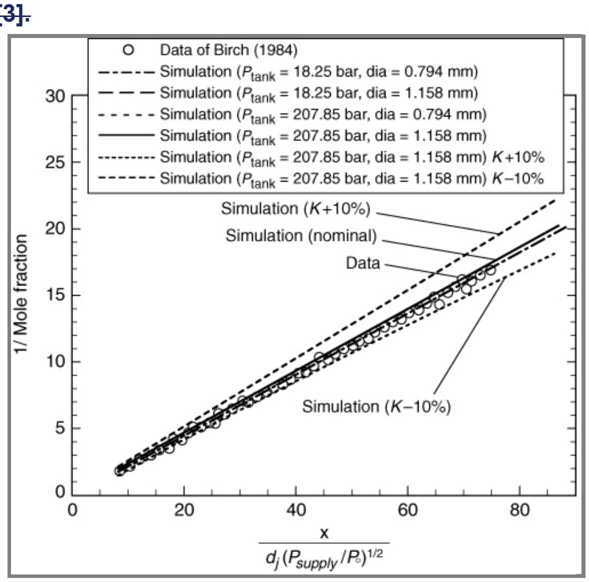
~~**H.3.2** – Unignited Jet Concentration Decay Model.~~

~~There appears to be a lack of data in the literature for the concentration decay of momentum-dominated, choked flow, unignited turbulent hydrogen jets resulting from supercritical releases. Hence the unignited jet model was compared with the jet concentration decay data of Birch (1984) for supercritical releases of natural gas. Birch measured the concentration decay of natural gas into air for a 2.7 mm diameter round nozzle connected to a regulated high-pressure natural gas supply. The method of concentration measurement in the experiment integrated the turbulent concentration fluctuations in the flow and resulted in a time-averaged concentration measurement at each axial location. Measurements of the mean concentration level at different axial positions along the jet centerline were made for supply pressures ranging from 3.5 to 71 bar. Birch found if the mean concentration decay along centerline was plotted in terms of the non-dimensional coordinate~~ $x/(d_j\ (p_{supply}/p_\infty)^{0.5})$~~, then the data collapsed onto a single curve.~~

~~Calculations with the unignited jet model discussed in the previous section were performed using natural gas properties and generating jet exit conditions for a large high-pressure supply attached to a short round nozzle. The Topaz network flow code with an ideal gas equation of state for natural gas was used to generate jet exit conditions for this geometry. Calculations were performed at pressures of 18.25 bar (250 psig) and 207.85 bar (3000 psig) for jet exit diameters of 0.794 mm and 1.158 mm. The axial variation of the reciprocal of the mean concentration~~ $(1/\bar{\eta}_{cl})$ ~~on jet centerline was plotted in terms of the non-dimensional axial coordinate,~~ $x/(d_j\ (p_{supply}/p_\infty)^{0.5})$~~, where~~ d_j ~~is the jet exit diameter,~~ p_{supply} ~~is the pressure in high-pressure supply,~~ p_∞ ~~is the ambient pressure. Comparison of the calculations from the model with the data of Birch (1984) using the nominal value of the turbulent entrainment constant (K = 5.40) is shown in Figure H.3.2 . Based on data reported by Birch (1984, 1987) there appears to be approximately ±10% variation in the value of the turbulent entrainment constant, K. Hence, in addition to using the nominal value of K, calculations were performed for the 207.85 bar 1.158 diameter nozzle by varying K ±10% from the nominal value. Results of the calculations using the nominal value of K are in excellent agreement with the data of Birch. Moreover the calculations at 207.8 bar, which are well beyond the maximum pressure of 71 bar used in Birch's experiments, are found to be in excellent agreement with the collapsed data curve plotted in terms of~~ $x/(d_j\ (p_{supply}/p_\infty)^{0.5})$~~. The work of Ruffin *et al* . (1996) also appears to confirm the notional expansion concentration decay model of Birch for supercritical jets of methane and hydrogen at a pressure of 40 bar.~~

~~**Figure H.3.2 Comparison of Simulation of Centerline Concentration Decay for Gas Unignited Jets with the Data of Birch [3].**~~



~~**H.4** – Simulation of Unintended Releases.~~

~~**H.4.1** – Hydrogen Jet Flame Radiation and Unignited Jet Concentration Decay.~~

~~Simulations for unintended releases of hydrogen were performed by considering a break in the tubing directly connected to a large hydrogen storage container. Based on a survey of a panel of experts (ICC, 2003) familiar with current and intended uses of hydrogen, pressures in the range from 18.25 bar (250 psig) to 1,035.21 bar (15,000 psig) and leak diameters in the range from 9.525 mm (~~ $^3/_8$ ~~inch) to 0.25 mm were suggested for analysis.~~

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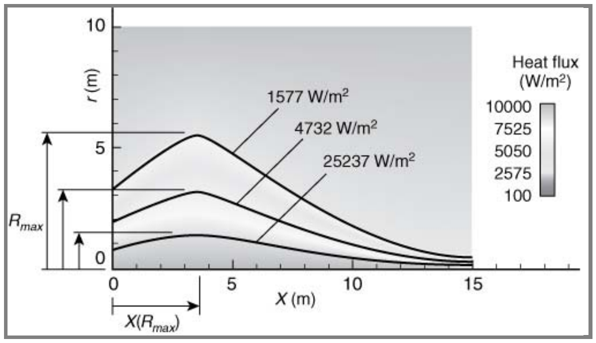
~~For the simulations reported in this section a storage tank volume of 29.7 m~~ ^{3} ~~was used based on the recommendation of the expert panel. Calculations are reported for pressures of 18.25 bar (250 psig), 207.85 bar (3000 psig), 518.11 bar (7500 psig), and 1,035.21 bar (15,000 psig) and leak diameters ranging between 1.587 mm (~~ $^1/_{16}$ ~~inch) and 6.35 mm (~~ $^1/_4$ ~~inch). Jet exit conditions were computed using the Topaz network flow code with an Abel-Nobel equation of state for hydrogen to simulate a large tank of hydrogen connected to a short length of tubing (3.175 mm) with a diameter equal to the diameter of the leak under consideration. The tank temperature was assumed to be initially at ambient temperature (294K) with the end of the tubing exiting to the ambient environment (1.0133 bar, 294K). Calculations were performed for hydrogen jet flames and unignited jets with the results for radiative heat flux and concentration decay being reported at 1 second into the tank blow-down for each case. At 1 second, the tank pressure has not changed significantly from its initial value and the radiative and concentration length scales are at their largest values.~~

~~Figure H.4.1(a) Simulation of Radiation Heat Flux from a Hydrogen Jet Flame with a Leak Diameter of 3.175 mm and a Tank Pressure of 207.85 bar (3000 psig).~~



~~For the hydrogen jet flames, radiative heat flux contours were recorded for heat flux levels of 1577 W/m~~ ^{2} ~~(500 Btu/hr-ft~~ ^{2} ~~), 4732 W/m~~ ^{2} ~~(1500 Btu/hr-ft~~ ^{2} ~~), and 25237 W/m~~ ^{2} ~~(8000 Btu/hr-ft~~ ^{2} ~~). These heat flux levels corresponding to values listed in the 2003 International Fire Code (2002) for exposure at property line, exposure for employees for a maximum of 3 minutes, and exposure for noncombustible equipment, respectively. Figure H.4.1(a) shows results for the radiative heat flux from a hydrogen jet flame with a tank pressure of 207.85 bar (3000 psig) and a leak diameter of 3.175 mm (~~ $^1/_8$ ~~inch). Important safety related information recorded from the simulations includes the maximum radial position from the flame centerline for the given heat flux level,~~ R_{max} ~~, the axial location at which the maximum occurs,~~ $X(R_{max})$ ~~, the combination of these two distances,~~ $D_{rad} = (R_{max} + X(R_{max})$ ~~, and the visible flame length,~~ L_{vis} ~~. Figure H.4.1(b) shows a plot of~~ D_{rad} ~~and the visible flame length for various leak diameters for a tank pressure of 207.85 bar. Also included on the plot are the upper and lower bounds for~~ D_{rad} ~~and~~ L_{vis} ~~assuming an uncertainty of ±10% in each of the values of C*, L*, and~~ X_{rad} ~~. Figure H.4.1(c) shows a plot of~~ R_{max} ~~and~~ $X(R_{max})$ ~~for various leak diameters for a tank pressure of 207.85 bar, including the upper and lower bounds for~~ R_{max} ~~and~~ $X(R_{max})$ ~~assuming ±10% uncertainty in each of the values of C*, L*, and~~ X_{rad} ~~. At this pressure the value of~~ D_{rad} ~~can be computed to approximately ±14% to ±18% depending on the jet diameter, while the flame length can be computed to approximately ±10%.~~

~~Figure H.4.1(b) Simulations of Hydrogen Jet Flame Radiation from a Tank at Pressure 207.85 bar (3000 psig) for Various Diameter Leaks. Results showing radiation distance,~~ $D_{rad} = (X(R_{max}) + R_{max})$ ~~, for a heat flux level of 1577 W/m~~ ^{2} ~~and the visible flame length. Solid lines show distances using nominal values of C*, L*, and~~ X_{rad} ~~. Dashed lines show upper and lower bounds for~~ D_{rad} ~~and visible flame length with ±10% uncertainty in each of the values of C*, L*, and~~ X_{rad} ~~.~~

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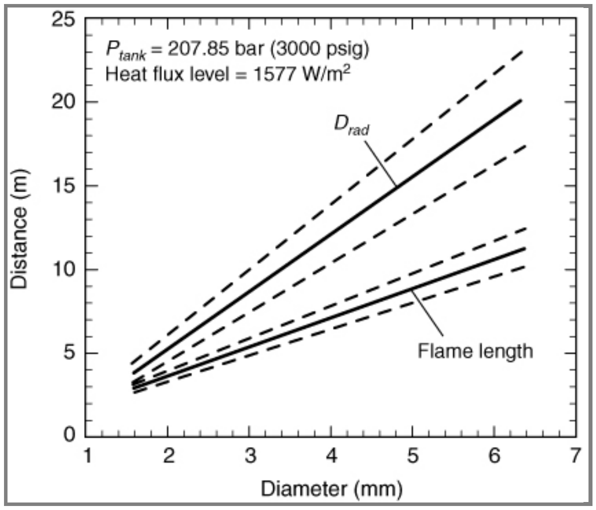
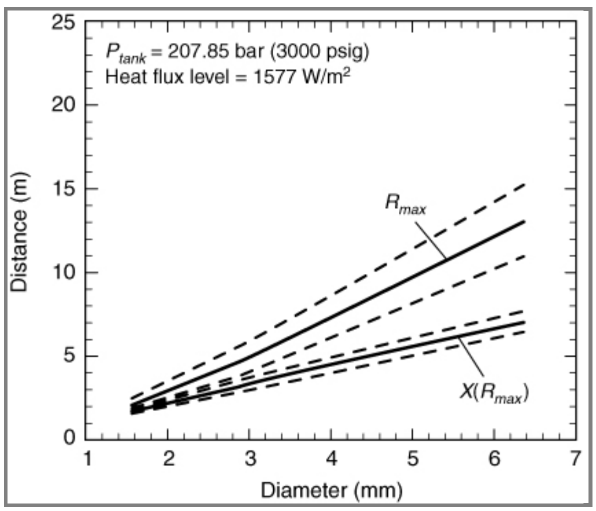
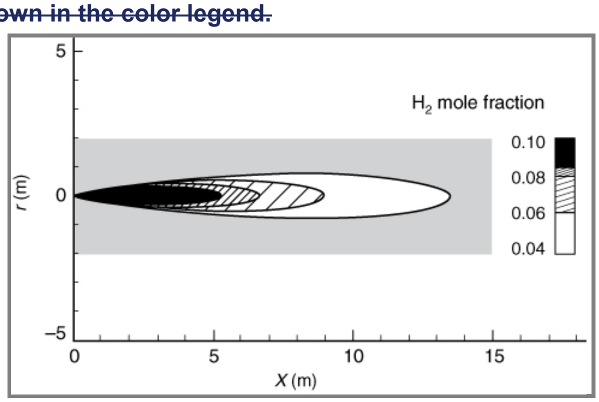


~~Figure H.4.1(c) Simulations of Hydrogen Jet Flame Radiation from a Tank at Pressure 207.85 bar (3000 psig) for Various Diameter Leaks. Results showing maximum radial distance from the flame centerline, R max , for a heat flux level of 1577 W/m 2 and the axial location on centerline, X(R max), where the maximum occurs. Solid lines show distances using nominal values of C*, L*, and X rad . Dashed lines show upper and lower bounds for R max and X(R max) with ±10% uncertainty in each of the values of C*, L*, and X rad .~~



~~Figure H.4.1(d) Simulations of Concentration Decay of an Unignited Hydrogen Jet with a Diameter of 3.175 mm (1 ⁄8 in.) and a Tank Pressure of 207.85 bar (3000 psig). Contour lines correspond to mole fraction levels shown in the color legend.~~



~~Figure H.4.1(d) shows mole fraction contours for the simulation of the concentration decay of an unignited~~

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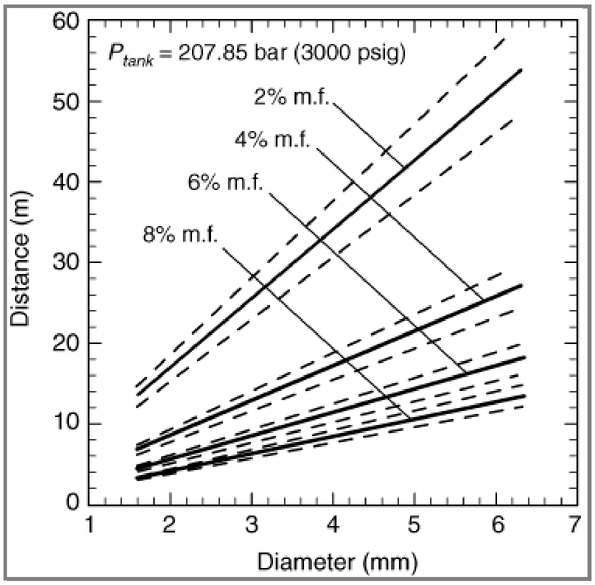
~~jet of hydrogen for a tank pressure of 207.85 bar (3000 psig) and a leak diameter of 3.175 mm (1/8 inch). Important safety information recorded from the simulations is the distance from the jet exit to where the mean concentration decays to a given concentration level on the jet centerline. Although the generally accepted value for the upward-propagating lower flammability limit of hydrogen in air is 0.04 mole fraction, experimental data in the literature indicate that the limit may be as high as 0.072 mole fraction for horizontal-propagating flames and 0.095 mole fraction for downward-propagating flames (Zebetakis, 1965, Coward and Jones, 1952). For the unignited hydrogen jet simulations, distances from the origin to jet centerline concentration levels of 0.08, 0.06, 0.04, and 0.02 mole fraction were recorded, and these distances are referred to as x8%, x6%, x4%, and x2% respectively. Figure H.4.1(e) shows a plot of unignited jet concentration decay distances for a tank pressure of 207.85 bar (3000 psig) for various leak diameters. Upper and lower bounds for the concentration decay distances are also shown on the plot assuming a ±10% uncertainty in the turbulent jet entrainment constant K.~~

~~Figure H.4.1(e) Simulations of Concentration Decay for a Turbulent High-Momentum Supercritical Unignited Hydrogen Jet from a Tank at Pressure 207.85 bar (3000 psig) for Various Diameter Leaks. Results showing axial distance from jet origin to the point where jet concentration reaches 2.0%, 4.0%, 6.0%, and 8.0% mole fraction on jet centerline. Solid lines show distances using the nominal value of the turbulent jet entrainment constant, K = 5.40. Dashed lines show upper and lower bounds for distances with ±10% uncertainty in the value of K.~~



~~Table H.4.1(a) shows a summary of radiation distances recorded from hydrogen jet flame simulations for tank pressures of 18.25 bar (250 psig), 207.85 bar (3000 psig), 518.11 bar (7500 psig), and 1035.21 bar (15,000 psig) for selected leak diameters using the nominal values of C*, L*, and X_{rad}. Table H.4.1(b) shows a summary of concentration decay distances for unignited hydrogen jets for the same tank pressures and selected leak diameters using the nominal value of the entrainment constant K. Detailed plots of radiation and concentration decay distances for the range of parameters considered are presented in H.7.~~

~~Figure H.4.1(f) shows a comparison of hydrogen jet flame radiation hazard distances with unignited jet concentration decay distances for a range of tank pressures and leak diameters. Results are shown for the visible flame length and the radiation hazard distance, D_{rad}, for heat flux levels of 1577 W/m² and 4732 W/m². These radiation hazard distances are compared with unignited jet concentration decay distances from origin to jet centerline mean concentration levels of 0.08, 0.06, 0.04 mole fractions. For the range of pressures studied, the unignited jet concentration decay distance to the generally accepted lower flammability limit of hydrogen in air (0.04 mole fraction) is greater than the radiation jet flame hazard distance (D_{rad}) for exposure at property line (1577 W/m²).~~

~~Table H.4.1(a) Hydrogen Jet Flame Radiation Distances for Selected Leak Diameters and Tank Pressures (Note: Assuming worst case of no pressure loss in tubing).~~

~~P_{tank}~~

~~(bar) d_j~~

~~(mm) $X(R_{max})$~~

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~~(m) R max~~

~~(m) D rad~~

~~(m) L vis~~

~~(m) Heat Flux~~

~~(W/m^2) 18.25 1.00 0.35 0.10 0.45 0.55 1577 18.25 1.00 0.35 0.059 0.41 0.55 4732 18.25 1.00 0.35 0.026 0.38 0~~

~~Table H.4.1(b) Unignited Hydrogen Jet Concentration Decay Distances on Jet Centerline for Selected Leak Diameters, Tank Pressures, and Mole Fractions (i.e., X2% indicates the distance from jet origin to the point where the centerline concentration has decayed to a mean concentration of 2% mole fraction).~~

~~P tank~~

~~(bar) d j~~

~~(mm) X 2%~~

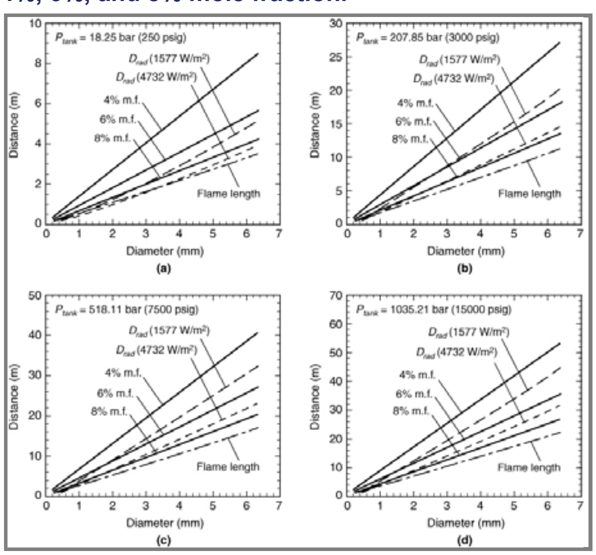
~~(m) X 4%~~

~~(m) X 6%~~

~~(m) X 8%~~

~~(m) 18.25 0.25 0.67 0.33 0.22 0.16 18.25 0.50 1.34 0.67 0.44 0.33 18.25 1.00 2.67 1.34 0.89 0.67 18.25 2.3810 6.~~

~~**Figure H.4.1(f) Comparison of Simulations of Hydrogen Jet Flame Radiation Hazard Distances with Unignited Hydrogen Jet Centerline Concentration Decay Distances for Various Tank Pressures [18.25 bar (250 psig), 207.85 bar (3000 psig), 518.11 bar (7500 psig), 1035.21 bar (15000 psig)] and Leak Diameters. Dashed lines show the radiation hazard distance, D rad = (X(R max) + R max), for radiation heat flux levels of 1577 W/m^2 and 4732 W/m^2 and the visible flame length. Solid lines show unignited jet concentration decay distances along jet centerline for concentration levels of 4%, 6%, and 8% mole fraction.**~~



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~~**H.5** – Summary and Conclusions.~~

~~The previous sections presented methods by which the radiant heat flux from hydrogen jet flames and the concentration decay of supercritical high-momentum unignited hydrogen jets may be computed. If the jet exit conditions can be computed at the leak (Chernicoff *et al.* , 2005), then these methods can be used to compute hydrogen jet flame radiation and unignited jet concentration decay based on the models.~~

~~An uncertainty analysis of the hydrogen jet flame radiation model (207.85 bar case) using an uncertainty of ±10% in each of the three experimentally measured correlations (C*, L*, X_{rad}), indicates that the radiation distance, D_{rad} , can be computed to approximately ±14% to ±18% for the jet diameters studied. The flame length can be computed to approximately ±10%. Assuming a ±10% uncertainty in the experimentally measured turbulent jet entrainment constant, K, an uncertainty analysis of the unignited jet concentration decay model indicates that concentration decay distances can be computed to ±10%. Figure H.7(a) through Figure H.7(e) in the appendix of this paper give detailed plots of the hydrogen jet flame radiation hazard distances [D_{rad} , X(R_{max}), R_{max}] and unignited jet concentration decay distances (including upper and lower bounds) for tank pressures of 18.25 bar (250 psig), 207.85 bar (3000 psig), 518.11 bar (7500 psig), and 1035.21 bar (15,000 psig) over a range of leak diameters from 0.25 mm to 6.35 mm.~~

~~**H.6** – Acknowledgements.~~

~~This work was supported by the U. S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Hydrogen, Fuel Cells and Infrastructure Technologies Program.~~

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~~**H.7** – Appendix.~~

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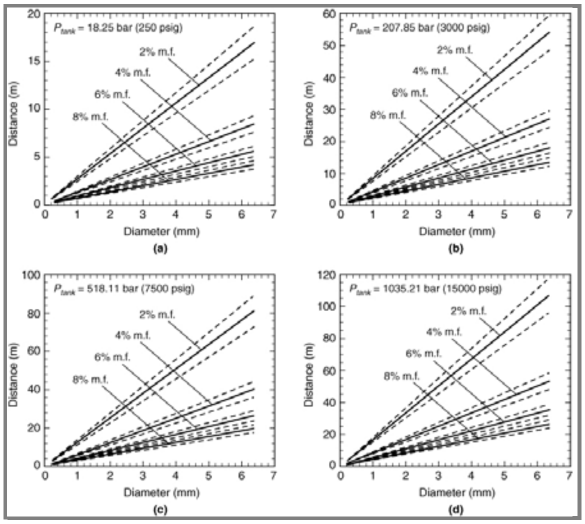
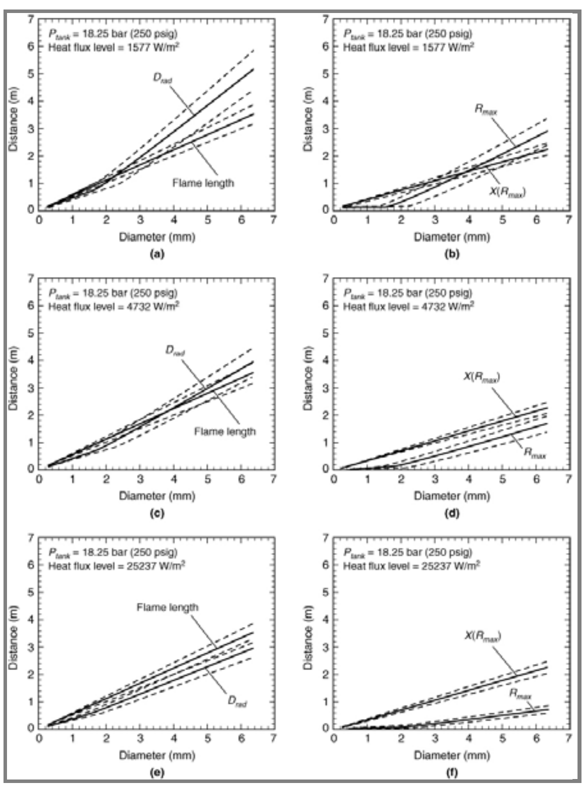
~~Figure H.7(a) shows simulation results of unignited hydrogen jet concentration decay distances and their uncertainty for the range of leak diameters and tank pressures studied. Figure H.7(b) through Figure H.7(e) show simulation results of hydrogen jet flame radiation distances and their uncertainty for the range of leak diameters and tank pressures studied.~~

~~Figure H.7(a) Simulations of Concentration Decay for Turbulent High-Momentum Supercritical Unignited Hydrogen Jets from Tanks at Pressures from 18.25 bar (250 psig) to 1035.21 bar (15000 psig) for Various Diameter Leaks. Results showing axial distance from jet origin to the point where jet concentration reaches 2.0%, 4.0%, 6.0%, and 8.0% mole fraction on jet centerline. Solid lines show distances using the nominal value of the turbulent jet entrainment constant, K = 5.40. Dashed lines show upper and lower bounds for distances with ±10% uncertainty in the value of K.~~

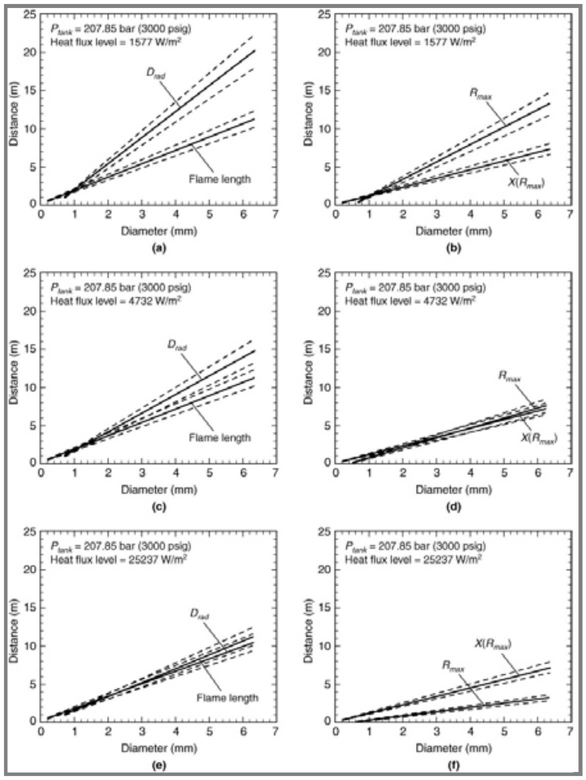


~~Figure H.7(b) Simulations of Hydrogen Jet Flame Radiation from a Tank at Pressure 18.25 bar (250 psig) for Various Diameter Leaks. Results showing maximum radial distance from the flame centerline, R_{max}, for a heat flux levels of 1577, 4732, and 25237 W/m^2 and the axial location on centerline, $X(R_{max})$, where the maximum occurs. Solid lines show distances using nominal values of C*, L*, and X_{rad}. Dashed lines show upper and lower bounds for R_{max} and $X(R_{max})$ with ±10% uncertainty in each of the values of C*, L*, and X_{rad}.~~



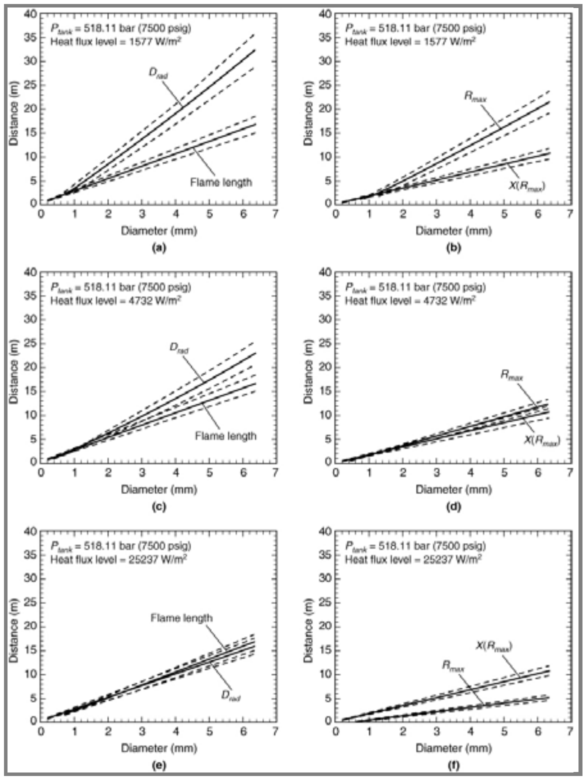
Attachment F - NFPA 55 Public Inputs

~~**Figure H.7(c) Simulations of Hydrogen Jet Flame Radiation from a Tank at Pressure 207.85 bar (3000 psig) for Various Diameter Leaks. Results showing maximum radial distance from the flame centerline, R $_{max}$, for a heat flux levels of 1577, 4732, and 25237 W/m ^{2} and the axial location on centerline, X(R $_{max}$), where the maximum occurs. Solid lines show distances using nominal values of C*, L*, and X $_{rad}$. Dashed lines show upper and lower bounds for R $_{max}$ and X(R $_{max}$) with ±10% uncertainty in each of the values of C*, L*, and X $_{rad}$.**~~

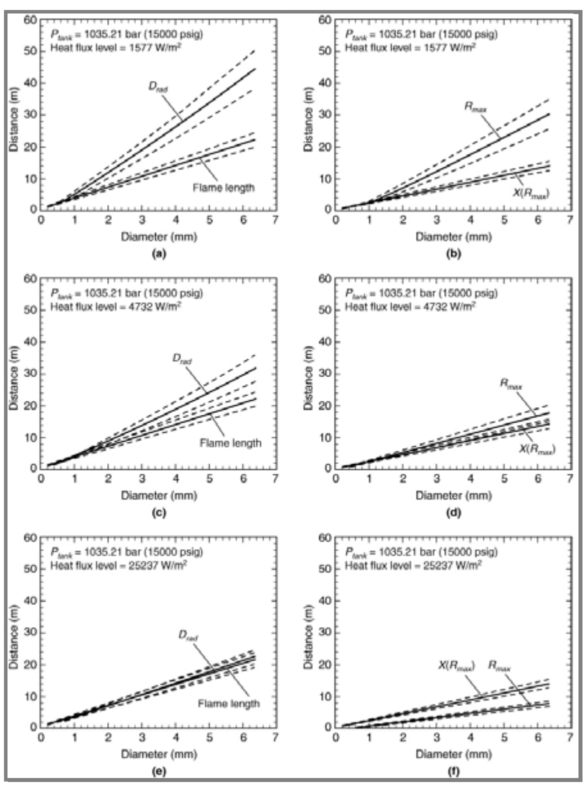


~~**Figure H.7(d) Simulations of Hydrogen Jet Flame Radiation from a Tank at Pressure 518.11 bar (7500 psig) for Various Diameter Leaks. Results showing maximum radial distance from the flame centerline, R $_{max}$, for a heat flux levels of 1577, 4732, and 25237 W/m ^{2} and the axial location on centerline, X(R $_{max}$), where the maximum occurs. Solid lines show distances using nominal values of C*, L*, and X $_{rad}$. Dashed lines show upper and lower bounds for R $_{max}$ and X(R $_{max}$) with ±10% uncertainty in each of the values of C*, L*, and X $_{rad}$.**~~

Attachment F - NFPA 55 Public Inputs



~~**Figure H.7(c) Simulations of Hydrogen Jet Flame Radiation from a Tank at Pressure 1035.21 bar (15000 psig) for Various Diameter Leaks. Results showing maximum radial distance from the flame centerline, R_{max}, for a heat flux levels of 1577, 4732, and 25237 W/m^2 and the axial location on centerline, $X(R_{max})$, where the maximum occurs. Solid lines show distances using nominal values of C*, L*, and X_{rad}. Dashed lines show upper and lower bounds for R_{max} and $X(R_{max})$ with ±10% uncertainty in each of the values of C*, L*, and X_{rad}.**~~



Attachment F - NFPA 55 Public Inputs

~~**H.8** – References.~~

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~~Sivathanu, Y. R. and Gore, J. P., *Combust. Flame* 94: 265-270, 1993.~~

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Statement of Problem and Substantiation for Public Input

The storage, use, handling, and many other aspects of hydrogen including the physical properties are addressed

Attachment F - NFPA 55 Public Inputs

by NFPA 2. Per the committee scope statements the HYD Committee has "primary responsibility for documents on the storage, transfer, production, and use hydrogen" and the IMG "Committee shall coordinate the material on gaseous and liquid hydrogen storage and use with the Hydrogen Technology Committee." The simplest, least error prone way for NFPA 55 to coordinate with NFPA 2 regarding hydrogen gas is to just refer the user to NFPA 2. This is best accomplished in in 7.6.1.2 and 8.1.4. This nullifies the need for Chapter 10 and the associated Annex H. And, the presence of Annex H in NFPA 55 causes confusion regarding whether NFPA 2 or NFPA 55 applies.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 85-NFPA 55-2020 [Chapter 10]	Annex H discusses separation distances from Chapter 10.

Submitter Information Verification

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Committee:	IMG-AAA

Attachment F - NFPA 55 Public Inputs

Public Input No. 40-NFPA 55-2020 [Section No. I.1.2.4]

I.1.2.4 ASTM Publications.

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

ASTM A380/A380 M, *Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems*, 2017.

ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, ~~2018~~ 2020 .

ASTM E681, *Standard Test Method for Concentration Limits of Flammability of Chemicals (Vapors and Gases)*, 2009 (2015) .

Statement of Problem and Substantiation for Public Input

updates

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Attachment F - NFPA 55 Public Inputs

Public Input No. 20-NFPA 55-2020 [Section No. I.1.2.9]

I.1.2.9 UL Publications.

Underwriters Laboratories, 333 Pfingsten Road, Northbrook, IL 60062-2096.

~~ANSI/~~ UL 558, *~~Standard for Safety Industrial~~ Industrial Trucks, Internal Combustion Engine–Powered*, 1996, Revised ~~2012~~ 2000 .

~~ANSI/~~ UL 583, *~~Standard for Safety Electric~~ Electric -Battery-Powered Industrial Trucks*, 1996, Revised ~~2012~~ 2017 .

~~ANSI/~~ UL 2075, *~~Standard for Gas~~ Gas and Vapor Detectors and Sensors*, ~~2013~~ 2017 .

Statement of Problem and Substantiation for Public Input

Reason: Many years ago, UL preferred the ANSI/UL reference because there was a transition of traditional UL standards towards an ANSI standards development process.

Now, years later, a large majority of UL Standards are ANSI approved and follow the ANSI development and maintenance process. However, sometimes readers are confused because they don't understand the standards are actually UL standards, not developed by ANSI. There are many other references to standards promulgated by other standards development organizations where they are considered ANSI approved but do not include ANSI in the reference.
The terms "Standard for" or "Subject" are redundant and unnecessary. All references to UL are standards.

Update of existing references.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 19-NFPA 55-2020 [Section No. 2.3.9]	

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Committee: IMG-AAA

Attachment G - NFPA 2 Public Inputs

Public Input No. 9-NFPA 2-2020 [Section No. 6.4.1.5.1 [Excluding any Sub-Sections]]

[GH_2] shall not be stored or used in excess of the MAQ in other than industrial ~~or~~ and storage occupancies~~, or laboratory work areas of business occupancies where NFPA 45 does not apply~~ .
~~[**55:** 6.3.1.6.1]~~

Additional Proposed Changes

File Name	Description	Approved
NFPA_2_PC_63.pdf	NFPA 2 Public Comment No. 63	

Statement of Problem and Substantiation for Public Input

NOTE: This Public Input appeared as "Reject but Held" in the Public Comment No. 63 of the A2019 Second Draft Report for NFPA 2 and per the Regs. at 4.4.8.3.1.

There are 3 parts to this comment:

1. Allowing the "use" of H2 in only 2 occupancies is overly prohibitive. Small, even "micro", fuel cells, hydrogen generators, etc. do not add a significant risk and should be allowed similar to the way gas stoves, gas refrigerators, gas heaters, etc. are allowed in businesses, offices, and even residences. Note: MAO was a convenient value to use as the limit; committee may want to chose another value (but "O" is not appropriate).

2. The changes to 6.4.1.5.1 were not needed as 16.1.1 permits GH2 in labs. And 16.1.1.4 indicates Chapter 16 applies, i.e. it "overrules" Chapter 6.

3. If this change is not adopted by NFPA 55, I propose that NFPA 2 drop the extract tag.

Ref. FR-135.
Ref. NFPA 55: PC-14

Submitter Information Verification

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Submittal Date: Thu Feb 06 13:38:41 EST 2020
Committee: HYD-AAA

Attachment G - PI9 (PC-63)

Public Comment No. 63-NFPA 2-2018 [Section No. 6.4.1.5.1 [Excluding any Sub-Sections]]

[GH_2] shall not be stored or used in excess of the MAQ in other than industrial and storage occupancies ~~or laboratory work areas of business occupancies where NFPA 45 does not apply~~ . ~~[**55:** 6.3.1.6.1]~~

Statement of Problem and Substantiation for Public Comment

There are 3 parts to this comment:
1. Allowing the "use" of H2 in only 2 occupancies is overly prohibitive. Small, even "micro", fuel cells, hydrogen generators, etc. do not add a significant risk and should be allowed similar to the way gas stoves, gas refrigerators, gas heaters, etc. are allowed in businesses, offices, and even residences. Note: MAQ was a convenient value to use as the limit; committee may want to chose another value (but "0" is not appropriate).
2. The changes to 6.4.1.5.1 were not needed as 16.1.1 permits GH2 in labs. And 16.1.1.4 indicates Chapter 16 applies, i.e. it "overrules" Chapter 6.
3. If this change is not adopted by NFPA 55, I propose that NFPA 2 drop the extract tag.

Ref. FR-135.
Ref. NFPA 55: PC-14

Related Item

• First Draft (FR-135)

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Submittal Date:	Wed Apr 11 13:36:26 EDT 2018
Committee:	

Committee Statement

Committee Action:	Rejected but held
Resolution:	The committee would like to correlate with NFPA 55 and establish a more appropriate threshold and requires more time to determine what that threshold should be.

Attachment G - NFPA 2 Public Inputs

Public Input No. 13-NFPA 2-2020 [New Section after 6.6.5.2]

Electrical wiring and equipment shall be in accordance with Section 6.7, ~~and~~ ~~NFPA 70,~~ NFPA 70[, and NFPA 79] . [55:6.7]

Additional Proposed Changes

File Name	Description	Approved
NFPA_2_PC_191.pdf	NFPA 2 PC NO. 191	

Statement of Problem and Substantiation for Public Input

NOTE: This Public Input appeared as "Reject but Hold" in Public Comment No. 191 of the (A2019) Second Draft Report for NFPA 2 and per the Regs. at 4.4.8.3.1.

Change made in 8.1.9.1 applies to all hydrogen systems not just liquid hydrogen and should be in Chapter 6.

Change made in square brackets to keep extract tag.

Ref. FR #157
See also PC #190

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Committee:	HYD-AAA

Attachment F - PI13 (PC-191)

Public Comment No. 191-NFPA 2-2018 [Section No. 6.7 [Excluding any Sub-Sections]]

Electrical wiring and equipment shall be in accordance with Section 6.7 ~~and NFPA 70~~ , *NFPA 70[, and NFPA 79]* . [**55:**6.7]

Statement of Problem and Substantiation for Public Comment

Change made in 8.1.9.1 applies to all hydrogen systems not just liquid hydrogen and should be in Chapter 6.

Change made in square brackets to keep extract tag.

Ref. FR #157.
See also PC #190.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 190-NFPA 2-2018 [Section No. 8.1.9.1]	Same
Public Comment No. 190-NFPA 2-2018 [Section No. 8.1.9.1]	

Related Item

• First Revision (FR #157)

Submitter Information Verification

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Submittal Date: Wed May 09 16:45:46 EDT 2018
Committee:

Committee Statement

Committee Action: Rejected but held

Resolution: The committee agrees with the context but would like to maintain the extract with NFPA 55. The committee recommends submitting the public comment to NFPA 55.

Attachment G - NFPA 2 Public Inputs

Public Input No. 222-NFPA 2-2020 [Section No. 7.3.2.3.1.1]

7.3.2.3.1.~~1~~ *– Minimum Distance for Aboveground Locations.

The minimum distance from a [GH_2] system located outdoors to specified exposures shall be in accordance with Table 7.3.2.3.1.1(A)(a), Table 7.3.2.3.1.1(A)(b), or Table 7.3.2.3.1.1(A)(c). [**55:**10.4.2.2.1]

Insert new: 7.3.2.3.1.1* The minimum distance to exposures for individual components of the bulk hydrogen compressed gas system shall be taken from Table 10.4.2.2.1 (a), (b), or (c) based on the maximum internal diameter and respective system design pressure in which they are installed.

Annex A .7.3.2.3.1.1 Table 10.4.2.2.1 (a) , (b), and (c) define minimum distances between exposures and components of a bulk hydrogen compressed gas system. The exposure distances are a function of exposure type (Groups 1, 2, and 3), system design pressure, and maximum internal diameter. A bulk hydrogen compressed gas system may have portions of the system that operate within differing pressure ranges. For example, components that operate within a system between 15 and 250 psig with a largest pipe size less than or equal to 52.5 mm have a minimum Group 1 exposure distance of 16 feet. Components that operate within a different portion of the system between 250 psig and 3000 psig with the largest pipe size less than or equal to 18.97 mm have a minimum Group 1 exposure of 20 feet. It is not necessary to apply the 20 feet minimum Group 1 exposure distances to the components that form a portion of the system that operate between 15 and 250 psig.

Attachment G - NFPA 2 Public Inputs

(A) Maximum Internal Diameter of Interconnecting Piping.

Attachment G - NFPA 2 Public Inputs

The maximum internal diameter of the piping system used for interconnecting piping between the shutoff valve on any single storage container to the point of connection to the system source valve shall not be required to be in accordance with the values shown in Table 7.3.2.3.1.1(A)(a) when in accordance with Table 7.3.2.3.1.1(A)(b) or Table 7.3.2.3.1.1(A)(c). [**55:**10.4.2.2.2]

(1) The separation distance for piping systems with internal diameters other than those specified in Table 7.3.2.3.1.1(A)(a) for the pressure range selected shall be permitted with tabular distances determined based on the use of Table 7.3.2.3.1.1(A)(b) or Table 7.3.2.3.1.1(A)(c). [**55:**10.4.2.2.1.1]

(2) Separation distances determined based on the use of Table 7.3.2.3.1.1(A)(b) or Table 7.3.2.3.1.1(A)(c) shall be subject to review and approval by the AHJ. [**55:**10.4.2.2.2.2]

(3) The separation distance shall be measured from the part of the bulk hydrogen compressed gas system closest to the exposure.

(4)* **Determination of Internal Diameter.** The internal diameter of the piping system shall be determined by the diameter of the piping serving that portion of a storage array with content greater than 5000 scf (141.6 Nm^3). The piping system size used in the application of Table 7.3.2.3.1.1(A)(a), Table 7.3.2.3.1.1(A)(b) or Table 7.3.2.3.1.1(A)(c) shall be determined based on that portion of the system with the greatest maximum internal diameter. [**55:**10.4.2.2.2.1]

(5)* **Determination of System Pressure.** The system pressure shall be determined by the maximum operating pressure of the storage array with content greater than 5000 scf (141.6N m^3), irrespective of those portions of the system elevated to a higher pressure. [**55:**10.4.2.2.3]

Table 7.3.2.3.1.1(A)(a) Minimum Distance (D) from Outdoor Bulk Hydrogen Compressed Gas Systems to Exposures — Typical Maximum Pipe Size

Pressure	>15 to ≤250 psig		>250 to ≤3000 psig		>3000 to ≤7500 psig		>7500 to ≤15000 psig	
Internal Pipe Diameter (ID)	>103.4 to ≤1724 kPa		>1724 to ≤20,684 kPa		>20,684 to ≤51,711 kPa		>51,711 to ≤103,421 kPa	
d mm	d = 52.5mm		d = 18.97mm		d = 7.31mm		d = 7.16mm	
Exposures Group 1	**m**	**ft**	**m**	**ft**	**m**	**ft**	**m**	**ft**
Lot lines	5	16	6	20	4	13	5	16
Air intakes (HVAC, compressors, other)	-	-	-	-	-	-	-	-
Operable openings in buildings and structures	-	-	-	-	-	-	-	-
Ignition sources such as open flames and welding	-	-	-	-	-	-	-	-
Exposures Group 2	**m**	**ft**	**m**	**ft**	**m**	**ft**	**m**	**ft**
Exposed persons other than those servicing the system	5	16	6	20	3	10	4	13
Parked cars	-	-	-	-	-	-	-	-
Exposures Group 3	**m**	**ft**	**m**	**ft**	**m**	**ft**	**m**	**ft**
Buildings of non-combustible non-fire-rated construction	4	13	5	16	3	10	4	13
Buildings of combustible construction	-	-	-	-	-	-	-	-
Flammable gas storage systems above or below ground	-	-	-	-	-	-	-	-
Hazardous materials storage systems above or below ground	-	-	-	-	-	-	-	-
Heavy timber, coal, or other slow-burning combustible solids	-	-	-	-	-	-	-	-
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	-	-	-	-	-	-	-	-
Unopenable openings in building and structures	-	-	-	-	-	-	-	-
Encroachment by overhead utilities (horizontal distance from the vertical plane Below the nearest overhead electrical wire of building service)	-	-	-	-	-	-	-	-
Piping containing other hazardous materials	-	-	-	-	-	-	-	-
Flammable gas metering and regulating stations such as natural gas or propane.	-	-	-	-	-	-	-	-

[**55:**Table 10.4.2.2.1(a)]

Table 7.3.2.3.1.1(A)(b) Minimum Distance (D) from Outdoor Bulk Hydrogen Compressed Gas Systems to Exposures by Maximum Pipe Size with Pressures >15 to ≤3000 psig

Pressure		>15 to ≤250 psig >103.4 to ≤1724 kPa						>250 to ≤3000 psig >1724 to ≤20,684 kPa						
		Exposures*†						Exposures*†						
Internal Pipe Diameter (ID)		Group 1		Group 2		Group 3		Group 1		Group 2		Group 3		
		-	-	D = 0.0952d		D = 0.1019d -0.3485		D = 0.0762		D = 0.3168d		D = 0.3384d - 0.4188		D = 0.2636d
ID (in.)	d (mm)	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft	
0.2	5.1	0.5	2	0.2	1	0.4	1	1.6	5	1.3	4	1.3	4	
0.3	7.6	0.7	2	0.4	1	0.6	2	2.4	8	2.2	7	2.0	7	
0.4	10.2	1.0	3	0.7	2	0.8	3	3.2	11	3.0	10	2.7	9	
0.5	12.7	1.2	4	0.9	3	1.0	3	4.0	13	3.9	13	3.3	11	
0.6	15.2	1.4	5	1.2	4	1.2	4	4.8	16	4.7	16	4.0	13	
0.7	17.8	1.7	6	1.5	5	1.4	4	5.6	19	5.6	18	4.7	15	
0.8	20.3	1.9	6	1.7	6	1.5	5	6.4	21	6.5	21	5.4	18	
0.9	22.9	2.2	7	2.0	7	1.7	6	7.3	24	7.3	24	6.0	20	
1.0	25.4	2.4	8	2.2	7	1.9	6	8.0	26	8.2	27	6.7	22	
1.1	27.9	2.7	9	2.5	8	2.1	7	8.8	29	9.0	30	7.4	24	
1.2	30.5	2.9	10	2.8	9	2.3	8	9.7	32	9.9	32	8.0	26	
1.3	33.0	3.1	10	3.0	10	2.5	8	10.5	34	10.7	35	8.7	29	
1.4	35.6	3.4	11	3.3	11	2.7	9	11.3	37	11.6	38	9.4	31	
1.5	38.1	3.6	12	3.5	12	2.9	10	12.1	40	12.5	41	10.0	33	
1.6	40.6	3.9	13	3.8	12	3.1	10	12.9	42	13.3	44	10.7	35	
1.7	43.2	4.1	13	4.1	13	3.3	11	13.7	45	14.2	47	11.4	37	
1.8	45.7	4.4	14	4.3	14	3.5	11	14.5	47	15.0	49	12.0	40	
1.9	48.3	4.6	15	4.6	15	3.7	12	15.3	50	15.9	52	12.7	42	
2.0	50.8	4.8	16	4.8	16	3.9	13	16.1	53	16.8	55	13.4	44	
2.1	53.3	5.1	17	5.1	17	4.1	13	16.9	55	17.6	58	14.0	46	

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

*For a list of exposures in each exposure group, see Column 1 of Table 7.3.2.3.2(A)(a).

†When calculating the minimum separation distance (D) using the formulas indicated, based on the exposure group and pressure indicated, the internal pipe diameter (d) is entered in millimeters (mm). The calculated distance (D) is expressed in units of measure in meters (m). To convert distance (D) to units of measure in feet, multiply the value of (D) in meters by 3.2808 and round to the nearest whole foot. [**55:**Table 10.4.2.2.1(b)]

Table 7.3.2.3.1.1(A)(c) Minimum Distance (D) from Outdoor Bulk Hydrogen Compressed Gas Systems to Exposures by Maximum Pipe Size with Pressures >3000 to ≤15,000 psig

Pressure		>3000 to ≤7500 psig >20,684 to ≤51,711 kPa						>7500 to ≤15,000 psig >51,711 to ≤103,421 kPa						
		Exposures*†						Exposures*†						
Internal Pipe Diameter (ID)		Group 1		Group 2		Group 3		Group 1		Group 2		Group 3		
		-	-	D = 0.5471d		D = 0.6831d - 1.99		D = 0.459d - 0.355		D = 1.448d - 5.368		D = 0.9291d - 2.65		D = 0.602d - 0.3103
ID (in.)	d (mm)	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft	
0.2	5.1	1.6	5	1.5	5	2	7	2	7	2	7	3	9	
0.3	7.6	4.3	14	3.2	11	3	10	6	18	4	14	4	14	
0.4	10.2	7.2	24	5.0	16	4	14	9	31	7	22	6	19	
0.5	12.7	10.0	33	6.7	22	5	18	13	43	9	30	7	24	

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Pressure		>3000 to ≤7500 psig >20,684 to ≤51,711 kPa						>7500 to ≤15,000 psig >51,711 to ≤103,421 kPa						
		Exposures*†						Exposures*†						
Internal Pipe Diameter (ID)		Group 1		Group 2		Group 3		Group 1		Group 2		Group 3		
		-	-	D = 0.5471d		D = 0.6831d - 1.99		D = 0.459d - 0.355		D = 1.448d - 5.368		D = 0.9291d - 2.65		D = 0.602d - 0.3103
ID (in.)	d (mm)	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft	
0.6	15.2	12.7	42	8.4	28	7	22	17	55	11	38	9	29	
0.7	17.8	15.6	51	10.2	33	8	26	20	67	14	46	10	34	
0.8	20.3	18.4	60	11.9	39	9	29	24	79	16	53	12	39	
0.9	22.9	21.2	70	13.7	45	10	33	28	91	19	61	13	44	
1.0	25.4	24.0	79	15.4	50	11	37	31	103	21	69	15	49	
1.1	27.9	26.8	88	17.1	56	12	41	35	115	23	76	16	54	
1.2	30.5	29.6	97	18.8	62	14	45	39	127	26	84	18	59	
1.3	33	32.4	106	20.6	67	15	49	42	139	28	92	20	64	
1.4	35.6	35.3	116	22.3	73	16	52	46	152	30	100	21	69	
1.5	38.1	38.0	125	24.0	79	17	56	50	163	33	107	23	74	
1.6	40.6	40.8	134	25.7	84	18	60	53	175	35	115	24	79	
1.7	43.2	43.7	143	27.5	90	19	64	57	188	37	123	26	84	
1.8	45.7	46.4	152	29.2	96	21	68	61	199	40	131	27	89	
1.9	48.3	49.3	162	31.0	102	22	72	65	212	42	139	29	94	
2.0	50.8	52.1	171	32.7	107	23	75	68	224	45	146	30	99	

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

*For a list of exposures in each exposure group, see Column 1 of Table 7.3.2.3.2(A)(a).

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

[**55:**Table 10.4.2.2.1(c)]

Statement of Problem and Substantiation for Public Input

The separation distances are a function of Exposure Group, system pressure and line diameter. Many systems have portions which operate at differing pressures or are of different line size. Since the hazard is aligned with the potential leakage, it's logical to apply the appropriate separation distance for each portion of the system of a given pressure or line size. This is also consistent with existing material that uses similar logic for LH2 and GH2 distances being applied to their respective portions of the system.

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Attachment G - NFPA 2 Public Inputs

Public Input No. 258-NFPA 2-2020 [Section No. 6.18.2.1.4.1]

6.18.2.1.4.1

The exhaust ventilation system design shall take into account the ~~density~~ <u>potential hydrogen concentration and density</u> of the potential gases released. ~~[**55:** 6.17.4.1]~~

Statement of Problem and Substantiation for Public Input

this will require the extract tag to be dropped.
this change is specific to NFPA-2
the subsequent requirements will retain the extract tags to NFPA-55

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Committee: HYD-AAA

Attachment G - NFPA 2 Public Inputs

Public Input No. 265-NFPA 2-2020 [New Section after 7.3.2.3.1.1]

Air Intakes (HVAC, compressors, other)

Distances in Table 7.3.2.3.1.1(A) to air intakes shall apply only to Mechanical Connections that are part og the Outdoor Bulk Hydrogen Compressed Gas System.

Statement of Problem and Substantiation for Public Input

The hazard posed by hydrogen systems to HVAC units and air intakes is the entertainment of un-ignited hydrogen. The side-walls of a hydrogen storage vessel, for example, pose no threat of releasing un-ignited hydrogen that could be entrained into an HVAC system; the threat is only from credible leak points. These are encompassed in the existing code definition of Mechanical Connection as proposed here.

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Submittal Date: Tue Jun 30 08:45:22 EDT 2020

Committee: HYD-AAA

Attachment G - NFPA 2 Public Inputs

Public Input No. 270-NFPA 2-2020 [Section No. 7.3.2.3.1.1(A)]

Attachment G - NFPA 2 Public Inputs

(A) Maximum Internal Diameter of Interconnecting Piping.

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The maximum internal diameter of the piping system used for interconnecting piping between the shutoff valve on any single storage container to the point of connection to the system source valve shall not be required to be in accordance with the values shown in Table 7.3.2.3.1.1(A)(a) when in accordance with Table 7.3.2.3.1.1(A)(b) or Table 7.3.2.3.1.1(A)(c). [**55:**10.4.2.2.2]

(1) The separation distance for piping systems with internal diameters other than those specified in Table 7.3.2.3.1.1(A)(a) for the pressure range selected shall be permitted with tabular distances determined based on the use of Table 7.3.2.3.1.1(A)(b) or Table 7.3.2.3.1.1(A)(c). [**55:**10.4.2.2.1.1]

(2) Separation distances determined based on the use of Table 7.3.2.3.1.1(A)(b) or Table 7.3.2.3.1.1(A)(c) shall be subject to review and approval by the AHJ. [**55:**10.4.2.2.2.2]

(3) The separation distance shall be measured from the part of the bulk hydrogen compressed gas system closest to the exposure.

(4)* **Determination of Internal Diameter.** The internal diameter of the piping system shall be determined by the diameter of the piping serving that portion of a storage array with content greater than 5000 scf (141.6 Nm^3). The piping system size used in the application of Table 7.3.2.3.1.1(A)(a), Table 7.3.2.3.1.1(A)(b) or Table 7.3.2.3.1.1(A)(c) shall be determined based on that portion of the system with the greatest maximum internal diameter. [**55:**10.4.2.2.2.1]

(5)* **Determination of System Pressure.** The system pressure shall be determined by the maximum operating pressure of the storage array with content greater than 5000 scf (141.6N m^3), irrespective of those portions of the system elevated to a higher pressure. [**55:**10.4.2.2.3]

Table 7.3.2.3.1.1(A)(a) Minimum Distance (D) from Outdoor Bulk Hydrogen Compressed Gas Systems to Exposures — Typical Maximum Pipe Size

Pressure	>15 to ≤250 psig		>250 to ≤3000 psig		>3000 to ≤7500 psig		>7500 to ≤15000 psig	
Internal Pipe Diameter (ID)	>103.4 to ≤1724 kPa		>1724 to ≤20,684 kPa		>20,684 to ≤51,711 kPa		>51,711 to ≤103,421 kPa	
dmm	d = 52.5mm		d = 18.97mm		d = 7.31mm		d = 7.16mm	
Exposures Group 1	m	ft	m	ft	m	ft	m	ft
Lot lines	5	16	6	20	4	13	5	16
Air intakes (HVAC, compressors, other)	-	-	-	-	-	-	-	-
Operable openings in buildings and structures	-	-	-	-	-	-	-	-
Ignition sources such as open flames and welding	-	-	-	-	-	-	-	-
Exposures Group 2	m	ft	m	ft	m	ft	m	ft
Exposed persons other than those servicing the system	5	16	6	20	3	10	4	13
Parked cars	-	-	-	-	-	-	-	-
Exposures Group 3	m	ft	m	ft	m	ft	m	ft
Buildings of non-combustible non-fire-rated construction	4	13	5	16	3	10	4	13
Buildings of combustible construction	-	-	-	-	-	-	-	-
Flammable gas storage systems above or below ground	-	-	-	-	-	-	-	-
Hazardous materials storage systems above or below ground	-	-	-	-	-	-	-	-
Heavy timber, coal, or other slow-burning combustible solids	-	-	-	-	-	-	-	-
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	-	-	-	-	-	-	-	-
Unopenable openings in building and structures	-	-	-	-	-	-	-	-
Encroachment by overhead utilities operating above 50 volts (horizontal distance from the vertical plane Below the nearest overhead electrical wire of building service)	-	-	-	-	-	-	-	-
Piping containing other hazardous materials	-	-	-	-	-	-	-	-
Flammable gas metering and regulating stations such as natural gas or propane.	-	-	-	-	-	-	-	-

[**55:**Table 10.4.2.2.1(a)]

Table 7.3.2.3.1.1(A)(b) Minimum Distance (D) from Outdoor Bulk Hydrogen Compressed Gas Systems to Exposures by Maximum Pipe Size with Pressures >15 to ≤3000 psig

Pressure		>15 to ≤250 psig >103.4 to ≤1724 kPa						>250 to ≤3000 psig >1724 to ≤20,684 kPa						
		Exposures*†						Exposures*†						
Internal Pipe Diameter (ID)		Group 1		Group 2		Group 3		Group 1		Group 2		Group 3		
		-	-	D = 0.0952d		D = 0.1019d -0.3485		D = 0.0762		D = 0.3168d		D = 0.3384d - 0.4188		D = 0.2636d
ID (in.)	d (mm)	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft	
0.2	5.1	0.5	2	0.2	1	0.4	1	1.6	5	1.3	4	1.3	4	
0.3	7.6	0.7	2	0.4	1	0.6	2	2.4	8	2.2	7	2.0	7	
0.4	10.2	1.0	3	0.7	2	0.8	3	3.2	11	3.0	10	2.7	9	
0.5	12.7	1.2	4	0.9	3	1.0	3	4.0	13	3.9	13	3.3	11	
0.6	15.2	1.4	5	1.2	4	1.2	4	4.8	16	4.7	16	4.0	13	
0.7	17.8	1.7	6	1.5	5	1.4	4	5.6	19	5.6	18	4.7	15	
0.8	20.3	1.9	6	1.7	6	1.5	5	6.4	21	6.5	21	5.4	18	
0.9	22.9	2.2	7	2.0	7	1.7	6	7.3	24	7.3	24	6.0	20	
1.0	25.4	2.4	8	2.2	7	1.9	6	8.0	26	8.2	27	6.7	22	
1.1	27.9	2.7	9	2.5	8	2.1	7	8.8	29	9.0	30	7.4	24	
1.2	30.5	2.9	10	2.8	9	2.3	8	9.7	32	9.9	32	8.0	26	
1.3	33.0	3.1	10	3.0	10	2.5	8	10.5	34	10.7	35	8.7	29	
1.4	35.6	3.4	11	3.3	11	2.7	9	11.3	37	11.6	38	9.4	31	
1.5	38.1	3.6	12	3.5	12	2.9	10	12.1	40	12.5	41	10.0	33	
1.6	40.6	3.9	13	3.8	12	3.1	10	12.9	42	13.3	44	10.7	35	
1.7	43.2	4.1	13	4.1	13	3.3	11	13.7	45	14.2	47	11.4	37	
1.8	45.7	4.4	14	4.3	14	3.5	11	14.5	47	15.0	49	12.0	40	
1.9	48.3	4.6	15	4.6	15	3.7	12	15.3	50	15.9	52	12.7	42	
2.0	50.8	4.8	16	4.8	16	3.9	13	16.1	53	16.8	55	13.4	44	
2.1	53.3	5.1	17	5.1	17	4.1	13	16.9	55	17.6	58	14.0	46	

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

*For a list of exposures in each exposure group, see Column 1 of Table 7.3.2.3.2(A)(a).

†When calculating the minimum separation distance (D) using the formulas indicated, based on the exposure group and pressure indicated, the internal pipe diameter (d) is entered in millimeters (mm). The calculated distance (D) is expressed in units of measure in meters (m). To convert distance (D) to units of measure in feet, multiply the value of (D) in meters by 3.2808 and round to the nearest whole foot. [**55:**Table 10.4.2.2.1(b)]

Table 7.3.2.3.1.1(A)(c) Minimum Distance (D) from Outdoor Bulk Hydrogen Compressed Gas Systems to Exposures by Maximum Pipe Size with Pressures >3000 to ≤15,000 psig

Pressure		>3000 to ≤7500 psig >20,684 to ≤51,711 kPa						>7500 to ≤15,000 psig >51,711 to ≤103,421 kPa						
		Exposures*†						Exposures*†						
Internal Pipe Diameter (ID)		Group 1		Group 2		Group 3		Group 1		Group 2		Group 3		
		-	-	D = 0.5471d		D = 0.6831d - 1.99		D = 0.459d - 0.355		D = 1.448d - 5.368		D = 0.9291d - 2.65		D = 0.602d - 0.3103
ID (in.)	d (mm)	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft	
0.2	5.1	1.6	5	1.5	5	2	7	2	7	2	7	3	9	
0.3	7.6	4.3	14	3.2	11	3	10	6	18	4	14	4	14	
0.4	10.2	7.2	24	5.0	16	4	14	9	31	7	22	6	19	
0.5	12.7	10.0	33	6.7	22	5	18	13	43	9	30	7	24	

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Pressure		>3000 to ≤7500 psig >20,684 to ≤51,711 kPa						>7500 to ≤15,000 psig >51,711 to ≤103,421 kPa						
		Exposures*†						Exposures*†						
Internal Pipe Diameter (ID)		Group 1		Group 2		Group 3		Group 1		Group 2		Group 3		
		-	-	D = 0.5471d		D = 0.6831d - 1.99		D = 0.459d - 0.355		D = 1.448d - 5.368		D = 0.9291d - 2.65		D = 0.602d - 0.3103
ID (in.)	d (mm)	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft	
0.6	15.2	12.7	42	8.4	28	7	22	17	55	11	38	9	29	
0.7	17.8	15.6	51	10.2	33	8	26	20	67	14	46	10	34	
0.8	20.3	18.4	60	11.9	39	9	29	24	79	16	53	12	39	
0.9	22.9	21.2	70	13.7	45	10	33	28	91	19	61	13	44	
1.0	25.4	24.0	79	15.4	50	11	37	31	103	21	69	15	49	
1.1	27.9	26.8	88	17.1	56	12	41	35	115	23	76	16	54	
1.2	30.5	29.6	97	18.8	62	14	45	39	127	26	84	18	59	
1.3	33	32.4	106	20.6	67	15	49	42	139	28	92	20	64	
1.4	35.6	35.3	116	22.3	73	16	52	46	152	30	100	21	69	
1.5	38.1	38.0	125	24.0	79	17	56	50	163	33	107	23	74	
1.6	40.6	40.8	134	25.7	84	18	60	53	175	35	115	24	79	
1.7	43.2	43.7	143	27.5	90	19	64	57	188	37	123	26	84	
1.8	45.7	46.4	152	29.2	96	21	68	61	199	40	131	27	89	
1.9	48.3	49.3	162	31.0	102	22	72	65	212	42	139	29	94	
2.0	50.8	52.1	171	32.7	107	23	75	68	224	45	146	30	99	

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

*For a list of exposures in each exposure group, see Column 1 of Table 7.3.2.3.2(A)(a).

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

[**55:**Table 10.4.2.2.1(c)]

Statement of Problem and Substantiation for Public Input

If the intent for separation from utilities is intended to prevent ignition of un-ignited releases, then utilities such as phone lines, internet lines, etc. should not apply.

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Attachment G - NFPA 2 Public Inputs

Public Input No. 232-NFPA 2-2020 [Section No. 7.3.2.3.1.2(A)]

(A)* Passive Means.

Except for distances to air intakes, the distances to Group 1 and 2 exposures shown in Table 7.3.2.3.1.1(A)(a), Table 7.3.2.3.1.1(A)(b), and Table 7.3.2.3.1.1(A)(c) shall be permitted to be reduced by one-half and shall not apply to Group 3 exposures where fire barrier walls are located between the system and the exposure and constructed in accordance with the following: [**55:**10.4.2.2.4.1]

(1) The fire barrier wall shall be without openings or penetrations. [**55:**8.6.3.2.1]

(2) Penetrations of the fire barrier wall by conduit or piping shall be permitted provided that the penetration is protected with a firestop system in accordance with the [adopted] building code. [**55:** 8.6.3.2.1.1]

(3) Fire barrier walls shall have a minimum fire resistance rating of not less than 2 hours. [**55:**10.4.2.2.4.1(1)]

(4) The fire barrier wall shall interrupt the line of sight between the bulk hydrogen compressed gas system and the exposure. [**55:**10.4.2.2.4.1(2)]

(5) The configuration of the fire barrier shall allow natural ventilation to prevent the accumulation of hazardous gas concentrations. [**55:**10.4.2.2.4.1(3)]

(6) The number of fire barrier walls used to separate individual systems shall be limited to three. [**55:**10.4.2.2.4.1(4)]

(7) The fire barrier wall shall not have more than two sides at 90 degree (1.57 rad) directions or not more than three sides with connecting angles of 135 degrees (2.36 rad), except as provided in 7.3.2.3.1.2(A)(6)(a). [**55:**10.4.2.2.4.1(5)]

(8) The connecting angles between fire barrier walls shall be permitted to be reduced to less than 135 degrees (2.36 rad) for installations consisting of three walls when in accordance with 8.3.2.3.1.5(D) . [**55:** 10.4.2.2.4.1(6)]

(9) 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 and shall be designed to resist the overturning effects caused by lateral forces due to wind, soil, flood, and seismic events. [**55:**10.4.2.2.4.1(7)]

(10) Where clearance is required between the bulk hydrogen compressed gas system and the barrier wall for the performance of service or maintenance-related activities, a minimum horizontal clearance of ~~5 ft~~ 3 ft (~~1~~ 0 .~~5 m~~ 91m) shall be provided between the structure and the system. [**55:**10.4.2.2.4.1(8)]

(11) 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. [**55:**10.4.2.2.4.1(9)]

(12) The construction of a fire barrier wall that is part of a hydrogen equipment enclosure and used to reduce separation distances shall be in accordance with 7.1.22.16.

Statement of Problem and Substantiation for Public Input

This proposal is for the reduction of horizontal clearance requirements between equipment and fire barrier wall for maintenance-related activities. The reduction is from 5 ft to 3 ft.

If the text will remain as-is with the stated 5 ft maintenance space requirement, the request to the technical committee is to please add sources or explanation in the document's appendices for the 5 ft requirement.

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Attachment G - NFPA 2 Public Inputs

Public Input No. 264-NFPA 2-2020 [Section No. 7.3.2.3.1.3(B)]

(B)

The ~~minimum~~ separation distance between independent gaseous and liquid systems ~~integrated into a single system where the liquid source is vaporized, compressed, and stored in the gaseous state shall be 15 ft (4.6 m~~ shall meet the minimum distance requirements for Group 3 Exposures shown in Table 7.3.2.3.1.1(A)(a), Table 7.3.2.3.1.1(A)(b), and Table 7.3.2.3.1.1(A)(c) unless integrated with a shared control system in which case the distance can be reduced to 0 ft (0 m). [**55:**10.4.2.2.5.2]

Statement of Problem and Substantiation for Public Input

The way the code is currently written appears to be the opposite of the way that it should be. An integrated GH2/LH2 system should not require separation distances, whereas two independent systems that happen to be sited adjacent to one another should be treated as separate Group 3 hazards.

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Attachment G - NFPA 2 Public Inputs

Public Input No. 143-NFPA 2-2020 [Section No. 7.3.2.3.1.5]

7.3.2.3.1.5 Electrical Equipment.

Electrical wiring and equipment shall be in accordance with Article 500 of *NFPA 70*. [**55:**10.4.2.1.2]

Table 7.3.2.3.1.5 Electrical Area Classification

Location	Classification	Extent of Classified Area
Within 3 ft (1 m) of any vent outlet and any points where hydrogen is vented to the atmosphere under normal conditions	Class 1, Division 1	Between 0 ft (0 m) and 3 ft (0.9 m) and measured spherically from the outlet.
Between 3 ft (1 m) and 15 ft (4.6 m) of any vent outlet and any points where hydrogen is vented to the atmosphere under normal operations.	Class I, Division 2	Between 3 ft (0.9 m) and 15 ft (4.6 m) and measured spherically from the vent outlet
Storage equipment excluding the piping system downstream of the source valve	Class I, Division 2	Between 0 ft (0 m) and 15 ft (4.6 m) and measured spherically from the source

Note: Other than at vent outlets, where a fire barrier is used to separate an exposure, the electrical area classification shall terminate on the opposite side of the fire barrier.

Statement of Problem and Substantiation for Public Input

Previous editions of NFPA 2 stated that the electrical area classification separation of up to 15 ft from exposures, would terminate at the opposite side of a fire barrier. This proposed change is to recapture this detail inside the standard.

Submitter Information Verification

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Committee: HYD-AAA

Attachment G - NFPA 2 Public Inputs

Public Input No. 277-NFPA 2-2020 [Sections 8.2.2.3.4.2, 8.2.2.3.4.3]

Sections 8.2.2.3.4.2, 8.2.2.3.4.3

8.2.2.3.4.2 Air Intakes.

Storage and use of [LH_2] shall not be located within 50 ft (15.2 m) of air intakes or the minimum distance from a bulk storage system (Tables 8 .3.2.3.1.6(A)(a), (b) and (c)). [**55:**7.6.2.4]

8.2.2.3.4.3 Building Openings.

Storage and use of [LH_2] outside of buildings shall also be separated from building openings by 25 ft (7.6 m) or the minimum distance from a bulk storage system (Tables 8 .3.2.3.1.6(A)(a), (b) and (c)). Fire barriers shall be permitted to be used as a means to separate storage areas from openings or a means of egress used to access the public way. [**55:**7.6.2.5]

Statement of Problem and Substantiation for Public Input

There is a possible situation in which you could have a non-bulk system that has a larger setback than a bulk system, suggesting that to reduce your setbacks you can just make the system large.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 262-NFPA 2-2020 [Section No. 8.3.2.3.1.6(A)]	this PI refers to new tables in PI 262

Submitter Information Verification

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Committee: HYD-AAA

Attachment G - NFPA 2 Public Inputs

Public Input No. 272-NFPA 2-2020 [Section No. 8.3.2.3.1.6(A)]

Attachment G - NFPA 2 Public Inputs

(A)*

Attachment G - NFPA 2 Public Inputs

The minimum distance from [LH_2] systems of indicated capacity shall be in accordance with Table 8.3.2.3.1.6(A). [**55:**11.3.2.2]

Table 8.3.2.3.1.6(A) Minimum Distance from Bulk Liquefied Hydrogen [LH_2] Systems to Exposures

	-		Total Bulk Liquefied Hydrogen [LH_2] Storage							
	-	39.7 gal to 3500 gal	150 L to 13,250 L	-		3501 gal to 15,000 gal	13,251 L to 56,781 L	-	15,001 gal to 75,000 gal	56,782 L to 283,906 L
Type of Exposure	ft	m	-		ft	m	-		ft	m
Group 1	-	-	-	-	-	-	-	-		
1. Lot lines	25	7.6	-		50	15	-		75	23
2. Air intakes [heating, ventilating, or air-conditioning equipment (HVAC), compressors, other]	75	23	-		75	23	-		75	23
3. Wall openings	-	-	-	-	-	-	-	-		
Operable openings in buildings and structures	75	23	-		75	23	-		75	23
4. Ignition sources such as open flames and welding	50	15	-		50	15	-		50	15
Group 2	-	-	-	-	-	-	-	-		
5. Places of public assembly	75	23	-		75	23	-		75	23
6. Parked cars (distance shall be measured from the container fill connection)	25	7.6	-		25	7.6	-		25	7.6
Group 3	-	-	-	-	-	-	-	-		
7. Building or structure	-	-	-	-	-	-	-	-		
(a) Buildings constructed of noncombustible or limited-combustible materials	-	-	-	-	-	-	-	-		
(1) Sprinklered building or structure or unsprinklered building or structure having noncombustible contents	5[a]	1.5	-		5[a]	1.5	-		5[a]	1.5
(2) Unsprinklered building or structure with combustible contents	-	-	-	-	-	-	-	-		
i. Adjacent wall(s) with fire resistance rating less than 3 hours	25	7.6	-		50	15	-		75	23
ii. Adjacent wall(s) with fire resistance rating of 3 hours or greater[b]	5	1.5	-		5	1.5	-		5	1.5
(b) Buildings of combustible construction	-	-	-	-	-	-	-	-		
(1) Sprinklered building or structure	50	15	-		50	15	-		50	15
(2) Unsprinklered building or structure	50	15	-		75	23	-		100	30.5
8. Flammable gas storage or systems (other than hydrogen) above or below ground	50	15	-		75	23	-		75	23
9. Between stationary liquefied hydrogen containers	5	1.5	-		5	1.5	-		5	1.5
10. All classes of flammable and combustible liquids (above ground and vent or fill openings if below ground)[c]	50	15	-		75	23	-		100	30.5
11. Hazardous materials storage or systems including liquid oxygen storage and other oxidizers, above or below ground	75	23	-		75	23	-		75	23
12. Heavy timber, coal, or other slow-burning combustible solids	50	15	-		75	23	-		100	30.5
13. Wall openings	-	-	-	-	-	-	-	-		
Unopenable openings in buildings and structures	25	7.6	-		50	15	-		50	15
14. Inlet to underground sewers	5	1.5	-		5	1.5	-		5	1.5
15. Utilities overhead, including electric power ~~, building services,~~ operating above 50 volts or hazardous materials piping systems	-	-	-	-	-	-	-	-		

Attachment G - NFPA 2 Public Inputs

	-	Total Bulk Liquefied Hydrogen [LH_2] Storage						
	-	39.7 gal to 3500 gal	150 L to 13,250 L	-	3501 gal to 15,000 gal	13,251 L to 56,781 L	-	15,001 gal to 75,000 gal / 56,782 L to 283,906 L
Type of Exposure	ft	m	-	ft	m	-	ft	m
(a) Horizontal distance from the vertical plane below the nearest overhead wire of an electric trolley, train, or bus line	50	15	-	50	15	-	50	15
(b) Horizontal distance from the vertical plane below the nearest overhead electrical wire	25	7.5	-	25	7.5	-	25	7.5
(c) Piping containing other hazardous materials	15	4.6	-	15	4.6	-	15	4.6
16. Flammable gas metering and regulating stations above grade	15	4.6	-	15	4.6	-	15	4.6

[a]Portions of wall less than 10 ft (3.1 m) (measured horizontally) from any part of a system must 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).

[**55:**Table 11.3.2.2]

(1) The distances in 1, 7, 8, 10, 11, and 12 in Table 8.3.2.3.1.6(A) 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. [**55:**11.3.2.2.2]

(2)* **Fire Barrier Walls.** The distances in 1, 7, 8, 10, 11, and 12 in Table 8.3.2.3.1.6(A) shall be permitted to be reduced to 0 ft (0 m) by the use of fire barrier walls having a fire resistance rating of not less than 2 hours when constructed in accordance with 8.3.2.3.1.6(A). [**55:**11.3.2.2.3]

(3) The fire barrier or the insulated [LH_2] tank shall interrupt the line of sight between uninsulated portions of the [LH_2] storage system and the exposure. [**55:** 11.3.2.2.4]

(4) The fire barrier wall shall not have more than two sides at 90 degree (1.57 rad) directions or not more than three sides with connecting angles of not less than 135 degrees (2.36 rad). [**55:** 11.3.2.2.5]

(5) The connecting angles between fire barrier walls shall be permitted to be reduced to less than 135 degrees (2.36 rad) for installations consisting of three walls when in accordance with 8.3.2.3.1.5(D) . [**55:** 11.3.2.2.5.1]

(6) When fire barrier walls of three sides are used, piping and control systems serving stationary tanks shall be located at the open side of the enclosure created by the barrier walls to provide access for filling and ventilation. [**55:** 11.3.2.2.5.2]

(7)Vertical tanks shall be located at a distance not less than one tank diameter from the enclosing walls. [**55:** 11.3.2.2.5.2(A)]

(8)Where horizontal tanks are used, the distance to any enclosing wall shall be not less than one-half the length of the tank. [**55:** 11.3.2.2.5.2(B)]

(9) The fire barrier wall shall be without openings or penetrations. [**55:** 8.6.2.1.1]

(10) Penetrations of the fire barrier wall by conduit or piping shall be permitted provided that the penetration is protected with a firestop system in accordance with the [adopted] building code. [**55:** 8.6.2.1.1.1]

(11)The fire barrier wall shall be either an independent structure or the exterior wall of the building adjacent to the storage system. [**55:** 8.6.2.1.2]

(12)The fire barrier wall shall be located not less than 5 ft (1.5 m) from any exposure. [**55:** 8.6.2.1.3]

(13)Where the requirement of 8.3.2.3.1.6(A)(2)(b) is met, the bulk system shall be a minimum distance of 1 ft (0.3 m) from the fire barrier wall. [**55:** 8.6.2.1.5]

Statement of Problem and Substantiation for Public Input

If the intent for separation from utilities is intended to prevent ignition of un-ignited releases, then utilities such as phone lines, internet lines, etc. should not apply.

Submitter Information Verification

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Submittal Date: Tue Jun 30 09:40:47 EDT 2020
Committee: HYD-AAA

Attachment G - NFPA 2 Public Inputs

Public Input No. 262-NFPA 2-2020 [Section No. 8.3.2.3.1.6(A)]

Attachment G - NFPA 2 Public Inputs

(A)*

Attachment G - NFPA 2 Public Inputs

The minimum distance from ~~[LH 2] systems of indicated capacity~~ bulk liquefied hydrogen systems to specified exposures shall be in accordance ~~with~~ with Table 8.3.2.3.1.6(A)(a), Table 8 . 3.2.3.1.6(A)(b), and Table 8.3.2.3.1.6(A)(c) . [**55:**11.3.2.2]

~~[a] Portions of wall less than 10 ft (3.1 m) (measured horizontally) from any part of a system must 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).~~

~~[**55:** Table 11.3.2.2]~~

~~The distances in 1, 7, 8, 10, 11, and 12 in~~

~~Table 8~~ Table 8 .3.2.3.1.6(A) ~~Minimum~~ (a) Minimum Distance from Outdoor Bulk Liquefied Hydrogen [~~LH 2~~ LH2] Systems to Exposures

~~- Total Bulk Liquefied Hydrogen [LH 2] Storage - 39.7 gal to 3500 gal 150 L to 13,250 L - 3501 gal to 15,000 gal 13,251 L to 56,781 L - 15,001 gal to 75,000 gal 56,782 L to 283,906 L Type of Exposure ft m - ft m - ft m **Group 1** - - - - - - - - 1. Lot lines 25 7.6 - 50 15 - 75 23 2. Air intakes [heating, ventilating, or air-conditioning equipment (HVAC), compressors, other] 75 23 - 75 23 - 75 23 3. Wall openings - - - - - - - - Operable openings in buildings and structures 75 23 - 75 23 - 75 23 4. Ignition sources such as open flames and welding 50 15 - 50 15 - 50 15 **Group 2** - - - - - - - - 5. Places of public assembly 75 23 - 75 23 - 75 23 6. Parked cars (distance shall be measured from the container fill connection) 25 7.6 - 25 7.6 - 25 7.6 **Group 3** - - - - - - - - 7. Building or structure - - - - - - - - (a) Buildings constructed of noncombustible or limited-combustible materials - - - - - - - - (1) Sprinklered building or structure or unsprinklered building or structure having noncombustible contents 5 [a] 1.5 - 5 [a] 1.5 - 5 [a] 1.5 (2) Unsprinklered building or structure with combustible contents - - - - - - - - i. Adjacent wall(s) with fire resistance rating less than 3 hours 25 7.6 - 50 15 - 75 23 ii. Adjacent wall(s) with fire resistance rating of 3 hours or greater [b] 5 1.5 - 5 1.5 - 5 1.5 (b) Buildings of combustible construction - - - - - - - - (1) Sprinklered building or structure 50 15 - 50 15 - 50 15 (2) Unsprinklered building or structure 50 15 - 75 23 - 100 30.5 8. Flammable gas storage or systems (other than hydrogen) above or below ground 50 15 - 75 23 - 75 23 9. Between stationary liquefied hydrogen containers 5 1.5 - 5 1.5 - 5 1.5 10. All classes of flammable and combustible liquids (above ground and vent or fill openings if below ground) [c] 50 15 - 75 23 - 100 30.5 11. Hazardous materials storage or systems including liquid oxygen storage and other oxidizers, above or below ground 75 23 - 75 23 - 75 23 12. Heavy timber, coal, or other slow-burning combustible solids 50 15 - 75 23 - 100 30.5 13. Wall openings - - - - - - - - Unopenable openings in buildings and structures 25 7.6 - 50 15 - 50 15 14. Inlet to underground sewers 5 1.5 - 5 1.5 - 5 1.5 15. Utilities overhead, including electric power, building services, or hazardous materials piping systems - - - - - - - - (a) Horizontal distance from the vertical plane below the nearest overhead wire of an electric trolley, train, or bus line 50 15 - 50 15 - 50 15 (b) Horizontal distance from the vertical plane below the nearest overhead electrical wire 25 7.5 - 25 7.5 - 25 7.5 (c) Piping containing other hazardous materials 15 4.6 - 15 4.6 - 15 4.6 16. Flammable gas metering and regulating stations above grade 15 4.6 - 15 4.6 - 15 4.6~~

~~— Typical Maximum Pipe Size (1.5 in [38.1 mm])~~

	< 30 psig		30 to 75 psig		75 to 120 psig		120 to 165 psig		165 to 210 psig		210 to 255 psig	
Relief Pressure (gauge)	< 21 kPa		21 to 52 kPa		52 to 83 kPa		83 to 114 kPa		114 to 145 kPa		145 to 176 kPa	
Exposures Group 1	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft
Lot lines Air intakes (HVAC, compressors, other) Operable openings in buildings and structures Ignition sources such as open flames and welding	7	23	9	30	11	36	13	42	14	47	17	54
Exposures Group 2	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft
Exposed Persons other than those servicing the system Parked Cars	5	16	7	22	8	26	9	30	10	32	11	37
Exposures Group 3	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft
Buildings of non-combustible non-fire-rated construction Buildings of combustible construction Flammable gas storage systems above or below ground Hazardous materials storage systems above or below ground Heavy timber, coal, or other slow-burning combustible solids Ordinary combustibles, including fast-burning solids such as ordinary lumber, excelsior, paper, or combustible waste and vegetation oterh than that found in maintained landscaped areas Unopenable openings in buildings and structures Encroachment by overhead utilities (horizontal distance from the vertical plane below the nearest overhead electrical wire of building service Piping containing other hazardous materials Flammable gas metering and regulating stations such as natural gas or propane	4	12	5	16	6	19	6	20	6	21	7	24

~~[**55:** Table 11.3.2.2(a)]~~

~~**Table 8.3.2.3.1.6(A)(b) Minimum Distance from Outdoor Bulk Liquefied Hydrogen [LH 2] Systems to Exposures by Maximum Pipe Size**~~

Relief Pressure (gauge)		< 30 psig						30 to 75 psig						75 to 120 psig					
		< 21 kPa						21 to 52 kPa						52 to 83 kPa					
Exposures		Group 1		Group 2		Group 3		Group 1		Group 2		Group 3		Group 1		Group 2		Group 3	
Internal Pipe Diameter																			
in	mm	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft
0.1	2.5	0.5	1.6	0.4	1.4	0.5	1.5	0.7	2.2	0.6	1.8	0.6	2	0.8	2.6	0.7	2.2	0.7	2.4
0.25	6.4	1.2	3.9	1	3.2	1	3.4	1.6	5.4	1.3	4.3	1.4	4.5	2	6.5	1.6	5.2	1.6	5.3
0.5	12.7	2.4	7.8	1.8	6.1	1.8	5.9	3.3	11	2.5	8.2	2.4	7.8	4	13	3	9.9	2.7	9
0.75	19	3.6	12	2.7	8.8	2.5	8	4.9	16	3.7	12	3.2	11	5.6	19	4.2	14	3.5	12
1	25.4	4.8	16	3.3	11	2.9	9.4	6.1	20	4.6	15	3.8	12	7.5	24	5.5	18	4.3	14
1.25	31.8	6	20	4.1	13	3.4	11	7.6	25	5.6	18	4.4	14	9.3	30	6.7	22	5	16
1.5	**38.1**	**7.1**	**23**	**4.8**	**16**	**3.8**	**12**	**9.1**	**30**	**6.6**	**22**	**5**	**16**	**11**	**36**	**7.9**	**26**	**5.7**	**19**
1.75	44.4	8.3	27	5.5	18	4.2	14	11	34	7.6	25	5.5	18	13	42	9.2	30	6.3	21
2	50.8	9.5	31	6.2	20	4.6	15	12	39	8.6	28	6	20	14	48	10	34	7.2	24
2.25	57.2	11	35	6.9	23	5	16	13	44	9.6	31	6.6	22	16	54	12	38	7.8	26
2.5	63.5	12	39	7.7	25	5.4	18	15	49	10	34	7.1	23	18	59	13	42	8.6	28
2.75	69.8	13	43	8.3	27	5.7	19	16	53	12	38	7.8	26	20	65	14	46	9.3	31
3	76.2	14	47	9	30	6.2	20	18	58	12	41	8.5	28	22	71	15	49	10	33

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

~~*For a list of exposures in each exposure group, see Column 1 of - Table 8.3.2.3.1.6(A)(a) .~~

~~[**55:** Table 11.3.2.2(b)]~~

Attachment G - NFPA 2 Public Inputs

~~Table 8.3.2.3.1.6(A)(c) Minimum Distance from Outdoor Bulk Liquefied Hydrogen [LH 2] Systems to Exposures by Maximum Pipe Size~~

Relief Pressure (gauge)		120 to 165 psig						165 to 210 psig						210 to 255 psig					
		83 to 114 kPa						114 to 145 kPa						145 to 176 kPa					
Exposures		Group 1		Group 2		Group 3		Group 1		Group 2		Group 3		Group 1		Group 2		Group 3	
Internal Pipe Diameter																			
in	mm	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft
0.1	2.5	1	3.1	0.8	2.5	0.8	2.8	1.1	3.7	0.9	2.9	0.9	3	1.3	4.3	1	3.3	1	3.4
0.25	6.4	2.4	7.7	1.8	6	1.8	5.9	2.6	8.5	2	6.4	1.7	5.7	3	9.8	2.2	7.2	1.9	6.2
0.5	12.7	4.7	15	3.5	11	3	9.9	5	16	3.6	12	2.8	9	5.8	19	4.1	13	3	9.8
0.75	19	6.6	22	4.8	16	3.8	12	7.4	24	5.2	17	3.6	12	8.5	28	5.9	19	4	13
1	25.4	8.7	28	6.3	21	4.6	15	9.7	32	6.8	22	4.5	15	11	37	7.7	25	5.1	17
1.25	31.8	11	35	7.7	25	5.3	18	12	39	8.3	27	5.5	18	14	46	9.5	31	6.2	20
1.5	**38.1**	**13**	**42**	**9.1**	**30**	**6.2**	**20**	**14**	**47**	**9.8**	**32**	**6.3**	**21**	**17**	**54**	**11**	**37**	**7.2**	**24**
1.75	44.4	15	49	10	34	7.1	23	17	55	11	37	7.3	24	19	63	13	43	8.3	27
2	50.8	17	55	12	39	7.9	26	19	62	13	42	8.2	27	22	72	15	48	9.2	30
2.25	57.2	19	62	13	43	8.8	29	21	70	14	47	9	30	25	81	16	54	10	33
2.5	63.5	21	69	15	48	9.6	32	24	77	16	52	10	33	27	89	18	59	11	37
2.75	69.8	23	75	16	52	11	35	26	85	17	57	11	36	30	98	20	65	13	42
3	76.2	25	82	17	56	11	37	28	92	19	62	12	38	33	107	22	71	13	43

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

~~*For a list of exposures in each exposure group, see Column 1 of~~ - ~~Table 8.3.2.3.1.6(A)~~

~~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.~~

~~(a)~~ ~~.~~

~~[**55:** Table 11.3.2.2~~

~~.2~~

~~(c)~~]

(1)~~*~~

~~**Fire Barrier Walls.** The distances in 1, 7, 8, 10, 11, and 12 in Table 8~~

(1) ~~Except for distances to air intakes, the distances to Group 1 and 2 exposures shown in Tables 11 .3.2.~~

~~3.1.6(A)~~

(1) ~~2 (a), (b), and (c) shall be permitted to be reduced~~

~~to 0 ft (0 m) by the use of fire barrier walls having a fire resistance rating of not less than 2 hours when constructed in accordance~~

(1) ~~by one-half and shall not apply to Group 3 exposures where fire barrier walls are located between the system and the exposure and when constructed in accordance~~ ~~with 8.3.2.3.1.6(A) . [**55:** 11.3.2.2.3]~~

(2) ~~The fire barrier or the insulated [LH 2] tank shall interrupt the line of sight between uninsulated portions of the [LH 2] storage system and the exposure. [**55:** 11.3.2.2.4]~~

(3) ~~The fire barrier wall shall not have more than two sides at 90 degree (1.57 rad) directions or not more than three sides with connecting angles of not less than 135 degrees (2.36 rad). [**55:** 11.3.2.2.5]~~

(4~~*~~ ~~The connecting angles between fire barrier walls shall be permitted to be reduced to less than 135 degrees (2.36 rad) for installations consisting of three walls when in accordance with 8.3.2.3.1.5(D) . [**55:** 11.3.2.2.5.1]~~

(5~~*~~ ~~When fire barrier walls of three sides are used, piping and control systems serving stationary tanks shall be located at the open side of the enclosure created by the barrier walls to provide access for filling and ventilation. [**55:** 11.3.2.2.5.2]~~

(6~~Vertical tanks shall be located at a distance not less than one tank diameter from the enclosing walls. [**55:** 11.3.2.2.5.2(A)]~~

(7~~Where horizontal tanks are used, the distance to any enclosing wall shall be not less than one-half the length of the tank. [**55:** 11.3.2.2.5.2(B)]~~

(8) ~~The fire barrier wall shall be without openings or penetrations. [**55:** 8.6.2.1.1]~~

(9) ~~Penetrations of the fire barrier wall by conduit or piping shall be permitted provided that the penetration is protected with a firestop system in accordance with the [adopted] building code. [**55:** 8.6.2.1.1.1]~~

(10~~The fire barrier wall shall be either an independent structure or the exterior wall of the building adjacent to the storage system. [**55:** 8.6.2.1.2]~~

(11 ~~The fire barrier wall shall be located not less than 5 ft (1.5 m) from any exposure. [**55:** 8.6.2.1.3]~~

(12~~Where the requirement of 8.3.2.3.1.6(A)(~~

~~2~~

(1)

(a) ~~1~~ ~~)(b)~~ ~~is met, the bulk system shall be a minimum distance of 1 ft (0.3 m) from the fire barrier wall. [**55:** 8.6.2.1.5]~~

Statement of Problem and Substantiation for Public Input

The scientific basis for Table 8.3.2.3.1.6(A) is unclear. There is no evidence that exposure distances should be a function of storage volume. With the exception of cold temperature hazard (cryogenic 'burn'), the hazards from liquid hydrogen system leaks are similar to compressed gaseous hydrogen leaks, and the extent of an unignited or ignited release will be a function of the system operating pressure and the leak size.

Following the logic in Annex I for gaseous bulk storage, we have regrouped the exposures and calculated exposure distances as a function of system pipe size and pressure. Calculations were done using Sandia's HyRAM models, assuming a 1% leak area as a typical size, and a factor of safety of 2 due to uncertainty in the leak size and the modeling. Group 1 distances were calculated as the greater of the streamline distance to an 8% concentration or a bird's-eye heat flux of 1.577 kW/m^2. Group 2 distances were calculated as the bird's-eye distance to a heat flux of 4.732 kW/m^2, and the Group 3 distances were calculated as the bird's eye view distance to a flame length or a heat flux of 20 kW/m^2.

We presented this material to the NFPA 2 storage task group with positive feedback regarding this approach.

Since this is an extract, it has also been proposed as Public Input 112 for NFPA 55.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 277-NFPA 2-2020 [Sections 8.2.2.3.4.2, 8.2.2.3.4.3]	

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Attachment G - NFPA 2 Public Inputs

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Attachment G - NFPA 2 Public Inputs

Public Input No. 223-NFPA 2-2020 [New Section after 8.3.2.3.1.6(B)]

TITLE OF NEW CONTENT

New (C) inserted

The distances for combined gaseous and liquified hydrogen storage systems, upstream of their respective source valves, shall be taken from section 10.4.2.2 for the gaseous system and from section 11.3.2.2 for the liquefied system.

Annex: For systems that are composed of combined gaseous and liquefied hydrogen storage systems and have separate source valves for both systems, the system can be viewed as having two source valves for determining minimum separation distances for bulk storage systems. Identifying two source valves means that each portion of the system is subject to its respective minimum separation distances.

Statement of Problem and Substantiation for Public Input

This proposal is moving content from the Annex A.3.3.232.3 and locating it in a more applicable location and within the body of the code text.

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Attachment G - NFPA 2 Public Inputs

Public Input No. 144-NFPA 2-2020 [New Section after 8.3.4.5.14]

8.3.4.5.15

The liquid hydrogen trailer and delivery connection shall be at least 10 ft from a canopy or the canopy shall be in accordance with 10.3.16 (1), 10.3.16 (3), and 11.3.1.17.

Statement of Problem and Substantiation for Public Input

Canopies are not common in industrial applications which is one reason that NFPA 55 may not mention this concern. This proposal will minimize the risk of accumulating hydrogen from an accidental or emergency release of hydrogen from the connection point or the trailer vent stack.

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Attachment G - NFPA 2 Public Inputs

Public Input No. 145-NFPA 2-2020 [New Section after 8.3.4.5.14]

8.3.4.5.16

The traffic pattern for liquid hydrogen trailers should avoid illegal driving maneuvers such as reversing into oncoming traffic.

Statement of Problem and Substantiation for Public Input

Provide clear guidance to avoid unsafe conditions for the delivery driver and the LH2 trailer.

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Attachment G - NFPA 2 Public Inputs

Public Input No. 215-NFPA 2-2020 [Section No. A.7.3.2.3.1.1]

A.7.3.2.3.1.1

Conversions for distance between inch-pound and SI units of measure cannot be consistently performed using typical mathematical conversion factors. The majority of separation distances shown in the SI table have been determined by the application of a risk-informed approach substantiated by statistical evaluation and modeling based on validated models for both ignited and unignited release of hydrogen gas. Where distance has been determined to allow for access or for correlation with the electrical code, the distances were not established through the use of models. Tabular distances in the inch-pound table have been determined by first converting SI units into inch-pound units and then rounding the distance to the nearest 5 ft for ease of application by code enforcers and users. A similar rounding technique has not been applied in the tabular distances shown in the SI table.

The exposures integral to Table 7.3.2.3.1.1(A)(a), Table 7.3.2.3.1.1(A)(b), and Table 7.3.2.3.1.1(A)(c) have been arranged into groups based on similar risks. The estimated leak area was changed from 3 percent to 1 percent of the pipe diameter to evaluate separation distances. The 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/ft^2 (1577 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~~ 8 percent mole fraction (volume fraction) of hydrogen, whichever is greater. In all cases, the distance required to achieve a ~~4 percent~~ 8 percent mole fraction was the greater distance and was used to establish the requirements.

A task group reviewed the hydrogen concentration threshold to sustain combustion. Based on work done at Sandia National Laboratories Combustion Research Facility, the task group concluded that there would not be sustained ignition at hydrogen concentrations at 8% or less. There could be localized hydrogen ignition, but it would not develop into sustained combustion.

(2) *Group 2 Exposures.* The distances specified are those required to reduce the radiant heat flux level to 1500 Btu/hr/ft^2 (4732 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 6340 Btu/hr/ft^2 (20,000 W/m^2) or the visible flame length for combustible materials, or a radiant heat flux level of 8000 Btu/hr/ft^2 (25,237 W/m^2) or the visible flame length for noncombustible equipment. In both cases, the visible flame length was used to establish the requirements.

A 50 percent safety factor was added to all resulting separation distance values.

[**55:**A.10.4.2.2.1]

Table 7.3.2.3.1.1(A)(a)Exposures Group 1(a). 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 can result in an encroachment that will necessitate relocation of the hydrogen system at the system user's expense. [**55:**A.10.4.2.2.1]

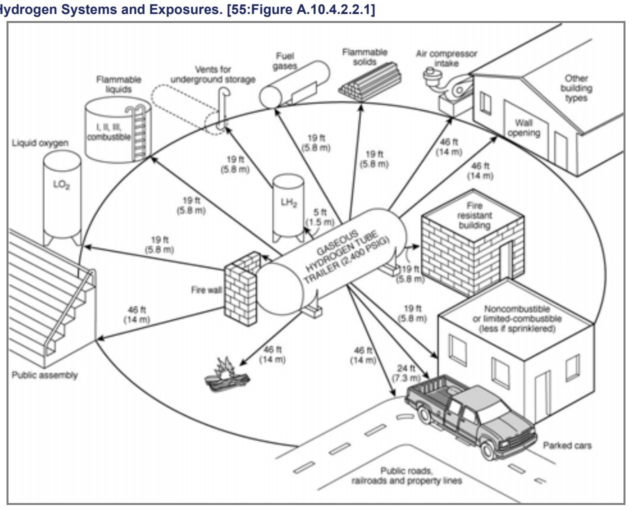
Where the property on the other side of a property line is determined to be unbuildable or unoccupiable due to natural features including, but not limited to, waterways, terrain, wetlands, or similar features encroachment by the hydrogen system on the property line can be acceptable with the approval of the authority having jurisdiction. Should the property that is encroached upon become buildable or otherwise occupiable, the hydrogen system location should be reevaluated by the system user and the AHJ notified of the results. [**55:**A.10.4.2.2.1]

Table 7.3.2.3.1.1(A)(a) Exposure Group 2(a). The exposed persons of concern are non-work-related persons or members of the public who are not involved with servicing the system, because these persons typically are neither trained nor knowledgeable in the operation of the system, but are on the premises. By comparison, service personnel or those involved with servicing the system are trained and engaged in activities related to the system operation including, but not limited to, inspecting, monitoring system inventory, delivering product, maintenance, or similar functions. Administrative controls, engineering controls, or construction features are typically used to restrict persons other than service personnel from being within the zone of potential exposure. The permit holder is responsible for managing and administering the controls to restrict access. Examples of such controls could include painted lines or signs or physical barriers such as a fence. [**55:**A.10.4.2.2.1]

See Figure A.7.3.2.3.1.1 for a graphical representation of separation distances from bulk hydrogen systems. [**55:**A.10.4.2.2.1]

CGA PS-48, *Clarification of Existing Hydrogen Setback Distances and Development of New Hydrogen Setback Distances in NFPA 55*, provides guidance and clarification on types of exposures as well as applications of the separation distances. [**55:**A.10.4.2.2.1]

Figure A.7.3.2.3.1.1 Distances Between Bulk Hydrogen Systems and Exposures. [55:Figure A.10.4.2.2.1]



Statement of Problem and Substantiation for Public Input

The 8 percent was not properly extracted from NFPA 55. An explanatory paragraph was added from Annex I.7 to provide context for the 8 percent. A PI has been submitted to NFPA 55 for the added paragraph.

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Attachment G - NFPA 2 Public Inputs

Public Input No. 246-NFPA 2-2020 [Section No. A.7.3.2.3.1.1]

A.7.3.2.3.1.1

Conversions for distance between inch-pound and SI units of measure cannot be consistently performed using typical mathematical conversion factors. The majority of separation distances shown in the SI table have been determined by the application of a risk-informed approach substantiated by statistical evaluation and modeling based on validated models for both ignited and unignited release of hydrogen gas. Where distance has been determined to allow for access or for correlation with the electrical code, the distances were not established through the use of models. Tabular distances in the inch-pound table have been determined by first converting SI units into inch-pound units and then rounding the distance to the nearest 5 ft for ease of application by code enforcers and users. A similar rounding technique has not been applied in the tabular distances shown in the SI table.

The exposures integral to Table 7.3.2.3.1.1(A)(a), Table 7.3.2.3.1.1(A)(b), and Table 7.3.2.3.1.1(A)(c) have been arranged into groups based on similar risks. The estimated leak area was changed from 3 percent to 1 percent of the pipe diameter to evaluate separation distances. The thresholds are applicable to the exposures identified in each group, as follows:

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(2) *Group 2 Exposures.* The distances specified are those required to reduce the radiant heat flux level to 1500 Btu/hr/ft^2 (4732 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 6340 Btu/hr/ft^2 (20,000 W/m^2) or the visible flame length for combustible materials, or a radiant heat flux level of 8000 Btu/hr/ft^2 (25,237 W/m^2) or the visible flame length for noncombustible equipment. In both cases, the visible flame length was used to establish the requirements.

A 50 percent safety factor was added to all resulting separation distance values.

[**55:**A.10.4.2.2.1]

Table 7.3.2.3.1.1(A)(a)Exposures Group 1(a). 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 can result in an encroachment that will necessitate relocation of the hydrogen system at the system user's expense. [**55:**A.10.4.2.2.1]

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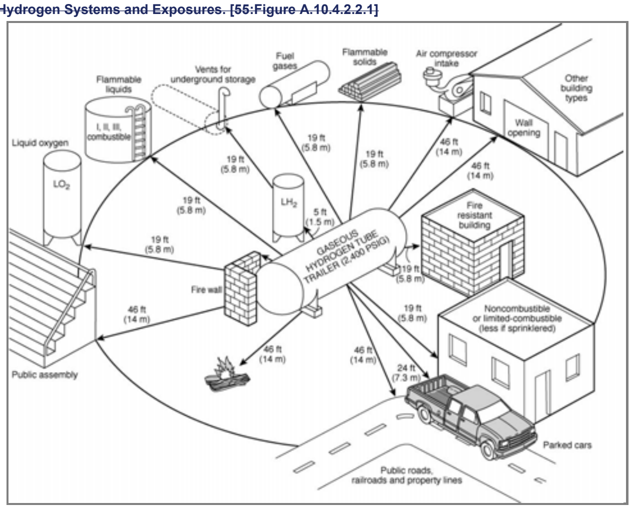
Table 7.3.2.3.1.1(A)(a) Exposure Group 2(a). The exposed persons of concern are non-work-related persons or members of the public who are not involved with servicing the system, because these persons typically are neither trained nor knowledgeable in the operation of the system, but are on the premises. By comparison, service personnel or those involved with servicing the system are trained and engaged in activities related to the system operation including, but not limited to, inspecting, monitoring system inventory, delivering product, maintenance, or similar functions. Administrative controls, engineering controls, or construction features are typically used to restrict persons other than service personnel from being within the zone of potential exposure. The permit holder is responsible for managing and administering the controls to restrict access. Examples of such controls could include painted lines or signs or physical barriers such as a fence. [**55:**A.10.4.2.2.1]

~~See Figure A.7.3.2.3.1.1 for a graphical representation of separation distances from bulk hydrogen systems. [**55:** A.10.4.2.2.1]~~

<u>CGA PS-48, *Clarification of Existing Hydrogen Setback Distances and Development of New Hydrogen Setback Distances in NFPA 55* , provides guidance and clarification on types of exposures as well as applications of the separation distances. [**55:** A.10.4.2.2.1]</u>

~~**Figure A.7.3.2.3.1.1 Distances Between Bulk Hydrogen Systems and Exposures. [55:Figure A.10.4.2.2.1]**~~



Statement of Problem and Substantiation for Public Input

Figure A.7.3.2.3.1.1 is very misleading and should be revised or deleted. The relative distances between the hydrogen storage and the exposures are inaccurate, inconsistent, and wrong. For example it shows the open fire (46 ft) INSIDE the circle that mostly has a radius of 19 ft. And, it shows the parked vehicle (24 ft) further away than the road (46 ft). And, it shows the fire resistant building right next to the storage but with text indicating a distance the same as the other building (19 ft). It also does not show the reduced distance permitted by the fire wall. And, the distance to liquid oxygen contradicts Chapter 9 of NFPA 55 (see also Figure A.9.3.2 in NFPA 55).

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