



# NATIONAL FIRE PROTECTION ASSOCIATION

The leading information and knowledge resource on fire, electrical and related hazards

## AGENDA

### NFPA Technical Committee on Hydrogen Technology (HYD-AAA) NFPA 2 Pre-Second Draft Meeting (F2025)

December 11, 2024  
11:00 a.m. – 4:00 p.m. (ET)

Web/Teleconference  
To join the meeting, please contact [ylee@nfpa.org](mailto:ylee@nfpa.org)

1. **Call to order.** Chris LaFleur.
2. **Introductions.** See committee roster attached.
3. **Staff liaison report.** Heath Dehn.
4. **Previous meeting minutes.** April 2024 Indianapolis, IN. See attached.
5. **Meeting Items.**
  - a. **Task Group(s).**
    - i. **Hydrogen Generation Systems.**
      1. **Scope:** Update Chapter 13 to be similar to Chapter 12. For example: require prepackaged, self-contained hydrogen generators to be designed, tested, and approved to ANSI standards. And, to require pre-engineered hydrogen generators and matched modular components to be designed and tested to ANSI standards. The TG will additionally focus the remainder of Chapter 13 on installation requirements. The current scope of Chapter 13 is 100kg/hr, while current industrial systems can be much larger. Recommendations will also be provided for large scale hydrogen production, along with possible changes in scope for Chapter 13.
      2. **Member:** Stephen Goyette (chair), Lawrence C. Moulthrop, Jr., Larry M. Danner, Bryan R. Gordon, Paul Coco, Sara Marxen, Robert W. Boyd, William P. Collins, Chris McWhinney, David Cornish, Jessica Robertson\*, Elizabeth Krasowski\*, Steven Delmonaco, Michael Ciotti, Carl Rivkin\*, Martin T. Gresho, Chris LaFleur, Dave Cherkowsy\*, Andrew Markle\*, and Joe Joshi\*  
\*Non-Committee Member.
    - ii. **Fueling.**
      1. **Scope:** The scope of the Fueling Task Group is related to transferring hydrogen from all station types (e.g., mobile, compact, and residential) to all vehicle types and sizes. This includes, but is not limited to, vehicle tank protections, fueling protocols, and

customer interfaces. For the 2023 edition of NFPA 2 the task group will focus on clarifying the language for mobile fueling, heavy duty vehicles, VFA and RFF, and on-demand, requirements. Additionally, the task group will review NFPA 2 fueling requirements and coordinate its language with NFPA 30A, Code for Motor Fuel Dispensing Facilities and Repair Garages, and the International Fire Code.

2. Member: David J. Farese (chair), Bryan R. Gordon, Tim Brown, Jennifer Hamilton\*, Brian Ladds, William P. Collins, David Cornish, Steven Hoffman\*, Gary Stottler, Martin T. Gresho, Robert W. Boyd, Ian Monk\*, Daniel John Hunter, Carl Rivkin\*, Montgomery Jay Sinisi\*, Amy H. Ryan, and Robert Davidson\*  
\*Non-Committee Member.

iii. **Chapter 9 Explosion Protection.**

1. Scope: Coordinate and identify what requirements should be adopted into the code for explosion protection.
2. Member: Robert W. Boyd (chair), John J. Anicello, Larry M. Danner, Rob Early, Stephen Goyette, Achim Wechsung, Alexandra Schluneker, Sunil Lakshmipathy, Chris LaFleur, Jessica Robertson\*, Martin T. Gresho, David J. Farese, Nicholas Bartlett\*, and Amy Shen\*  
\*Non-Committee Member.

iv. **Home Fueling Appliances.**

1. Scope: Review Committee Input No. 86 from the A2022 revision cycle.
2. Member: Bryan R. Gordon (chair), Nathan Weyandt, William P. Collins, Mark Fasel, Sara Marxen, Chris McWhinney, Gary Stottler, and Robert W. Boyd  
\*Non-Committee Member.

v. **Hydrogen as a Combustion Fuel.**

1. Scope: Coordinate with evolving hydrogen industry to determine if new requirements need to be adopted into NFPA 2.
2. Member: Joseph D. DiGiacomo (chair), Larry M. Danner, Brian Ladds, Elizabeth Krasowski\*, Franklin Switzer\*, Kevin Carlisle\*, Mark Hannum\*, Phil Domenicucci\*, and Allen Adriani\*  
\*Non-Committee Member.
3. See attached task group work.

vi. **NFPA 1 and NFPA 400 Extract Updates.**

1. Scope: Review the extracted material from NFPA 1 and NFPA 400 and provide updates to the extracts per NFPA 1, 2024 and NFPA 400, 2025 editions. There are several instances in NFPA 2 where

extracts have been customized through the use of brackets. Since this is in violation of the NFPA extract policy, extracts with such edits will be revised to either match the source document, or the extract tag will be deleted.

2. Member: William Rutherford (chair), Robert W. Boyd, Joseph D. DiGiacomo, Elizabeth Krasowski\*, and Fred Hencken\*  
\*Non-Committee Member.
3. See attached task group work.

vii. **ASME B31 Reference.**

1. Scope: Per the Regulations Governing the Development of NFPA Standards (the Regs), mandatory references within NFPA standards must be written using mandatory language and identified by title and date or edition, see 3.3.7.1.1 of the Regs. There are several instances in NFPA 2 where ASME B31, Code for Pressure Piping, is referenced. This is not a reference to a single document, but instead to several documents within the ASME B31 series. By referencing the entire series of documents, NFPA 2 is in violation of the Regs. This introduces vagueness as to which documents and editions from the ASME B31 series users must follow to align with NFPA 2 requirements.  
This task group is to review all instances where ASME B31, Code for Pressure Piping, is referenced and identify specific documents and editions from the ASME series that should be referenced.
2. Member: Karen I. Quackenbush (chair), Joseph D. DiGiacomo, Rob Early, David J. Farese, Stephen Goyette, Chris McWhinney, Lawrence C. Moulthrop, Jr., and Carl Rivkin\*  
\*Non-Committee Member.
3. See attached task group work.

viii. **IFC, IFGC, and NFPA 1 Harmonization.**

1. Scope: Review NFPA 2 and provide appropriate revisions on hydrogen balloons, flange and threaded joints, MAQs (including MAQ exemptions), and gas room (as defined by the IFC) requirements to ensure harmonization with the IFC, IFGC, and NFPA 1.
2. Member: Elizabeth Krasowski\* (chair), David Cornish, David J. Farese, Cory J. Kreutzer\*, Lisa Reiheld\*, Kelvin Sumba, Thomas G. Witte, John J. Anicello, Martin T. Gresho, and Stephen Goyette  
\*Non-Committee Member.

ix. **Bulk Separation Distance.**

1. Scope: Review the gaseous bulk threshold criteria and continue the work of PI-96 and create PC for the Second Draft.

2. Member: Brian Ehrhart (chair), John J. Anicello, Robert W. Boyd, David J. Farese, Martin T. Gresho, Carl Rivkin\*, and Ethan Hecht\*

\*Non-Committee Member.

x. **NFPA 86 Extract Updates.**

1. Scope: Review the extracted material from NFPA 86 and provide updates to the extracts per the 2023 edition. There are several instances in NFPA 2 where extracts have been customized through the use of brackets. Since this is in violation of the NFPA extract policy, extracts with such edits will be revised to either match the source document, or the extract tag will be deleted.
2. Member: Jeremy R. Conjura, Joseph D. DiGiacomo, Achim Wechsung, Thomas G. Witte, Susan Bayley\*, Larry M. Danner, and Robert W. Boyd  
\*Non-Committee Member.

xi. **NFPA 45 Extract Updates.**

1. Scope: Review the extracted material from NFPA 45 and provide updates to the extracts per NFPA 45, 2024 edition. There are several instances in NFPA 2 where extracts have been customized through the use of brackets. Since this is in violation of the NFPA extract policy, extracts with such edits will be revised to either match the source document, or the extract tag will be deleted.
2. Member: Richard P. Palluzi (chair), Robert W. Boyd, Carl Rivkin\*, Alexandra Schluneker, Susan Bayley\*, and Gary Stottler,  
\*Non-Committee Member.
3. See attached task group work.

**6. Other Business.**

- a. Subsection 6.18.6.1: Review statement structure.
- b. Subsection 11.3.1.11: The title mentions shutoff valves, but shutoff valves are not mention in 11.2.3.1.11.
- c. Subsection 11.3.1.5.2.4: The term “inspection tested” was added to align with Chapter 10 language, see FR-222, but it is not clear where this term exists in Chapter 10.
- d. Subsection 18.3.2.7.1 cross-references NFPA 77. This violates the NFPA Manual of Style since NFPA 77 is a recommended practice and not a mandatory document.
- e. Annex N: There is mention of a “more exhaustive report” but is not directly referenced.
- f. Section 18.4: This section is (Reserved) but referenced in 18.2.5.1.1, 18.2.6.1, and 18.2.6.2. Since there are no requirements in Section 18.4 is a violation of the NFPA Manual of Style.

**7. Future meetings.**

**8. Adjournment.**

# Address List No Phone

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|                                                                                                                                                                        |                      |                                                                                                                |                      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|----------------------------------------------------------------------------------------------------------------|----------------------|
| <b>Chris LaFleur</b>                                                                                                                                                   | <b>RT</b> 08/11/2014 | <b>Peter Anderson</b>                                                                                          | <b>I</b> 08/23/2023  |
| <b>Chair</b><br>Sandia National Laboratories<br>Risk & Reliability Department<br>PO Box 5800, MS-0748<br>Albuquerque, NM 87185-0909<br><b>Alternate: Brian Ehrhart</b> | <b>HYD-AAA</b>       | <b>Principal</b><br>Aegis Insurance Services<br>One Meadowlands Plaza<br>East Rutherford, NJ 07073             | <b>HYD-AAA</b>       |
| <b>John J. Anicello</b>                                                                                                                                                | <b>M</b> 12/07/2021  | <b>Bryan R. Baesel</b>                                                                                         | <b>M</b> 08/23/2023  |
| <b>Principal</b><br>Chart Industries, Inc.<br>29604 11th Place South<br>Federal Way, WA 98003-3727<br><b>Alternate: Thomas K. Drube</b>                                | <b>HYD-AAA</b>       | <b>Principal</b><br>Honeywell/Eclipse/CEC Combustion Safety, Inc.<br>2100 Apollo Drive<br>Brook Park, OH 44142 | <b>HYD-AAA</b>       |
| <b>James B. Biggins</b>                                                                                                                                                | <b>I</b> 04/17/2024  | <b>Robert W. Boyd</b>                                                                                          | <b>SE</b> 10/23/2013 |
| <b>Principal</b><br>CAC Specialty - Natural Resources<br>15732 West Barr Road<br>Manhattan, IL 60442-9012                                                              | <b>HYD-AAA</b>       | <b>Principal</b><br>Boyd Hydrogen LLC<br>14 Cherry Court<br>Spring Lake, NJ 07762                              | <b>HYD-AAA</b>       |
| <b>Jeffrey Robert Brassel</b>                                                                                                                                          | <b>I</b> 03/20/2023  | <b>Tim Brown</b>                                                                                               | <b>IM</b> 12/07/2018 |
| <b>Principal</b><br>Nationwide Insurance<br>25W 735 White Birch Court<br>Wheaton, IL 60189                                                                             | <b>HYD-AAA</b>       | <b>Principal</b><br>FirstElement Fuel, Inc.<br>5151 California Avenue<br>Suite 220<br>Irvine, CA 92617         | <b>HYD-AAA</b>       |
| <b>Ted Bukowski</b>                                                                                                                                                    | <b>RT</b> 12/07/2022 | <b>Michael Ciotti</b>                                                                                          | <b>U</b> 4/4/2017    |
| <b>Principal</b><br>Gas Technology Institute (GTI)<br>1700 South Mt. Prospect Road<br>Des Plaines, IL 60018                                                            | <b>HYD-AAA</b>       | <b>Principal</b><br>PDC Machines LLC<br>59 Fretz Road<br>Souderton, PA 18964                                   | <b>HYD-AAA</b>       |
| <b>Paul Coco</b>                                                                                                                                                       | <b>I</b> 08/23/2023  | <b>Jeremy R. Conjura</b>                                                                                       | <b>U</b> 08/23/2023  |
| <b>Principal</b><br>Hartford Steam Boiler<br>One State Street<br>Hartford, CT 06073<br><b>Alternate: Regina M. Loschiavo</b>                                           | <b>HYD-AAA</b>       | <b>Principal</b><br>Corning Incorporated<br>11773 Lower Drive<br>Corning, NY 14830                             | <b>HYD-AAA</b>       |
| <b>David Cornish</b>                                                                                                                                                   | <b>IM</b> 12/07/2022 | <b>Larry M. Danner</b>                                                                                         | <b>M</b> 7/28/2006   |
| <b>Principal</b><br>Engineering, Procurement & Construction LLC (EPC)<br>6131 Trumpeter Drive<br>Cheyenne, WY 82007                                                    | <b>HYD-AAA</b>       | <b>Principal</b><br>GE Power<br>300 Garlington Road<br>GTTC Room 200D<br>Greenville, SC 29615-0648             | <b>HYD-AAA</b>       |

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|---------------------------------------------------------------------------------------------------------------------------|----------------------|------------------------------------------------------------------------------------------------------------------------|----------------------|
| <b>Steven Delmonaco</b>                                                                                                   | <b>IM</b> 11/30/2016 | <b>Joseph D. DiGiacomo</b>                                                                                             | <b>U</b> 7/28/2006   |
| <b>Principal</b><br>Plug Power<br>8 British American Blvd<br>Latham, NY 12110<br><b>Alternate: Jordan Stinn</b>           | <b>HYD-AAA</b>       | <b>Principal</b><br>Retired<br>307 Hanging Star Lane<br>Georgetown, TX 78633                                           | <b>HYD-AAA</b>       |
| <b>Louis A. Donsbach, Jr.</b>                                                                                             | <b>U</b> 08/23/2023  | <b>Alexis Dubois</b>                                                                                                   | <b>U</b> 03/20/2023  |
| <b>Principal</b><br>US Steel Corporation<br>One North Broadway<br>91E2/TS 526<br>Gary, IN 46402-3101                      | <b>HYD-AAA</b>       | <b>Principal</b><br>Steelhead Composites, Inc.<br>500 Corporate Circle, Unit O<br>Golden, CO 80401                     | <b>HYD-AAA</b>       |
| <b>Rob Early</b>                                                                                                          | <b>M</b> 8/9/2012    | <b>David J. Farese</b>                                                                                                 | <b>SE</b> 08/23/2023 |
| <b>Principal</b><br>Compressed Gas Association<br>2540 Bowen Road<br>Elma, NY 14059<br><b>Alternate: Richard A. Craig</b> | <b>HYD-AAA</b>       | <b>Principal</b><br>Durham Consulting LLC<br>465 Hilltop Road<br>Riegelsville, PA 18077                                | <b>HYD-AAA</b>       |
| <b>Mark Fasel</b>                                                                                                         | <b>E</b> 08/23/2023  | <b>Gary R. Fleming</b>                                                                                                 | <b>I</b> 04/17/2024  |
| <b>Principal</b><br>International Code Council (ICC)<br>7338 Jackie Court<br>Indianapolis, IN 46221                       | <b>HYD-AAA</b>       | <b>Principal</b><br>PERse/Managing General Underwriter<br>21907 Riddles Court<br>Cornelius, NC 28031                   | <b>HYD-AAA</b>       |
| <b>Bryan R. Gordon</b>                                                                                                    | <b>IM</b> 12/06/2019 | <b>Stephen Goyette</b>                                                                                                 | <b>IM</b> 07/28/2006 |
| <b>Principal</b><br>Ivys Energy Solutions, Inc.<br>c/o Greentown Labs<br>444 Somerville Avenue<br>Somerville, MA 02143    | <b>HYD-AAA</b>       | <b>Principal</b><br>Nel Hydrogen<br>10 Technology Drive<br>Wallingford, CT 06492                                       | <b>HYD-AAA</b>       |
| <b>Martin T. Gresho</b>                                                                                                   | <b>SE</b> 7/28/2006  | <b>Aaron Harris</b>                                                                                                    | <b>M</b> 8/2/2010    |
| <b>Principal</b><br>FP2Fire, Inc.<br>1140 Indian Peak Road<br>Golden, CO 80403-9403                                       | <b>HYD-AAA</b>       | <b>Principal</b><br>Air Liquide<br>9811 Katy Freeway<br>Suite 100<br>Houston, TX 77024<br><b>Alternate: Josh Light</b> | <b>HYD-AAA</b>       |
| <b>Adrian T. Hemphill</b>                                                                                                 | <b>U</b> 03/20/2023  | <b>Daniel John Hunter</b>                                                                                              | <b>U</b> 03/20/2023  |
| <b>Principal</b><br>Saudi Aramco<br>Building 3150<br>Saudi Aramco<br>Dhahran, EASTERN PROVINCE 31311 Saudi Arabia         | <b>HYD-AAA</b>       | <b>Principal</b><br>Yoshi Inc.<br>555 Bryant Street, Suite 179<br>Palo Alto, CA 94301                                  | <b>HYD-AAA</b>       |

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| <b>Thomas Joseph</b>                                                                                                                                                            | <b>M</b> 7/28/2006   | <b>Denise Lackey</b>                                                                                                                     | <b>U</b> 08/29/2024  |
| <b>Principal</b><br>Bethlehem Hydrogen Inc.<br>5250 Deer Trail Circle<br>Emmaus, PA 18049                                                                                       | <b>HYD-AAA</b>       | <b>Principal</b><br>Amazon<br>2790 Vassar Drive<br>Boulder, CO 80305                                                                     | <b>HYD-AAA</b>       |
| <b>Brian Ladds</b>                                                                                                                                                              | <b>SE</b> 08/09/2011 | <b>Sara Marxen</b>                                                                                                                       | <b>RT</b> 08/17/2018 |
| <b>Principal</b><br>Ladds & Uzeloc Consulting Inc.<br>226044 - 80 Street East<br>Foothills, AB T1S 3W4 Canada                                                                   | <b>HYD-AAA</b>       | <b>Principal</b><br>Canadian Standards Association (CSA Group)<br>8501 East Pleasant Valley Road<br>Cleveland, OH 44131                  | <b>HYD-AAA</b>       |
| <b>Charles W. Mcknight</b>                                                                                                                                                      | <b>SE</b> 04/02/2020 | <b>Chris McWhinney</b>                                                                                                                   | <b>M</b> 08/24/2021  |
| <b>Principal</b><br>Jensen Hughes<br>27824 Resource Ridge Avenue NE<br>Kingston, WA 98346-9570<br><b>Alternate: Sunil Lakshmipathy</b>                                          | <b>HYD-AAA</b>       | <b>Principal</b><br>Millennium Reign Energy LLC<br>530 N. Main Street<br>Dayton, OH 45405-4924<br><b>Alternate: William P. Collins</b>   | <b>HYD-AAA</b>       |
| <b>Mark Christopher Mirek</b>                                                                                                                                                   | <b>I</b> 03/20/2023  | <b>Lawrence C. Moulthrop, Jr.</b>                                                                                                        | <b>SE</b> 7/28/2006  |
| <b>Principal</b><br>Brown & Brown, Inc./Beecher Carlson LLC<br>6215 Martel Avenue<br>Dallas, TX 75214                                                                           | <b>HYD-AAA</b>       | <b>Principal</b><br>H2@LMDesk<br>244 Carriage Way<br>Windsor, CT 06095                                                                   | <b>HYD-AAA</b>       |
| <b>John A. Mullen</b>                                                                                                                                                           | <b>U</b> 08/10/2022  | <b>Danielle Murphy</b>                                                                                                                   | <b>SE</b> 08/29/2024 |
| <b>Principal</b><br>International Association of Plumbing & Mechanical Officials (IAPMO)<br>733 Deep River Way<br>Waxhaw, NC 28173-0280                                         | <b>HYD-AAA</b>       | <b>Principal</b><br>WHA International, Inc.<br>2935 Baseline Road, Suite 300<br>Boulder, CO 80303<br><b>Alternate: Brian C. Anderson</b> | <b>HYD-AAA</b>       |
| <b>Ian Mylenbusch</b>                                                                                                                                                           | <b>U</b> 03/20/2023  | <b>Narendra Pal</b>                                                                                                                      | <b>SE</b> 8/11/2014  |
| <b>Principal</b><br>Southern Company<br>3535 Colonnade Parkway<br>BIN 5S-EC-530<br>Birmingham, AL 35243<br><b>Edison Electric Institute</b><br><b>Alternate: John Armstrong</b> | <b>HYD-AAA</b>       | <b>Principal</b><br>Pacific Hydrogen LLC<br>435 Reflections Circle, #13<br>San Ramon, CA 94583                                           | <b>HYD-AAA</b>       |
| <b>Richard P. Palluzi</b>                                                                                                                                                       | <b>SE</b> 03/20/2023 | <b>Karen I. Quackenbush</b>                                                                                                              | <b>M</b> 7/28/2006   |
| <b>Principal</b><br>Richard Palluzi LLC<br>72 Summit Drive<br>Basking Ridge, NJ 07920-1962                                                                                      | <b>HYD-AAA</b>       | <b>Principal</b><br>Fuel Cell & Hydrogen Energy Association<br>1025 Connecticut Avenue NW<br>Suite 1000<br>Washington, DC 20036          | <b>HYD-AAA</b>       |

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| <b>Denzel Robertson</b>                                                                                                                                    | <b>M</b> 12/07/2022  | <b>William Rutherford</b>                                                                                                                     | <b>SE</b> 12/07/2021 |
| <b>Principal</b><br>Messer North America, Inc.<br>15115 Park Row<br>Suite 160<br>Houston, TX 77084                                                         | <b>HYD-AAA</b>       | <b>Principal</b><br>Sargent & Lundy, LLC.<br>5048 Woodbridge Avenue<br>Portage, IN 46368                                                      | <b>HYD-AAA</b>       |
| <b>Amy H. Ryan</b>                                                                                                                                         | <b>M</b> 04/17/2024  | <b>Scott Singletary</b>                                                                                                                       | <b>M</b> 12/07/2022  |
| <b>Principal</b><br>Toyota Technical Center<br>3300 W. Industrial Blvd<br>Suite 200<br>W Sacramento, CA 95691-5002<br><b>Alternate: Jacquelyn Birdsall</b> | <b>HYD-AAA</b>       | <b>Principal</b><br>Thyssenkrupp<br>2433 Lark Street<br>New Orleans, LA 70122                                                                 | <b>HYD-AAA</b>       |
| <b>Jeremy Peter Smith</b>                                                                                                                                  | <b>SE</b> 12/07/2022 | <b>Gary Stottler</b>                                                                                                                          | <b>SE</b> 08/29/2024 |
| <b>Principal</b><br>Waldron Engineering and Construction<br>37 Industrial Drive<br>Exeter, NH 03833                                                        | <b>HYD-AAA</b>       | <b>Principal</b><br>Stottler Development LLC.<br>Po Box 179<br>Ionia, NY 14475                                                                | <b>HYD-AAA</b>       |
| <b>Kelvin Sumba</b>                                                                                                                                        | <b>U</b> 03/20/2023  | <b>Arpad Veress</b>                                                                                                                           | <b>U</b> 12/07/2022  |
| <b>Principal</b><br>ANGI Energy Systems (Gilbarco)<br>305 W. Delavan Drive<br>Janesville, WI 53546                                                         | <b>HYD-AAA</b>       | <b>Principal</b><br>ExNB Certification Institute<br>13-16 Kozak Square<br>Budapest, BUDAPEST 1154 Hungary                                     | <b>HYD-AAA</b>       |
| <b>Achim Wechsung</b>                                                                                                                                      | <b>SE</b> 04/14/2021 | <b>Nathan Weyandt</b>                                                                                                                         | <b>RT</b> 3/1/2011   |
| <b>Principal</b><br>Exponent, Inc.<br>1075 Worcester Street<br>Natick, MA 01760<br><b>Alternate: Harri K. Kytomaa</b>                                      | <b>HYD-AAA</b>       | <b>Principal</b><br>Southwest Research Institute<br>6220 Culebra Road<br>San Antonio, TX 78238-5166<br><b>Alternate: Alexandra Schluneker</b> | <b>HYD-AAA</b>       |
| <b>Steven Wheaton</b>                                                                                                                                      | <b>M</b> 08/03/2016  | <b>Justin Alexander Williams</b>                                                                                                              | <b>RT</b> 08/23/2023 |
| <b>Principal</b><br>Choshu Industry Corporation of America, Inc.<br>36245 Del Amo Boulevard<br>Suite 230<br>Torrance, CA 90503                             | <b>HYD-AAA</b>       | <b>Principal</b><br>UT-Battelle/Oak Ridge National Laboratory<br>129 Victory Drive<br>Madisonville, TN 37354                                  | <b>HYD-AAA</b>       |
| <b>Thomas G. Witte</b>                                                                                                                                     | <b>SE</b> 08/24/2021 | <b>Edgar Wolff Klammer</b>                                                                                                                    | <b>RT</b> 08/17/2017 |
| <b>Principal</b><br>Witte Engineered Gases<br>12425 Horton Highway<br>Greeneville, TN 37745                                                                | <b>HYD-AAA</b>       | <b>Principal</b><br>UL LLC<br>333 Pffingsten Road<br>Northbrook, IL 60062-2096<br><b>Alternate: LaTanya Schwalb</b>                           | <b>HYD-AAA</b>       |

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| <b>Jiann C. Yang</b>                                                                                                                                                                                                                 | <b>RT 1/10/2008</b>  | <b>Jennifer Morgan</b>                                                                                                                                   | <b>M 08/23/2023</b>  |
| <b>Principal</b><br>National Institute of Standards & Technology (NIST)<br>Building & Fire Research Laboratory<br>Building 224, Room B360<br>100 Bureau Drive, MS 8662<br>Gaithersburg, MD 20899<br><b>Alternate: Kuldeep Prasad</b> | <b>HYD-AAA</b>       | <b>Voting Alternate</b><br>Shell Global Solutions<br>17402 Aberdeenshire Drive<br>Richmond, TX 77407                                                     | <b>HYD-AAA</b>       |
| <b>Brian C. Anderson</b>                                                                                                                                                                                                             | <b>SE 08/29/2024</b> | <b>John Armstrong</b>                                                                                                                                    | <b>U 08/23/2023</b>  |
| <b>Alternate</b><br>WHA International, Inc.<br>5605 Dona Ana Road<br>Las Cruces, NM 88007<br><b>Principal: Danielle Murphy</b>                                                                                                       | <b>HYD-AAA</b>       | <b>Alternate</b><br>Dominion Energy<br>120 Tredegar Street<br>Richmond, VA 23219<br><b>Edison Electric Institute</b><br><b>Principal: Ian Mylenbusch</b> | <b>HYD-AAA</b>       |
| <b>Jacquelyn Birdsall</b>                                                                                                                                                                                                            | <b>M 03/03/2014</b>  | <b>William P. Collins</b>                                                                                                                                | <b>M 08/24/2021</b>  |
| <b>Alternate</b><br>Toyota Engineering & Manufacturing North America, Inc.<br>1630 West 186th Street<br>Gardena, CA 90248-3807<br><b>Principal: Amy H. Ryan</b>                                                                      | <b>HYD-AAA</b>       | <b>Alternate</b><br>WPC Sol, LLC<br>49 Autumn Court<br>East Windsor, CT 06088<br><b>Principal: Chris McWhinney</b>                                       | <b>HYD-AAA</b>       |
| <b>Richard A. Craig</b>                                                                                                                                                                                                              | <b>M 8/9/2011</b>    | <b>Thomas K. Drube</b>                                                                                                                                   | <b>M 04/17/2024</b>  |
| <b>Alternate</b><br>Compressed Gas Association<br>14501 George Carter Way<br>Suite 103<br>Chantilly, VA 20151<br><b>Principal: Rob Early</b>                                                                                         | <b>HYD-AAA</b>       | <b>Alternate</b><br>Chart Industries, Inc.<br>407 7th Street NW<br>New Prague, MN 56071<br><b>Principal: John J. Anicello</b>                            | <b>HYD-AAA</b>       |
| <b>Brian Ehrhart</b>                                                                                                                                                                                                                 | <b>RT 12/07/2018</b> | <b>Harri K. Kytomaa</b>                                                                                                                                  | <b>SE 08/23/2023</b> |
| <b>Alternate</b><br>Sandia National Laboratories<br>PO Box 5800<br>Mail Stop 0748<br>Albuquerque, NM 87185-0748<br><b>Principal: Chris LaFleur</b>                                                                                   | <b>HYD-AAA</b>       | <b>Alternate</b><br>Exponent, Inc.<br>1075 Worcester Street<br>Natick, MA 01760<br><b>Principal: Achim Wechsung</b>                                      | <b>HYD-AAA</b>       |
| <b>Sunil Lakshmipathy</b>                                                                                                                                                                                                            | <b>SE 08/11/2020</b> | <b>Josh Light</b>                                                                                                                                        | <b>M 12/02/2020</b>  |
| <b>Alternate</b><br>Jensen Hughes<br>13900 Maycrest Way<br>Unit 135<br>Richmond, BC V6V 3E2 Canada<br><b>Principal: Charles W. Mcknight</b>                                                                                          | <b>HYD-AAA</b>       | <b>Alternate</b><br>Air Liquide<br>9811 Katy Freeway<br>Suite 100<br>Houston, TX 77042<br><b>Principal: Aaron Harris</b>                                 | <b>HYD-AAA</b>       |

# Address List No Phone

11/22/2024

Heath Dehn

HYD-AAA

## Hydrogen Technology

|                                                                                                                                                                                         |                      |                                                                                                                                                                                                          |                      |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| <b>Regina M. Loschiavo</b>                                                                                                                                                              | <b>I 08/29/2024</b>  | <b>Kuldeep Prasad</b>                                                                                                                                                                                    | <b>RT 8/2/2010</b>   |
| <b>Alternate</b><br>Zurich NA<br>2950 Long Meadow Lane<br>Durham, NC 27703<br><b>Principal: Paul Coco</b>                                                                               | <b>HYD-AAA</b>       | <b>Alternate</b><br>National Institute of Standards & Technology (NIST)<br>Building & Fire Research Laboratory<br>100 Bureau Drive, MS 8663<br>Gaithersburg, MD 22182<br><b>Principal: Jiann C. Yang</b> | <b>HYD-AAA</b>       |
| <b>Alexandra Schluneker</b>                                                                                                                                                             | <b>RT 04/04/2017</b> | <b>LaTanya Schwalb</b>                                                                                                                                                                                   | <b>RT 03/20/2023</b> |
| <b>Alternate</b><br>Southwest Research Institute<br>Senior Research Engineer<br>6220 Culebra Road<br>B-143 Fire Technology<br>San Antonio, TX 78238<br><b>Principal: Nathan Weyandt</b> | <b>HYD-AAA</b>       | <b>Alternate</b><br>UL Solutions<br>333 Pfingsten Road<br>Northbrook, IL 60062<br><b>Principal: Edgar Wolff Klammer</b>                                                                                  | <b>HYD-AAA</b>       |
| <b>Jordan Stinn</b>                                                                                                                                                                     | <b>IM 08/29/2024</b> | <b>Heath Dehn</b>                                                                                                                                                                                        | <b>9/18/2018</b>     |
| <b>Alternate</b><br>Plug Power Inc.<br>284 Forrest Court<br>Sherwood Park, ALBERTA T8A 6K3 Canada<br><b>Principal: Steven Delmonaco</b>                                                 | <b>HYD-AAA</b>       | <b>Staff Liaison</b><br>National Fire Protection Association<br>1 Batterymarch Park<br>Quincy, MA 02169-7471                                                                                             | <b>HYD-AAA</b>       |



# NATIONAL FIRE PROTECTION ASSOCIATION

The leading information and knowledge resource on fire, electrical and related hazards

## MEETING MINUTES

### NFPA Technical Committee on Hydrogen Technology (HYD-AAA) NFPA 2 First Draft Meeting (F2025)

April 9 – 11, 2024 (in-person in Indianapolis, IN)  
April 23 – 24, 2024 (remote via Microsoft Teams)  
8:00 am – 5:00 pm (ET)

#### In-Person Meeting Location

Hyatt House Indianapolis  
130 S Pennsylvania Street  
Indianapolis, IN 46204

1. **Call to order.** Chris LaFleur, chair, called the meeting to order at 8:00am on April 9th.
2. **Introductions.** Attendees introduced themselves and identified their affiliation and staff took attendance.
3. **Chair report.** Chris LaFleur welcomed attendees and provided an overview of the meeting.
4. **Staff liaison report.** Alex Ing provided an overview of the standards development process and the revision cycle schedule.
  - a. Alex Ing acted as the NFPA staff liaison during the in-person meeting days, while Heath Dehn was the staff liaison during the remote meeting days.
5. **Previous meeting minutes.** The minutes from November 2023 web/teleconference were approved without revision.
6. **NFPA 2 First Draft.**
  - a. **Review of Public Inputs.** The Technical Committee reviewed the Public Inputs and developed Committee Inputs and First Revisions as necessary. These will be available in the First Draft Report at [www.nfpa.org/2](http://www.nfpa.org/2).
  - b. **Task Group(s).** The following task groups provided reports and recommendations for committee discussion:
    - i. **Hydrogen Generation Systems.**
      1. **Scope:** Update Chapter 13 to be similar to Chapter 12. For example: require prepackaged, self-contained hydrogen generators to be designed, tested, and approved to ANSI standards. And, to require pre-engineered hydrogen generators and matched modular components to be designed and tested to ANSI standards. The TG will additionally focus the remainder of Chapter 13 on installation requirements. The current scope of Chapter 13 is 100kg/hr, while

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These minutes are considered preliminary until approved at the next committee meeting.

current industrial systems can be much larger. Recommendations will also be provided for large scale hydrogen production, along with possible changes in scope for Chapter 13.

2. Member: Stephen Goyette\* (chair), Larry Moulthrop, Larry Danner, Bryan Gordon, Sara Marxen, Bob Boyd, Bill Collins, Chris McWhinney, David Cornish, Elizabeth Krasowski, Steven Delmonaco, Michael Ciotti, Carl Rivkin, Marty Gresho, Dave Cherkowsy\*, Andrew Markle\*, Paul Coco and Jessica Robertson\*.

\*Non-committee Member

3. See attached task group report.

## **ii. Fueling Task Group.**

1. Scope: The scope of the Fueling Task Group is related to transferring hydrogen from all station types (e.g., mobile, compact, and residential) to all vehicle types and sizes. This includes, but is not limited to, vehicle tank protections, fueling protocols, and customer interfaces. For the 2023 edition of NFPA 2 the task group will focus on clarifying the language for mobile fueling, heavy duty vehicles, VFA and RFF, and on-demand, requirements. Additionally, the task group will review NFPA 2 fueling requirements and coordinate its language with NFPA 30A, Code for Motor Fuel Dispensing Facilities and Repair Garages, and the International Fire Code.

2. Member: David Farese (chair), Bryan Gordon, Tim Brown, Jennifer Hamilton, Brian Ladds, William Collins, David Cornish, Steven Hoffman, Marty Gresho, Robert Boyd, Ian Monk, Dan Hunter, Carl Rivkin, Montgomery Jay Sinisi\*, Amy Ryan\*, Robert Davidson\*, and Gary Stottler\*

\*Non-committee Member

3. See attached task group report.

## **iii. Chapter 9 Explosion Protection.**

1. Scope: Coordinate and identify what requirements should be adopted into the code for explosion protection.
2. Member: Bob Boyd (chair), John J. Anicello, Larry M. Danner, Rob Early, Stephen Goyette\*, Achim Wechsung, Alexandra Schluneker, Sunil Lakshmipathy, Chris LaFleur, Elizabeth Krasowski, Marty Gresho, Jessica Robertson\*, and Dave Farese

\*Non-committee Member

3. See attached task group report.

## **iv. Home Fueling Appliances.**

1. Scope: Review Committee Input No. 86.
2. Member: Bryan Gordon (chair), Spencer Quong, Nathan Weyandt, Mark Fasel\*, Sara Marxen, Chris McWhinney, Gary Stottler\*, and William Collins

\*Non-committee Member

3. See attached task group report.

**v. Hydrogen as a Combustion Fuel.**

1. Scope: Coordinate with evolving hydrogen industry to determine if new requirements need to be adopted into NFPA 2.
2. Member: Joseph DiGiacomo (chair), Larry Danner, Elizabeth Krasowski, Franklin Switzer\*, Kevin Carlisle\*, Phil Domenicucci\*, Allen Adriani, Brian Ladds, and Mark Hannum\*  
\*Non-committee Member
3. See attached task group report.

**vi. NFPA 2/55 Joint Alignment.**

1. Scope: Revise NFPA 2 and NFPA 55 to align with the updated HYD-AAA and IMG-AAA technical committee scopes. This entails the revision or removal of NFPA 55 hydrogen general, use, and storage requirements, as appropriate, per the revised IMG-AAA committee scope. Additionally, this joint task group will review NFPA 2 requirements and determine what revisions are needed to align NFPA 2 with the revised HYD-AAA committee scope. Specific attention should be made to NFPA 2 requirements that were previously extracted and still reside in NFPA 55. All proposed revisions by this task group should be submitted as Public Inputs and Public Comments during the next revision cycle of both documents. An NFPA 2 and NFPA 55 pre-First Draft meeting is expected to take place to review this TG's work during the next revision cycle.
2. Member: Rob Early (chair)\*†, John Anicello\*†, Bob Carpenter†, Brian Ehrhart\*†, Kenneth Fegley\*, Jef Frick†, Stephen Goyette‡, Martin Gresho\*†, John Mullen\*, Richard Palluzi†, and Dimitri Sokolik‡  
\*NFPA 2 TC Member †NFPA 55 TC Member ‡Non-TC Member
3. See attached task group report.

**vii. Chapter 10 and 11 Scope.**

1. Scope: Revise the scopes of Chapter 10 and Chapter 11 to eliminate confusion about when the requirements of each chapter are applicable.
2. Members: Carl H. Rivkin (chair), Robert W. Boyd, Chris McWhinney, Kelvin Sumba, Steven Wheaton, Thomas G. Witte, William Collins, and Allen Adriani
3. See attached task group report.

**viii. IFC and NFPA 1 Alignment.**

1. Scope: Review NFPA 2 and provide appropriate revisions on hydrogen balloons, flange and threaded joints, MAQs (including MAQ exemptions), and gas room (as defined by the IFC) requirements to ensure alignment with the IFC and NFPA 1.
2. Members: Marty Gresho (chair), David Cornish, Elizabeth Krasowski, Cory J. Kreutzer, Kelvin Sumba, Thomas G. Witte, and John Anicello
3. No task group report provided.

**ix. Indoor Fueling Review.**

1. Scope: Review and develop any additional requirements that allows for complete indoor fueling systems (e.g., such as for HPIT).
2. Members: Marty Gresho (chair), Jeffrey Robert Brassel, Joseph D. DiGiacomo, Bryan R. Gordon, Stephen Goyette\*, and Allen Adriani  
\*Non-committee Member
3. No task group report provided.

**c. Presentation(s).** The committee heard presentations from the following individuals.

- i. **Chapter 9 Explosion Protection.** Bob Boyd. Presentation attached.
- ii. **PI-180 Discussion.** Marty Gresho. Presentation attached.
- iii. **Chapter 6 Table.** Marty Gresho. Presentation attached.
- iv. **ESS/ESD Topics.** Bob Boyd. Presentation attached.
- v. **GH<sub>2</sub> Outdoor Bulk Storage Setback Distance.** Brian Ehrhart. Presentation attached.
- vi. **PI-65 Discussion.** Steve Wheaton. Presentation attached.
- vii. **CSA B107.** Stephen Goyette. Presentation attached.

**7. Other Business.**

- 8. Future meetings.** The next committee meeting will be a continuation of the First Draft meeting on May 16<sup>th</sup>. A meeting notification and agenda will be posted at [www.nfpa.org/2next](http://www.nfpa.org/2next) when available.

- 9. Adjournment.** The meeting was adjourned at 5:00 on April 24<sup>th</sup>.

**Attendees**

**Committee Members:**

|   |                                |            |                                               |
|---|--------------------------------|------------|-----------------------------------------------|
| ✓ | <b>Chris LaFleur</b>           | Chair      | Sandia National Laboratories                  |
| ✓ | <b>Heath Dehn</b>              | NFPA Staff | National Fire Protection Association          |
| ✓ | <b>Alex Ing</b>                | NFPA Staff | National Fire Protection Association          |
| ✓ | <b>Peter Anderson*</b>         | Principal  | Aegis Insurance Services                      |
| ✓ | <b>John J. Anicello</b>        | Principal  | Chart Industries, Inc.                        |
| ✓ | <b>Bryan R. Baesel*</b>        | Principal  | Honeywell/Eclipse/CEC Combustion Safety, Inc. |
| ✓ | <b>Robert W. Boyd</b>          | Principal  | Boyd Hydrogen LLC                             |
| ✓ | <b>Jeffrey Robert Brassel*</b> | Principal  | Nationwide Insurance                          |
| ✓ | <b>Tim Brown*</b>              | Principal  | FirstElement Fuel, Inc.                       |
| ✓ | <b>Ted Bukowski*</b>           | Principal  | Gas Technology Institute (GTI)                |
|   | <b>Michael Ciotti</b>          | Principal  | PDC Machines LLC                              |

## Attendees

### **Committee Members:**

|   |                                    |           |                                                                      |
|---|------------------------------------|-----------|----------------------------------------------------------------------|
| ✓ | <b>Paul Coco*</b>                  | Principal | Hartford Steam Boiler                                                |
| ✓ | <b>Jeremy R. Conjura</b>           | Principal | Corning Incorporated                                                 |
| ✓ | <b>David Cornish*</b>              | Principal | Engineering, Procurement & Construction LLC (EPC)                    |
| ✓ | <b>Larry M. Danner</b>             | Principal | GE Power                                                             |
| ✓ | <b>Steven Anthony Delmonaco</b>    | Principal | Plug Power                                                           |
| ✓ | <b>Joseph D. DiGiacomo*</b>        | Principal | Retired                                                              |
| ✓ | <b>Louis A. Donsbach, Jr.</b>      | Principal | US Steel Corporation                                                 |
|   | <b>Alexis Dubois</b>               | Principal | Steelhead Composites, Inc.                                           |
| ✓ | <b>Rob Early*</b>                  | Principal | Compressed Gas Association                                           |
| ✓ | <b>David J. Farese</b>             | Principal | Durham Consulting LLC                                                |
| ✓ | <b>Mark Fasel</b>                  | Principal | International Code Council (ICC)                                     |
| ✓ | <b>Bryan R. Gordon*</b>            | Principal | Ivys Energy Solutions, Inc.                                          |
| ✓ | <b>Stephen Goyette</b>             | Principal | Nel Hydrogen                                                         |
| ✓ | <b>Martin T. Gresho</b>            | Principal | FP2Fire, Inc.                                                        |
| ✓ | <b>Aaron Harris*</b>               | Principal | Air Liquide                                                          |
| ✓ | <b>Adrian T. Hemphill*</b>         | Principal | Saudi Aramco                                                         |
| ✓ | <b>Daniel John Hunter*</b>         | Principal | Yoshi Inc.                                                           |
|   | <b>Thomas Joseph</b>               | Principal | Bethlehem Hydrogen Inc.                                              |
| ✓ | <b>Elizabeth Krasowski</b>         | Principal | Ramboll                                                              |
| ✓ | <b>Cory J. Kreutzer</b>            | Principal | WHA International                                                    |
|   | <b>Nick Lumley</b>                 | Principal | Burns & McDonnell Engineering Company                                |
| ✓ | <b>Sara Marxen*</b>                | Principal | Canadian Standards Association (CSA Group)                           |
|   | <b>Charles W. Mcknight</b>         | Principal | JENSEN HUGHES                                                        |
| ✓ | <b>Chris McWhinney</b>             | Principal | Millennium Reign Energy LLC                                          |
| ✓ | <b>Mark Christopher Mirek*</b>     | Principal | Brown & Brown, Inc./Beecher Carlson LLC                              |
| ✓ | <b>Lawrence C. Moulthrop, Jr.*</b> | Principal | H2@LMDesk                                                            |
| ✓ | <b>John Mullen</b>                 | Principal | International Association of Plumbing & Mechanical Officials (IAPMO) |
| ✓ | <b>Ian Mylenbusch</b>              | Principal | Southern Company                                                     |
|   | <b>Narendra Pal</b>                | Principal | Pacific Hydrogen LLC                                                 |
| ✓ | <b>Richard P. Palluzi</b>          | Principal | Richard Palluzi LLC                                                  |
| ✓ | <b>Karen I. Quackenbush*</b>       | Principal | Fuel Cell & Hydrogen Energy Association                              |
| ✓ | <b>Carl H. Rivkin</b>              | Principal | Nikola Motors Company                                                |
| ✓ | <b>Denzel Robertson*</b>           | Principal | Messer North America, Inc.                                           |
| ✓ | <b>William Rutherford*</b>         | Principal | Sargent & Lundy, LLC.                                                |

## Attendees

### **Committee Members:**

|   |                                  |           |                                                        |
|---|----------------------------------|-----------|--------------------------------------------------------|
| ✓ | <b>Michael A. Semeraro</b>       | Principal | Shell Hydrogen                                         |
|   | <b>Scott Singletary</b>          | Principal | Thyssenkrupp                                           |
| ✓ | <b>Jeremy Peter Smith</b>        | Principal | Waldron Engineering and Construction                   |
| ✓ | <b>Kelvin Sumba*</b>             | Principal | ANGI Energy Systems (Gilbarco)                         |
|   | <b>Arpad Veress</b>              | Principal | ExNB Certification Institute                           |
| ✓ | <b>Ryan Weber*</b>               | Principal | NW Natural Gas                                         |
| ✓ | <b>Achim Wechsung</b>            | Principal | Exponent, Inc.                                         |
| ✓ | <b>Nathan Weyandt*</b>           | Principal | Southwest Research Institute                           |
| ✓ | <b>Steven Wheaton</b>            | Principal | Choshu Industry Corporation of America, Inc.           |
| ✓ | <b>Justin Alexander Williams</b> | Principal | UT-Battelle/Oak Ridge National Laboratory              |
| ✓ | <b>Thomas G. Witte*</b>          | Principal | Witte Engineered Gases                                 |
| ✓ | <b>Edgar Wolff Klammer</b>       | Principal | UL LLC                                                 |
| ✓ | <b>Giann C. Yang*</b>            | Principal | National Institute of Standards & Technology (NIST)    |
| ✓ | <b>Allen Adriani*</b>            | Alternate | Plug Power                                             |
| ✓ | <b>John Armstrong</b>            | Alternate | Dominion Energy                                        |
|   | <b>Jacquelyn Birdsall</b>        | Alternate | Toyota Engineering & Manufacturing North America, Inc. |
|   | <b>William P. Collins</b>        | Alternate | WPC Sol, LLC                                           |
|   | <b>Richard A. Craig</b>          | Alternate | Compressed Gas Association                             |
| ✓ | <b>Brian Ehrhart</b>             | Alternate | Sandia National Laboratories                           |
| ✓ | <b>Harri K. Kytomaa</b>          | Alternate | Exponent, Inc.                                         |
| ✓ | <b>Sunil Lakshmipathy</b>        | Alternate | JENSEN HUGHES                                          |
|   | <b>Josh Light</b>                | Alternate | Air Liquide                                            |
| ✓ | <b>Jennifer Morgan</b>           | Alternate | Shell Hydrogen                                         |
|   | <b>Kuldeep Prasad</b>            | Alternate | National Institute of Standards & Technology (NIST)    |
| ✓ | <b>Alexandra Schluneker*</b>     | Alternate | Southwest Research Institute                           |
| ✓ | <b>LaTanya Schwalb*</b>          | Alternate | UL Solutions                                           |

### **Guests:**

Dan Gowin  
Amy Ryan  
David Cornish  
Jennifer Hamilton  
Mark Stelzel  
Marina Miletic  
Dan Johns  
Dan Ertl

THINKtECH  
Toyota  
Engineering Procurement & Construction, LLC  
California Hydrogen Business Council  
Nel Hydrogen  
Sandia Labs

Jordan Sintin

Melissa Sui-hui Louie

Franklin Switzer

Gary Stottler

Sandia Labs

NFPA 86 Committee Chair

Stottler Development, LLC

\*Participated by teleconference

Total number in attendance: 70

**NFPA 2**  
*Hydrogen Technologies Code*  
(F2025)

Task Group Reports

## NFPA 2 - Hydrogen Generation Systems Task Group Report

|            |                                                                                                                                                                                                                                                                                                 |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DOC #      | 2                                                                                                                                                                                                                                                                                               |
| TG #/NAME  | Hydrogen Generation Systems                                                                                                                                                                                                                                                                     |
| TG CHAIR   | Stephen Goyette                                                                                                                                                                                                                                                                                 |
| TG MEMBERS | Larry Moulthrop, Larry Danner, Bryan Gordon, Paul Coco, Sara Marxen, Bob Boyd, Bill Collins, Chris McWhinney, David Cornish, Jessica Robertson*, Elizabeth Krasowski, Steven Delmonaco, Michael Ciotti, Carl Rivkin, Marty Gresho, Dave Cherkowsy*, and Andrew Markle*<br>*Non-committee member |

Commented [SG1]: Check roster. Missing both Larrys, etc.

| COMBINED MOTIONS |                                                                                  |                                       |                                                                                                                                                                                                                                        |
|------------------|----------------------------------------------------------------------------------|---------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| #                | SECTION(s)                                                                       | Public Input #(s)                     | PROPOSED MOTION:<br>Create a First Revision to:                                                                                                                                                                                        |
| 1                | 13.1.1.1                                                                         | 125                                   | Expand scope the scope of Chapter 13 to include larger hydrogen generators.                                                                                                                                                            |
| 2                | 13.1.1.1.1,<br>13.2.1.1,<br>13.2.2,<br>New Section after 13.3.1.1,<br>(A.13.2.1) | 126,<br>128,<br>129,<br>137,<br>(127) | Expand the scope of Chapter 13 to include hydrogen generator modules.<br><br>Note: PI127 also adds modules but that is not the main point of that PI.                                                                                  |
| 3                | A.13.2.1                                                                         | 127                                   | Correct the information in Annex A regarding what types of hydrogen generators are addressed by this section.                                                                                                                          |
| 4                | 13.2.2.1                                                                         | 130                                   | Make editorial changes to use consistent terminology throughout Chapter 13.                                                                                                                                                            |
| 5                | 13.3.1 & A.13.3.1                                                                | 133 & 26<br>&<br>136 & 27             | Add CSA/ANSI B22734 for electrolyzers.                                                                                                                                                                                                 |
| 6                | New Section after 13.3.1.1                                                       | 134 & 135                             | Address types of electrolyzers that are outside the scope of ISO 22734 & CSA/ANSI B22734.                                                                                                                                              |
| 7                | 13.3.2.5,<br>New Section after 13.3.2.5                                          | 138,<br>139                           | Add requirements for hydrogen and oxygen vent terminations for electrolyzers.<br><br>Note: PI138 was not submitted by the Chapter 13 TG but it is related.                                                                             |
| 8                | New Section after 13.3.2.5                                                       | 140 & 141,<br>142 & 143               | Add exception to fire barrier requirements between listed electrolyzers or modules.                                                                                                                                                    |
| 9                | 13.4.1 & A.13.4.1                                                                | 144 & 24<br>&<br>147 & 25             | Add CSA FC 5 for reformers.                                                                                                                                                                                                            |
| 10               | 13.5.3.1,<br>A.13.5.2.3,<br>13.5.3.10.3.2                                        | 145,<br>148,<br>146 & 3               | Correct grammar, clarify application, and expand flame detector types to include all radiant energy types in the gasifier section.<br><br>Note: PI3 was not submitted by the Chapter 13 TG but it addresses the same section as PI146. |
| 11               | 3.3.7.1                                                                          | 149                                   | Correct definition of Control Area.                                                                                                                                                                                                    |

NFPA 2 - Hydrogen Generation Systems Task Group Report

| COMBINED MOTIONS |                             |                   |                                                                                                                                            |
|------------------|-----------------------------|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| #                | SECTION(s)                  | Public Input #(s) | PROPOSED MOTION:<br>Create a First Revision to:                                                                                            |
| 12               | 6.5.1 & A.6.5.1,<br>6.5.1.1 | 122 & 124,<br>123 | Align piping requirements with ASME / remove reference to IFGC.<br><br><b>Note: These PIs are preferred over PIs # 52, 190, &amp; 308.</b> |
| 13               | New Section after 13.2.5    | 131 & 132         | Make the piping requirements appropriate for hydrogen generators.<br>(Only if PIs 122 – 124 are NOT accepted)                              |

NFPA 2 - Hydrogen Generation Systems Task Group Report

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 6.5.1<br>A.6.5.1       | 122<br>124                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Create First Revision                                                  |
| PI TEXT                | <p><b>6.5.1* Piping Systems.</b><br/>Piping, tubing, valves, and fittings shall be designed and installed in accordance with applicable sections of ASME B31, <i>Code for Pressure Piping</i>, 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.</p> <p><del><b>A.6.5.1</b></del><br/>Any reference to listed or approved equipment in the noted sections of the IFGC is within the context of ASME B31.12, <i>Hydrogen Piping and Pipelines</i>, and describes a material or component that conforms to the specifications integral to ASME B31.12.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                        |
| PROPOSED REVISION (FR) | <p><b>6.5.1* Piping Systems.</b><br/>Piping, tubing, valves, and fittings shall be designed and installed in accordance with applicable sections of ASME B31, <i>Code for Pressure Piping</i>, 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 <a href="#">for hydrogen service</a>.</p> <p><del><b>A.6.5.1</b></del><br/>Any reference to listed or approved equipment in the noted sections of the IFGC is within the context of ASME B31.12, <i>Hydrogen Piping and Pipelines</i>, and describes a material or component that conforms to the specifications integral to ASME B31.12.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                        |
| PROPOSED STATEMENT     | <p><u>PI122:</u><br/>Piping systems for hydrogen systems should be designed and constructed to minimize the likelihood of a release (leak). Welded connections are generally considered the best way to achieve this, however, they are not always practical.</p> <p>In addition, many types of hydrogen systems include piping for fluids other than hydrogen. For example, electrolyzer based hydrogen generators include piping for water and reformer-based hydrogen generators often include piping for natural gas.</p> <p>The Code for Pressure Piping, ASME B31, addresses the design, fabrication, assembly, and testing of piping systems for all types of fluid including hydrogen. ASME B31.12, <i>Hydrogen Piping and Pipelines</i>, addresses piping system for hydrogen in particular.</p> <p>ASME B31 has been used successfully in hydrogen systems for many decades. And, many product safety standards for hydrogen equipment such as CSA FC 1 for fuel cells and CSA/<a href="#">ANSI</a> B22734 for electrolyzers refer specifically to ASME B31.</p> <p><a href="#">There is a contradiction between the International Fuel Gas Code (IFGC) and the American Society of Mechanical Engineers (ASME) B31 piping codes in the pressure testing requirements of hydrogen systems for high-pressure applications. The contradiction concerns the acceptable resultant hoop (circumferential) stress from a pneumatic or hydrostatic pressure test. The requirement in the IFGC is limiting and would require a lower test pressure</a></p> |                                                                        |

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| SECTION          | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|------------------|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 6.5.1<br>A.6.5.1 | 122<br>124     | Create First Revision                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|                  |                | <p><a href="#">and, in some cases, below the MAWP, where the B31 codes state that no test pressure reduction is required. B31 allows for testing up to the yield.</a></p> <p>Note: These standards and Codes such as NFPA 2 require additional safeguards to provide protection in the event of a release (leak). These include measures such as ventilation to dilute or remove the hydrogen, elimination of effective ignition sources, hydrogen detectors to initiate safety systems, etc. Hydrogen systems do not rely solely on piping for safety.</p> <p>The addition of the requirement to also meet sections of IFGC is both redundant and likely to cause confusion and possibly reduced safety as it has prohibitions and exceptions that are difficult to navigate.</p> <p>And, the limitations of the IFGC sections are not appropriate for the piping for other fluids used in hydrogen systems and conflict with standard practices for that piping.</p> <p>Finally, hydrogen is very often not used as a fuel gas which brings into doubt the applicability of any part of the IFGC.</p> <p>Referencing ASME B31 is both necessary <u>and sufficient</u>.</p> <p><u>PI124:</u><br/>. If reference to IFGC is removed from 6.5.1 as proposed, this Annex A information is no longer applicable.</p> |

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 6.5.1.1                | 123                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Create First Revision                                                  |
| PI TEXT                | <b>6.5.1.1</b><br>Prior to acceptance and initial operation, all piping installations shall be inspected and pressure tested in accordance with ASME B31, <i>Code for Pressure Piping</i> , <del>and Section 705 of the ICC-International Fuel Gas Code (IFGC).</del>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                        |
| PROPOSED STATEMENT     | <p><b>Note: TG13 prefers this PI123 over PI52, PI190, &amp; PI308.</b></p> <p><b>Note:</b> The problem statement &amp; rationale are the same as for PI122:</p> <p>Piping systems for hydrogen systems should be designed and constructed to minimize the likelihood of a release (leak). Welded connections are generally considered the best way to achieve this, however, they are not always practical.</p> <p>In addition, many types of hydrogen systems include piping for fluids other than hydrogen. For example, electrolyzer based hydrogen generators include piping for water and reformer-based hydrogen generators often include piping for natural gas.</p> <p>The Code for Pressure Piping, ASME B31, addresses the design, fabrication, assembly, and testing of piping systems for all types of fluid including hydrogen. ASME B31.12, Hydrogen Piping and Pipelines, addresses piping system for hydrogen in particular.</p> <p>ASME B31 has been used successfully in hydrogen systems for many decades. And, many product safety standards for hydrogen equipment such as CSA FC 1 for fuel cells and CSA/ANSI B22734 for electrolyzers refer specifically to ASME B31.</p> <p>Note: These standards and Codes such as NFPA 2 require additional safeguards to provide protection in the event of a release (leak). These include measures such as ventilation to dilute or remove the hydrogen, elimination of effective ignition sources, hydrogen detectors to initiate safety systems, etc. Hydrogen systems do not rely solely on piping for safety.</p> <p>The addition of the requirement to also meet sections of IFGC is both redundant and likely to cause confusion and possibly reduced safety as it has prohibitions and exceptions that are difficult to navigate.</p> <p>And, the limitations of the IFGC sections are not appropriate for the piping for other fluids used in hydrogen systems and conflict with standard practices for that piping.</p> <p>Finally, hydrogen is very often not used as a fuel gas which brings into doubt the applicability of any part of the IFGC.</p> |                                                                        |

| SECTION | Public Input #                                                                                                                                                                                                                                     | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 6.5.1.1 | 123                                                                                                                                                                                                                                                | Create First Revision                                                  |
|         | <p>Referencing ASME B31 is both necessary <u>and sufficient</u>.</p> <p><b>Note:</b> PI152 adds a similar requirement for fuel cell power systems – proposed new section 12.2.2.</p> <p><b>Note:</b> If PI122 is adopted, PI152 is not needed.</p> |                                                                        |

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| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 13.1.1.1.1             | 125                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Create First Revision                                                  |
| PI TEXT                | <b>13.1.1.1.1</b><br>This chapter shall apply to permanently installed hydrogen generation systems with rated capacity to generate greater than <del>1.3 oz/hr (36 g/hr)</del> but less than <del>220 lb/hr (100 kg/hr)</del> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                        |
| PROPOSED STATEMENT     | <p>There are 2 parts to this PI:</p> <p>1. The first part deletes the 1.3 oz/hr. It is not clear if this was meant to be mass, weight, or volume and could be misinterpreted as fluid ounces. And, no one in the hydrogen generation industry uses these units. Industry practice is to use the mass flow units.</p> <p>2. The second part deletes the upper limit. <del>This</del> <u>The upper</u> limit was originally based on the largest known "industrial" hydrogen generators at the time that this chapter was first written. The intent was to exclude hydrogen generation facilities such as refineries that are typically outside the scope of NFPA codes &amp; standards. In recent years hydrogen generators for "industrial" and similar applications have grown significantly in size. Many are now hydrogen production plants or facilities. These are designed and built using the same principles as the other hydrogen generators in Chapter 13 so, the requirements of Chapter 13 should apply to these larger hydrogen generators as well. Also, the hydrogen generator standards referenced in Chapter 13 do not have upper limits on size or production; this change aligns Chapter 13 with those standards.</p> <p>If the upper limit is not removed, there would be <u>no</u> specific requirements for these larger hydrogen generators.</p> |                                                                        |

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| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 13.1.1.1.1             | 126                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Create First Revision                                                  |
| PI TEXT                | <b>13.1.1.1.1</b><br><del>Systems that generate hydrogen in excess of the quantity indicated in 13.1.1.1 shall be constructed, installed, and operated in accordance with nationally recognized standards. This chapter shall also apply to permanently installed hydrogen generation modules with rated capacity to generate greater than 36 g/hr.</del>                                                                                                                                                                                                                                                                                                                                                                      |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                        |
| PROPOSED STATEMENT     | <p>There are 2 parts to this PI:</p> <ol style="list-style-type: none"> <li>1. This original text was related to hydrogen generators with production rates higher than the upper limit in 13.1.1.1. Since the upper limit is being removed (PI125), the original text in this section is no longer needed.</li> <li>2. A recent trend in hydrogen generation is the manufacturing and supply of hydrogen generation modules. These modules are subsets of complete hydrogen generators. They typically consist of one or more cell stacks, some related piping, and potentially some environmental control equipment such as heaters or HVAC equipment. Therefore, these modules should be addressed in Chapter 13.</li> </ol> |                                                                        |

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| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| A.13.2.1               | 127                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Create First Revision                                                  |
| PI TEXT                | <p><b>A.13.2.1</b><br/> <del>The equipment referenced is intended to include stationary applications and generation of hydrogen from portable or transportable hydrogen generation equipment. It does not include hydrogen production facilities intended to produce hydrogen used for distribution or repackaging operations operated by gas producers, distributors, and repackagers.</del></p> <p>Where the listing of the hydrogen generator already addresses the requirements in specific sections of Chapter 6 and/or 7, the provisions of those specific sections do not need to be applied. Many of these sections typically are not relevant for small hydrogen generation equipment. For generators in unoccupiable enclosures, the enclosure is typically not considered to be a building.</p>                         |                                                                        |
| PROPOSED REVISION (FR) | <p><b>A.13.2.1</b><br/> <del>The equipment referenced is intended to include stationary applications and generation of hydrogen from portable or transportable hydrogen generation equipment. It does not include hydrogen production facilities intended to produce hydrogen used for distribution or repackaging operations operated by gas producers, distributors, and repackagers.</del></p> <p>Where the listing of the hydrogen generator <u>system or module</u> already addresses the requirements in specific sections of Chapter 6 and/or 7, the provisions of those specific sections do not need to be applied. Many of these sections typically are not relevant for small hydrogen generation equipment. For generators in unoccupiable enclosures, the enclosure is typically not considered to be a building.</p> |                                                                        |
| PROPOSED STATEMENT     | <p>The first paragraph of A13.2.1 contradicts the application statement at the beginning of Chapter 13; see 13.1.1. For example, Chapter 13 applies only to permanently installed hydrogen generators not portable or transportable hydrogen generators and it may include hydrogen production operated by gas producers, distributors, etc.<br/> <del>Therefore, this paragraph should be deleted.</del></p> <p>The addition of the word "system" in the second paragraph is an editorial change to use the same terminology as used in the rest of Chapter 13 i.e., "hydrogen generation systems" (<del>see also PI130</del>).</p> <p><del>The addition of "modules" in the second paragraph correlates with the addition of "modules" in 13.1.1.1.1; see the 2<sup>nd</sup> part of PI126.</del></p>                            |                                                                        |

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| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 13.2.1.1               | 128                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Create First Revision                                                  |
| PI TEXT                | <b>13.2.1.1</b><br>Listed or approved hydrogen <del>generators</del> <u>generator systems and modules</u> shall not be required to meet the requirements of Chapter 7 except as noted in this chapter.                                                                                                                                                                                                                                                                                   |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                   |                                                                        |
| PROPOSED STATEMENT     | This PI correlates with the addition of "modules" in 13.1.1.1.1; see the 2nd part of PI126: A recent trend in hydrogen generation is the manufacturing and supply of hydrogen generation modules. These modules are subsets of complete hydrogen generators. They typically consist of one or more cell stacks, some related piping, and potentially some environmental control equipment such as heaters or HVAC equipment. Therefore, these modules should be addressed in Chapter 13. |                                                                        |

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| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 13.2.2                 | 129                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Create First Revision                                                  |
| PI TEXT                | <b>13.2.2 Siting.</b><br>Hydrogen generation <del>system(s)</del> <u>systems and modules</u> shall be <del>installed</del> <u>installed</u> in accordance with the manufacturer's instructions.                                                                                                                                                                                                                                                                               |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                        |                                                                        |
| PROPOSED STATEMENT     | This PI correlates with the addition of "modules" in 13.1.1.1.1; see the 2nd part of PI126: A recent trend in hydrogen generation is the manufacturing and supply of hydrogen generation modules. These modules are subsets of complete hydrogen generators. They typically consist of one or more cell stacks, some related piping, and potentially some environmental control equipment such as heaters or HVAC equipment. These modules should be addressed in Chapter 13. |                                                                        |

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| SECTION                | Public Input #                                                                                                                                                         | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 13.2.2.1               | 130                                                                                                                                                                    | Create First Revision                                                  |
| PI TEXT                | <b>13.2.2.1</b><br>All safety-related controls for the installation of the hydrogen <del>generator</del> <a href="#">generation systems</a> shall comply with NFPA 79. |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                 |                                                                        |
| PROPOSED STATEMENT     | This is an editorial change to use the same terminology as used in the rest of Chapter 13 i.e., "hydrogen generation systems".                                         |                                                                        |

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| SECTION                     | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|-----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| New Section<br>after 13.2.5 | 131<br>132                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Create First Revision                                                  |
| PI TEXT                     | <p><b><u>13.2.6 Piping.</u></b><br/>Piping, valves, and fittings shall conform to ASME B31, Code for Pressure Piping.</p> <p><b><u>A.13.2.6 Piping</u></b><br/>Hydrogen generation systems include piping, valves, and fittings for other fluids in addition to hydrogen such as water for electrolyzers and natural gas for reformers. These systems use flanges and threaded connections that may be prohibited by Sections 704.1.2.3, 704.1.2.4, and 704.1.2.5 of the ICC International Fuel Gas Code (IFGC).</p> <p>ASME B31.12 specifically addresses piping for hydrogen and is referenced by hydrogen equipment standards internationally. ASME B31 is both necessary and sufficient piping code.</p> <p><u>Note: ASME B31.12 does not include the restrictions in the IFGC.</u></p>                                                                                                                                                                                                                         |                                                                        |
| PROPOSED<br>REVISION (FR)   | <p><b><u>13.2.6 Piping.</u></b><br/>Piping, valves, and fittings shall conform to ASME B31, Code for Pressure Piping.</p> <p><b><u>A.13.2.6 Piping</u></b><br/>Hydrogen generation systems include piping, valves, and fittings for other fluids in addition to hydrogen such as water for electrolyzers and natural gas for reformers. These systems use flanges and threaded connections that <del>could</del> may be prohibited by Sections 704.1.2.3, 704.1.2.4, and 704.1.2.5 of the ICC International Fuel Gas Code (IFGC).</p> <p>ASME B31.12 specifically addresses piping for hydrogen and is referenced by hydrogen equipment standards internationally. ASME B31 is both necessary and sufficient piping code.</p> <p><u>Note: It should be noted that ASME B31.12 does not include some of the restrictions in the IFGC.</u></p>                                                                                                                                                                        |                                                                        |
| PROPOSED<br>STATEMENT       | <p><b><u>PI131:</u></b><br/>NOTE: If PI122 is accepted, this PI is not needed.</p> <p>Piping systems for hydrogen systems should be designed and constructed to minimize the likelihood of a release (leak). Welded connections are generally considered the best way to achieve this, however, they are not always practical.</p> <p>In addition, many types of hydrogen systems include piping for fluids other than hydrogen. For example, electrolyzer based hydrogen generators include piping for water and reformer-based hydrogen generators often include piping for natural gas.</p> <p>The Code for Pressure Piping, ASME B31, addresses the design, fabrication, assembly, and testing of piping systems for all types of fluid including hydrogen. ASME B31.12, Hydrogen Piping and Pipelines, addresses piping system for hydrogen in particular.</p> <p>ASME B31 has been used successfully in hydrogen systems for many decades. And, many product safety standards for hydrogen equipment such</p> |                                                                        |

**Commented [HD2]:** From Staff: Not good code language. Recommend changing to language similar to below:

"It should be noted that ASME B31.12 the restrictions in the IFGC."

**Commented [HD3]:** From Staff: Not good code language. Recommend changing to language similar to below:

"It should be noted that ASME B31.12 the restrictions in the IFGC."

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| SECTION                     | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|-----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| New Section<br>after 13.2.5 | 131<br>132                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Create First Revision                                                  |
|                             | <p>as CSA FC 1 for fuel cells and CSA/ANSI B22734 for electrolyzers refer specifically to ASME B31.</p> <p>Note: These standards and Codes such as NFPA 2 require additional safeguards to provide protection in the event of a release (leak). These include measures such as ventilation to dilute or remove the hydrogen, elimination of effective ignition sources, hydrogen detectors to initiate safety systems, etc. Hydrogen systems do not rely solely on piping for safety.</p> <p>The addition of the requirement to also meet sections of IFGC is both redundant and likely to cause confusion and possibly reduced safety as it has prohibitions and exceptions that are difficult to navigate.</p> <p>And, the limitations of the IFGC sections are not appropriate for the piping for other fluids used in hydrogen systems and conflict with standard practices for that piping.</p> <p>Finally, hydrogen is very often not used as a fuel gas which brings into doubt the applicability of any part of the IFGC. Referencing ASME B31 is both necessary and sufficient.</p> <p><u>PI132:</u></p> <p>A.13.2.6 provides some of the reasoning for the addition of 13.2.6 and clarifies that it does not include the restrictions in the IFGC that are imbedded in 6.5.1.</p> |                                                                        |

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| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 13.3.1<br>A.13.3.1     | 133 & 26<br>&<br>136 & 27                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Create First Revision                                                  |
| PI TEXT                | <p><b>13.3.1* General.</b><br/>Water electrolyzers shall be <del>listed to</del> ISO 22734, <i>Hydrogen generators using water electrolysis process—Industrial, commercial, and residential applications</i>, or <del>approved</del> <a href="#">CSA B22734, Hydrogen generators using water electrolysis process—Industrial, commercial, and residential applications (ISO 22734, MOD)</a>.</p> <p><b>A.13.3.1</b><br/>Listing standards for water electrolyzers are available. The 2019 edition of ISO 22734, <i>Hydrogen generators using water electrolysis process—Industrial, commercial, and residential applications</i>, combines and supersedes the 2008 edition of ISO 22734-1, <i>Hydrogen generators using water electrolysis process—Part 1: Industrial and commercial applications</i>, and the 2011 edition of ISO 22734-2, <i>Hydrogen generators using water electrolysis process—Industrial, commercial, and residential applications</i>. CSA Group <del>is working in cooperation</del> with the Compressed Gas Association <del>regarding publishing the binational adoption of</del> ISO 22734 with US <del>deviations &amp; Canadian deviations as</del> <a href="#">CSA/ANSI B22734</a>.</p>                                                                                                                                                                                                                                                                    |                                                                        |
| PROPOSED REVISION (FR) | <p>13.3.1* -General.<br/>Water electrolyzers shall be listed <del>—</del> to ISO 22734, <i>Hydrogen generators using water electrolysis process—Industrial, commercial, and residential applications</i>, or <del>approved</del> <a href="#">CSA/ANSI B22734, Hydrogen generators using water electrolysis process—Industrial, commercial, and residential applications (ISO 22734, MOD)</a> <del>or approved</del>.</p> <p>A.13.3.1<br/>Listing standards for water electrolyzers are available. <a href="#">The 2023 edition of CSA/ANSI B22734, Hydrogen generators using water electrolysis process—Industrial, commercial, and residential applications, is a binational adoption with US deviations &amp; Canadian deviations of the identically titled ISO 22734.</a> The 2019 edition of ISO 22734, <i>Hydrogen generators using water electrolysis process—Industrial, commercial, and residential applications</i>, <del>combines and supersedes the 2008 edition of ISO 22734-1, Hydrogen generators using water electrolysis process—Part 1: Industrial and commercial applications, and the 2011 edition of ISO 22734-2, Hydrogen generators using water electrolysis process—Industrial, commercial, and residential applications.</del> <del>CSA Group is working in cooperation with the Compressed Gas Association regarding publishing the binational adoption of</del> <a href="#">ISO 22734 with US deviations &amp; Canadian deviations as CSA/ANSI B22734.</a></p> |                                                                        |
| PROPOSED STATEMENT     | <p><a href="#">PI 133:</a><br/>The binational, U.S. &amp; Canadian, adoption of ISO 22734, CSA/ANSI B22734 was published in 2023 and should replace the reference to ISO 22734. However, the Chapter 13 TG thinks it prudent to keep the ISO 22734 reference for one more code cycle to give users of this code time to make the transition to CSA/ANSI B22734 so, the proposal is simply to add CSA/ANSI B22734 for now.</p> <p><a href="#">PI136:</a><br/>The Annex A information for 13.3.1 was out of date. Updated to indicate that the binational adoption of ISO 22734 was published as CSA/ANSI B22734.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                        |

Commented [SG4]: Question for TG (from Steve Delmonaco):  
Do we want to include “or approved”?

Commented [SG5R4]: At first I thought not. However, it is not likely that large electrolyzer “plants” that essentially built on site will be able to be listed so, perhaps we should add “or approved” back in.

Note: We don’t have to do this at the First Revision; it could be done between First & Second Draft.

Commented [SG6R4]: Add “or approved”.

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| SECTION                       | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| New Section<br>after 13.3.1.1 | 134<br>135                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Create First Revision                                                  |
| PI TEXT                       | <p><b>13.3.1.2</b><br/>Water electrolyzers outside the scope of ISO 22734 and CSA B22734 such as solid oxide electrolyzers shall be approved to the applicable parts of those standards.</p> <p><b>A.13.3.1.2</b><br/>These electrolyzers that are excluded from ISO 22734 and CSA B22734 may have additional hazards such as high temperatures that must be addressed in addition to the applicable parts of ISO 22734 and CSA B22734.</p>                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                        |
| PROPOSED REVISION (FR)        | <p><b>13.3.1.2</b><br/>Water electrolyzers outside the scope of ISO 22734 and CSA/ANSI B22734 such as solid oxide electrolyzers shall be approved to the applicable parts of those standards.</p> <p><b>A.13.3.1.2</b><br/>These electrolyzers that are excluded from ISO 22734 and CSA/ANSI B22734 could<del>may</del> have additional hazards such as high temperatures that must be addressed in addition to the applicable parts of ISO 22734 and CSA/ANSI B22734.</p>                                                                                                                                                                                                                                                                                                                                                                    |                                                                        |
| PROPOSED STATEMENT            | <p><u>PI134:</u><br/>The scopes of ISO 22734 and CSA/ANSI B22734 do not include all technologies for water electrolyzers and specifically exclude some such as solid oxide electrolyzers. However, most of the requirements in ISO 22734 and CSA/ANSI B22734 <u>do</u> apply to those excluded electrolyzers and they should comply with those requirements.</p> <p>Note: The requirement proposed is that these excluded electrolyzers be approved to the applicable parts of the standards. This allows approval by an AHJ since these excluded electrolyzers cannot be certified ("listed") to ISO 22734 or CSA/ANSI B22734.</p> <p><u>PI135:</u><br/>This Annex A information explains that electrolyzers that are excluded from ISO 22734 and CSA/ANSI B22734 may have additional hazards that are not addressed in those standards.</p> |                                                                        |

Commented [A17]: Need to implement

Commented [A18]: Move to annex

## NFPA 2 - Hydrogen Generation Systems Task Group Report

| SECTION                       | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|-------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| New Section<br>after 13.3.1.1 | 137                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Create First Revision                                                  |
| PI TEXT                       | <b>13.3.1.3</b><br>Water electrolyzer modules shall be listed to CSA FC6 / CSA 62282-2-100 , Fuel cell technologies – Part 2-100: Fuel cell & water electrolysis modules – Safety or shall be in accordance with 13.3.1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                        |
| PROPOSED<br>REVISION (FR)     | <b>13.3.1.3</b><br>Water electrolyzer modules shall be listed to <a href="#">CSA FC6 62282-2-100 / CSA C22.2 No. 62282-2-100</a> <del>CSA FC6 / CSA 62282-2-100</del> , Fuel cell technologies – Part 2-100: Fuel cell & water electrolysis modules – Safety <del>-or shall-</del> be in accordance with 13.3.1, <a href="#">or approved</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                        |
| PROPOSED<br>STATEMENT         | Water electrolyzer modules may or may not be able to be certified ("listed") to ISO 22734 or CSA/ANSI B22734. In general, the modules do not contain many equipment subsections that are included in a full electrolyzer, and the modules cannot meet all the requirements of those standards. There is a standard specifically for fuel cell modules, CSA FC6 62282-2-100 / CSA C22.2 No. 62282-2-100, and the binational, U.S. & Canadian, adoption of this standard is being expanded to include water electrolyzer modules. (Water electrolyzers are essentially "fuel cells running backwards".) To ensure the safety of these modules they should at least be listed to the new standard, CSA FC6 62282-2-100 / CSA C22.2 No. 62282-2-100. <a href="#">CSA FC6 has not been issued yet and its publication is pending.</a> |                                                                        |

Commented [IA9]: Create CI

Commented [SG10]: Question for TG (from Steve Delmonaco):  
Do we want to include "or approved"?

Commented [SG11R10]: I think not. The modules are typically manufactured not assembled on site and listing is appropriate.

Commented [SG12R10]: Add "or approved".

| SECTION                       | Public Input #                                                                                                                         | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|-------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| New Section<br>after 13.3.2.5 | 138                                                                                                                                    | Create First Revision                                                  |
| PI TEXT                       | <b>13.3.2.5 Vent terminations</b><br>Vent terminations from hydrogen generation systems shall be in accordance with Section 6.17.      |                                                                        |
| PROPOSED REVISION (FR)        | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.] |                                                                        |
| PROPOSED STATEMENT            | Added title to subsection for clarity.<br>Note: This PI was not initially submitted for TG13, however, TG13 does agree with it.        |                                                                        |

Commented [AI13]: Need to implement

Commented [AI14R13]: Removed the title from 13.3.2.5

Commented [SG15]: Question for TG:  
Do you agree with PI138?

Commented [SG16R15]: Agreed.

| SECTION                       | Public Input #                                                                                                                                                                                                                                       | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| New Section<br>after 13.3.2.5 | 139                                                                                                                                                                                                                                                  | Create First Revision                                                  |
| PI TEXT                       | <b>13.3.2.5.1</b><br>Oxygen and inert gas vent terminations from water electrolysis systems shall be in accordance with EIGA 154/16 Safe Location of Oxygen and Inert Gas Vents.                                                                     |                                                                        |
| PROPOSED REVISION (FR)        | <b>13.3.2.5.1</b><br>Oxygen and inert gas vent terminations from water electrolysis systems shall be in accordance with EIGA 154/16 CGA P-8.7, Safe Location of Oxygen and Inert Gas Vents.                                                          |                                                                        |
| PROPOSED STATEMENT            | Electrolyzers produce oxygen in addition to hydrogen. They also may use inert gases. Requirements for vent terminations for these gases is needed to prevent hazards from being created from improper venting, were missing; this PI addresses that. |                                                                        |

Commented [AI17]: Need to implement

Commented [SG18]: Change to CGA P-8.7?

## NFPA 2 - Hydrogen Generation Systems Task Group Report

| SECTION                       | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
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| New Section<br>after 13.3.2.5 | 140<br>141                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Create First Revision                                                  |
| PI TEXT                       | <p><b>13.3.2.6*</b><br/>Listed multiple factory matched water electrolysis systems may be permitted without fire-rated separation between the water electrolysis systems.</p> <p><b>A.13.3.2.6</b><br/>It is not uncommon to construct larger water electrolysis systems using multiple factory-matched water electrolysis systems co-located adjacent to each other.</p> <p>Factory matched water electrolysis systems listed to CSA B22734 or ISO 22734 undergo a mandatory structured risk assessment to comply with these listing standards. Particular attention is given in this risk assessment to mitigating the hazards of process hydrogen and oxygen hazards within the equipment and to the installation environment. These listed systems are then validated and verified to apply multiple process safeguards and layers of protection that mitigate potential hazards associated with the process H2 and O2 volumes, so that fire-separation distance is not necessary.</p> <p>For example, these listed water electrolysis systems stop hydrogen and oxygen generation upon detection of leaks, overpressure, excessive temperature, and other critical process upset conditions, removing the source of H2 and O2. Further, these systems then typically vent the internal hydrogen and oxygen pressurized inventory to a safe area via process vent terminals. These measures are implemented before conditions can escalate into a loss of containment and a fire condition.</p> <p>Note: Requirements to apply fire separation distances from water electrolysis systems to gas storage and other exposures may still apply.</p>                                                                                                                                                                                                                                                                                                                                               |                                                                        |
| PROPOSED REVISION (FR)        | <p>[If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]</p> <p><b>13.3.2.6*</b><br/>Listed multiple factory matched water electrolysis systems <del>shall</del> <del>may</del> be <del>allowed</del> <del>permitted</del> without fire-rated separation between the water electrolysis <del>systems</del>.</p> <p><b>A.13.3.2.6</b><br/>It is not uncommon to construct larger water electrolysis systems using multiple factory-matched water electrolysis systems co-located adjacent to each other.</p> <p>Factory matched water electrolysis systems listed to CSA/ANSI B22734 or ISO 22734 undergo a mandatory structured risk assessment to comply with these listing standards. Particular attention is given in this risk assessment to mitigating the hazards of process hydrogen and oxygen hazards within the equipment and to the installation environment. These listed systems are then validated and verified to apply multiple process safeguards and layers of protection that mitigate potential hazards associated with the process <del>H2</del>-hydrogen and <del>O2</del>-oxygen volumes, so that fire-separation distance is not necessary.</p> <p>For example, these listed water electrolysis systems stop hydrogen and oxygen generation upon detection of leaks, overpressure, excessive temperature, and other critical process upset conditions, removing the source of <del>H2</del>-hydrogen and <del>O2</del>oxygen. Further, these systems then typically vent the internal hydrogen and oxygen pressurized inventory to a safe area via process vent terminals. These measures are implemented before conditions can escalate into a loss of containment and a fire condition.</p> <p>Requirements that apply fire separation distances from water electrolysis systems to gas storage and other exposures may still be applicable. <del>Note: Requirements to apply</del></p> |                                                                        |

**Commented [HD19]:** From Staff: Not good code language. Recommend changing to language similar to below:

"Requirements that apply fire separation distances from water electrolysis systems to gas storage and other exposures may still be applicable."

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| SECTION                       | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| New Section<br>after 13.3.2.5 | 140<br>141                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Create First Revision                                                  |
|                               | <del>fire separation distances from water electrolysis systems to gas storage and other exposures may still apply.</del>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                        |
| PROPOSED<br>STATEMENT         | <p><u>PI 140:</u></p> <p>It is not uncommon to construct larger water electrolysis systems using multiple, smaller, factory-matched water electrolysis systems co-located adjacent to each other. Factory matched water electrolysis systems listed to CSA/ANSI B22734 or ISO 22734 undergo a mandatory structured risk assessment to comply with these listing standards. Particular attention is given in this risk assessment to mitigating the hazards of process hydrogen and oxygen hazards within the equipment and to the installation environment. These listed systems are then validated and verified to apply multiple process safeguards and layers of protection that mitigate potential hazards associated with the process hydrogen and oxygen volumes, so that fire-separation distances between these water electrolysis systems is not necessary. For example, these listed water electrolysis systems stop hydrogen and oxygen generation upon detection of leaks, overpressure, excessive temperature, and other critical process upset conditions, removing the source of hydrogen and oxygen. Further, these systems then typically vent the internal, pressurized hydrogen and oxygen inventory to a safe area via process vent terminals. These measures are implemented before conditions can escalate into a loss of containment and a fire condition.</p> <p><u>PI141:</u></p> <p>This Annex A information explains the reasoning behind the exemption from fire-rated separation requirements between water electrolysis systems-. And, it notes that separation distances to storage or other exposures may still apply.</p> |                                                                        |

**Commented [HD20]:** From Staff: Not good code language. Recommend changing to language similar to below:

*"Requirements that apply fire separation distances from water electrolysis systems to gas storage and other exposures may still be applicable."*

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| SECTION                       | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| New Section<br>after 13.3.2.5 | 142<br>143                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Create First Revision                                                  |
| PI TEXT                       | <p><b>13.3.2.6.1</b><br/>Listed multiple factory matched water electrolysis modules may be permitted without fire-rated separation between the water electrolysis <del>modules</del>.</p> <p><b>A.13.3.2.6.1</b><br/>It is not uncommon to construct larger water electrolysis systems using multiple factory-matched water electrolysis modules co-located adjacent to each other.</p> <p>Factory matched water electrolysis modules listed to CSA FC6 / CSA 62282-2-100 undergo a mandatory structured risk assessment to comply with these listing standards. Particular attention is given in this risk assessment to mitigating the hazards of process hydrogen and oxygen hazards within the equipment and to the installation environment. These listed modules are then validated and verified to apply multiple process safeguards and layers of protection that mitigate <del>potentenal</del>potential hazards associated with the process H<sub>2</sub>-hydrogen and O<sub>2</sub>-oxygen volumes, so that fire-separation distance is not necessary.</p> <p>For example, these listed water electrolysis systems stop hydrogen and oxygen generation upon detection of leaks, overpressure, excessive temperature, and other critical process upset conditions, removing the source of H<sub>2</sub>-hydrogen and O<sub>2</sub>oxygen. Further, these systems then typically vent the internal hydrogen and oxygen pressurized inventory to a safe area via process vent terminals. These measures are implemented before conditions can escalate into a loss of containment and a fire condition.</p> <p>Note: Requirements to apply fire separation distances from water electrolysis modules to gas storage and other exposures may still apply.</p>                                                                                       |                                                                        |
| PROPOSED REVISION (FR)        | <p><b>13.3.2.6.1</b><br/>Listed multiple factory matched water electrolysis modules may be permitted without fire-rated separation between the water electrolysis modules.</p> <p><b>A.13.3.2.6.1</b><br/>It is not uncommon to construct larger water electrolysis systems using multiple factory-matched water electrolysis modules co-located adjacent to each other.</p> <p>Factory matched water electrolysis modules listed to CSA/ANSI B22734 or ISO 22734 or CSA FC6 62282-2-100 / CSA C22.2 No. 62282-2-100 undergo a mandatory structured risk assessment to comply with these listing standards. Particular attention is given in this risk assessment to mitigating the hazards of process hydrogen and oxygen hazards within the equipment and to the installation environment. These listed modules are then validated and verified to apply multiple process safeguards and layers of protection that mitigate <del>potentenal</del>potential hazards associated with the process H<sub>2</sub>-hydrogen and O<sub>2</sub>-oxygen volumes, so that fire-separation distance is not necessary.</p> <p>For example, these listed water electrolysis systems stop hydrogen and oxygen generation upon detection of leaks, overpressure, excessive temperature, and other critical process upset conditions, removing the source of H<sub>2</sub>-hydrogen and O<sub>2</sub>oxygen. Further, these systems then typically vent the internal hydrogen and oxygen pressurized inventory to a safe area via process vent terminals. These measures are implemented before conditions can escalate into a loss of containment and a fire condition.</p> <p>Requirements that apply fire separation distances from water electrolysis modules to gas storage and other exposures may still be applicable. <del>Note: Requirements to apply</del></p> |                                                                        |

**Commented [HD21]:** From Staff: Not good code language. Recommend changing to language similar to below:

*"Requirements that apply fire separation distances from water electrolysis systems to gas storage and other exposures may still be applicable."*

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| SECTION                       | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| New Section<br>after 13.3.2.5 | 142<br>143                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Create First Revision                                                  |
|                               | <del>fire separation distances from water electrolysis modules to gas storage and other exposures may still apply.</del>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                        |
| PROPOSED<br>STATEMENT         | <p><u>PI142:</u><br/>Note: This PI is similar to PI140 except that it is for modules rather than electrolyzers.</p> <p>It is not uncommon to construct larger water electrolysis systems using multiple, smaller, factory-matched water electrolysis modules co-located adjacent to each other. Factory matched water electrolysis modules listed to CSA/ANSI B22734 or ISO 22734 or <u>CSA FC6 62282-2-100 / CSA C22.2 No. 62282-2-100</u> undergo a mandatory structured risk assessment to comply with these listing standards. Particular attention is given in this risk assessment to mitigating the hazards of process hydrogen and oxygen hazards within the equipment and to the installation environment. These listed modules are then validated and verified to apply multiple process safeguards and layers of protection that mitigate potential hazards associated with the process hydrogen and oxygen volumes, so that fire-separation distance is not necessary. For example, these listed water electrolysis systems stop hydrogen and oxygen generation upon detection of leaks, overpressure, excessive temperature, and other critical process upset conditions, removing the source of hydrogen and oxygen. Further, these systems then typically vent the internal hydrogen and oxygen pressurized inventory to a safe area via process vent terminals. These measures are implemented before conditions can escalate into a loss of containment and a fire condition. Note: Requirements to apply fire separation distances from water electrolysis modules to gas storage and other exposures may still apply.</p> <p><u>PI 143:</u><br/>This Annex A information explains the rationale for the exemption to the requirement for fire-rated separation between water electrolysis modules. It also notes that separation distances to storage and other exposures may still apply.</p> |                                                                        |

**Commented [HD22]:** From Staff: Not good code language. Recommend changing to language similar to below:

*"Requirements that apply fire separation distances from water electrolysis systems to gas storage and other exposures may still be applicable."*

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| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 13.4.1<br>A.13.4.1     | 144 & 24<br>&<br>147 & 25                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Create First Revision                                                  |
| PI TEXT                | <b>13.4.1* General.</b><br>Reforming-based hydrogen generators shall be listed or approved to ISO 16110-1, <a href="#">CSA/ANSI FC 5, Hydrogen generators using fuel processing technologies — Part 1: Safety (Adopted ISO 16110-1:2007, first edition, 2007-03-15, with U.S. deviations)</a> .<br><br><del><b>A.13.4.1</b></del><br><del>CSA Group is working with the Compressed Gas Association regarding the adoption of ISO 16110-1, Hydrogen Generators Using Fuel Processing Technologies — Part 1: Safety, with US deviation.</del>                                  |                                                                        |
| PROPOSED REVISION (FR) | <b>13.4.1* General.</b><br>Reforming-based hydrogen generators shall be listed <del>or approved</del> to ISO 16110-1, <del>or</del> CSA/ANSI FC 5, Hydrogen generators using fuel processing technologies — Part 1: Safety (Adopted ISO 16110-1 :2007, first edition, 2007-03-15, with U.S. deviations) <del>or approved</del> .<br><br><del><b>A.13.4.1</b></del><br><del>CSA Group is working with the Compressed Gas Association regarding the adoption of ISO 16110-1, Hydrogen Generators Using Fuel Processing Technologies — Part 1: Safety, with US deviation.</del> |                                                                        |
| PROPOSED STATEMENT     | <u>PI144:</u><br><br>The U.S. adoption of ISO 16110-1, CSA/ANSI FC 5, was published in 2007. The intent was always to replace the ISO standard with the CSA/ANSI standard when it became available.<br><br><u>PI147:</u><br><br>The adoption of ISO 16110-1 as CSA/ANSI FC 5 has been complete for several years; this Annex A information is no longer needed.                                                                                                                                                                                                              |                                                                        |

Commented [SG23]: Global comment: "Or approved" should be after the standard so it is listed to the standard or approved (by the AHJ).

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| SECTION                | Public Input #                                                                                                                                                                                                                                                                              | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 13.5.3.1               | 145                                                                                                                                                                                                                                                                                         | Create First Revision                                                  |
| PI TEXT                | <b>13.5.3.1* Conditioning Equipment.</b><br><del>Gasification</del> For gasification systems <del>contain</del> <del>containing</del> conditioning equipment to cool and scrub the gas prior to delivery as a fuel; the conditioning equipment shall comply with 13.5.3.1.1 and 13.5.3.1.2. |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                      |                                                                        |
| PROPOSED STATEMENT     | This is an editorial change to fix a grammatical error and clarify that this requirement only applies to gasification systems that include conditioning equipment.                                                                                                                          |                                                                        |

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                        | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| A.13.5.2.3             | 148                                                                                                                                                                                                                                                                                                   | Create First Revision                                                  |
| PI TEXT                | <b>A.13.5.2.3</b><br>Protection can either be integral <del>to the hydrogen generator gasifier</del> <del>the gasifier system</del> (e.g., locked enclosures, guards, and so on), or <del>the hydrogen generator gasifier</del> <del>the gasifier</del> can be installed in a controlled-access area. |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                |                                                                        |
| PROPOSED STATEMENT     | Editorial changes to improve clarity. Section 13.5 is specific to gasifier systems and does not apply generally to all hydrogen generators. Text was changed to indicate this specificity.                                                                                                            |                                                                        |

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 13.5.3.10.3.2          | 146 <a href="#">[&amp; 3]</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Create First Revision                                                  |
| PI TEXT                | <b>13.5.3.10.3.2</b><br>Ultraviolet/infrared (UV/IR) <del>or Multi-spectrum Infrared (MIR)</del> flame detection shall be provided in the vicinity of the gasifier vessel and all downstream equipment in which the gas temperature exceeds 80 percent of the lowest autoignition temperature of a contained constituent that exceeds 3 percent of the gas mix by volume.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                        |
| PROPOSED REVISION (FR) | <b>13.5.3.10.3.2</b><br>Ultraviolet/infrared (UV/IR) or Multi-spectrum Infrared (MIR) flame detection shall be provided in the vicinity of the gasifier vessel and all downstream equipment in which the gas temperature exceeds 80 percent of the lowest autoignition temperature of a contained constituent that exceeds 3 percent of the gas mix by volume.<br><br><u><a href="#">A.13.5.3.10.3.2</a></u><br><u>The historical detection technology for hydrogen flames is Ultraviolet (UV) or Ultraviolet/Infrared (UV/IR). These systems are susceptible to "false detection" due to sun light, either direct or reflected, and other sources such as welding and activities that result in sparks. In recent years, a Multi-Spectrum IR (MIR) technology has been developed that reduces the potential for false alarms. Multi-spectrum InfraRed (MIR) detectors are a newer technology that can be considered as an alternative to the traditional UV/IR detectors. Additionally, detectors that are specific to the fuel being burned (e.g., natural gas, hydrogen, etc.) are available and some detectors are capable of selectively detecting fires from various fuels.</u> |                                                                        |
| PROPOSED STATEMENT     | Hydrogen flame detection is not limited to UVIR technology <u>and has been expanded to include all types of fire detection</u> . Multispectrum infrared detectors are also                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                        |

**Commented [SG24]:** PI3 for 13.5.3.10.3.2: Ultraviolet/infrared (UV/IR) flame Radiant energy-sensing flame detection shall be provided in the vicinity of the gasifier vessel and all downstream equipment in which the gas temperature exceeds 80 percent of the lowest autoignition temperature of a contained constituent that exceeds 3 percent of the gas mix by volume.

**Substantiation:**  
Hydrogen flame detection is not limited to UVIR technology. Multispectrum infrared detectors are also capable of detecting Hydrogen flames and typically at greater distances. If the detector is listed for hydrogen flame detection by an accredited NRTL, it should be allowed to be used for the protection of hydrogen gasifier units.

**Commented [SG25R24]:** Stay with original PI for main body and add modified Annex A.

**Commented [SG26]:** Question for TG: Should we add this proposed Annex A text suggested by Larry Danner? (Copy of text proposed for Chapter14; see PI224.)

**Commented [SG27R26]:** Stay with original PI for main body and add modified Annex A.

## NFPA 2 - Hydrogen Generation Systems Task Group Report

| SECTION       | Public Input #                                                                                                                                                                                                                        | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 13.5.3.10.3.2 | 146 <a href="#">&amp; 3</a>                                                                                                                                                                                                           | Create First Revision                                                  |
|               | capable of detecting Hydrogen flames and typically at greater distances. If the detector is listed for hydrogen flame detection by an accredited NRTL, it should be allowed to be used for the protection of hydrogen gasifier units. |                                                                        |

| SECTION                | Public Input #                                                                                                                                                                                                                                                                               | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
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| 3.3.7.1                | 149                                                                                                                                                                                                                                                                                          | Create First Revision                                                  |
| PI TEXT                | <b>3.3.7.1 Control Area.</b><br>A building or portion of a building or outdoor area within which hazardous materials are allowed to be stored, dispensed, used, or handled <del>in quantities not exceeding the MAQ.</del><br><del>{400, 2022}</del>                                         |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                       |                                                                        |
| PROPOSED STATEMENT     | The last part of the definition, "in quantities not exceeding the MAQ", conflicts with 6.1.1.5 & 6.4.1.1.1. Also, definitions are not allowed to include requirements.<br>Note: NFPA 520 has a similar definition: "An area within a building for storage and use of high-hazard materials." |                                                                        |

**Commented [SG24]:** PI3 for 13.5.3.10.3.2: ~~Ultraviolet/infrared (UV/IR) flame~~ Radiant energy-sensing flame detection shall be provided in the vicinity of the gasifier vessel and all downstream equipment in which the gas temperature exceeds 80 percent of the lowest autoignition temperature of a contained constituent that exceeds 3 percent of the gas mix by volume.

**Substantiation:**  
 Hydrogen flame detection is not limited to UVIR technology. Multispectrum infrared detectors are also capable of detecting Hydrogen flames and typically at greater distances. If the detector is listed for hydrogen flame detection by an accredited NRTL, it should be allowed to be used for the protection of hydrogen gasifier units.

**Commented [SG25R24]:** Stay with original PI for main body and add modified Annex A.

## NFPA 2 - Fueling Task Group Report

| DOC #                       | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                        |
|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| TG #/NAME                   | Fueling                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                        |
| TG CHAIR                    | David Farese                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                        |
| TG MEMBERS                  | Bryan Gordon, Tim Brown, David Farese, Jennifer Hamilton*, Brian Ladds, William Collins, David Cornish, Steven Hoffman, Gary Stottler*, Marty Gresho, Robert Boyd, Ian Monk, Dan Hunter, Carl Rivkin, Montgomery Jay Sinisi*, Amy Ryan*, and Robert Davidson*<br>*Non-committee member                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                        |
| SECTION                     | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
| New Section<br>A.10.5.1.5.1 | 161                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Create First Revision                                                  |
| PI TEXT                     | <p><b><u>A.10.5.1.5.1</u></b><br/> <u>SAE J2601/5 High-Flow Prescriptive Fueling Protocols for Gaseous Hydrogen Powered Medium and Heavy-Duty Vehicles</u> is strongly recommended as the standard fueling protocol for heavy duty dispensers. This standard has been developed by the automotive and hydrogen industry, to ensure that the fueling protocol will not overheat, overpressurize, or overfill the vehicle fuel supply container. SAE J2601 provides methods of fueling fuel supply containers from 50 to 250 L at service pressures of 35 or 70 MPa. SAE J2601 assumes that the fuel systems and fuel supply containers meet the requirements in SAE J2578, Recommended Practice for General Fuel Cell Vehicle Safety, and SAE J2579, Standard for Fuel Systems in Fuel Cell and Other Hydrogen Vehicles. Vehicles not designed to these standards should not use public dispensers without appropriate review or safeguards. A default protocol is the protocol used to fuel a hydrogen vehicle without any action by the user or operator of the dispenser.</p>                                                                                                                                                                                                                                                                                                                                 |                                                                        |
| PROPOSED REVISION (FR)      | <p><b><u>A.10.5.1.5.1</u></b><br/> SAE <u>TIR J2601/5 High-Flow Prescriptive Fueling Protocols for Gaseous Hydrogen Powered Medium and Heavy-Duty Vehicles</u> establishes high flow fueling protocols, including their process limits, for fueling of compressed gaseous hydrogen vehicles at peak flow rates from 60 to 300 g/s with compressed hydrogen storage system (CHSS) volume capacities between 248.6 and 7500 L which have been qualified to UN GTR #13. <del>is strongly recommended as the standard fueling protocol for heavy duty dispensers.</del> This standard has been developed by the automotive and hydrogen industry, to ensure that the fueling protocol will not overheat, overpressurize, or overfill the vehicle fuel supply container. <del>SAE J2601 provides methods of fueling fuel supply containers from 50 to 250 L at service pressures of 35 or 70 MPa.</del> SAE J2601 assumes that the fuel systems and fuel supply containers meet the requirements in SAE J2578, Recommended Practice for General Fuel Cell Vehicle Safety, and SAE J2579, Standard for Fuel Systems in Fuel Cell and Other Hydrogen Vehicles. Vehicles not designed to these standards should not use public dispensers without appropriate review or safeguards. A default protocol is the protocol used to fuel a hydrogen vehicle without any action by the user or operator of the dispenser.</p> |                                                                        |

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| SECTION                     | Public Input #                                                                                                                                                                                                                                                                                                                                                                                           | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
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| New Section<br>A.10.5.1.5.1 | 161                                                                                                                                                                                                                                                                                                                                                                                                      | Create First Revision                                                  |
| PROPOSED<br>STATEMENT       | When the current version of NFPA2 was published, there were limited fueling protocols available for medium/heavy duty vehicles. As of February 2024, SAE published J2601/5 as a TIR and it provides a fast fueling protocol for H35 and H70 dispensers serving a wide range of buses, trucks, etc. CSA TS HGV 4.3.5 will be the accompanying standard which is used to validate SAE J2601/5 when issued. |                                                                        |

| SECTION                   | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
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| 10.3.1                    | 275                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <del>Choose Motion</del> Create First Revision                         |
| PI TEXT                   | <p><del>10.3.1 Design and Construction of Cylinders, Containers, and Tanks</del>General Design Considerations.</p> <p><b>10.3.1.1</b><br/>Components shall be designed, installed, or protected so their operation is not affected by freezing rain, sleet, snow, ice, mud, insects, or debris.</p> <p><b>10.3.1.2</b><br/>Cylinders, containers, and tanks shall be fabricated, installed, and maintained in accordance with Chapters 6, <u>7</u>, and <del>7</del>8 of this document.</p> |                                                                        |
| PROPOSED<br>REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                      |                                                                        |
| PROPOSED<br>STATEMENT     | <p>Changed title to General Design Considerations since current 10.3.1.1 does not match the previous title and does not address Cylinders, Containers, and Tanks. There is no need for a specific title that covers just one paragraph.</p> <p>Added Chapter 8 to 10.3.1.2 since LH2 can be used as a source of H2 for GH2 fuel stations.</p>                                                                                                                                               |                                                                        |

| SECTION                   | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
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| 10.3.2.1                  | 276                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Create First Revision                                                  |
| PI TEXT                   | <p><b>10.3.2.1</b><br/>Pressure relief devices <u>for protection of pressure vessels shall be</u> designed and installed in accordance with <del>10.6.3.1 shall be examined and tested in accordance with</del> the applicable requirements of the ASME <i>Boiler and Pressure Vessel Code</i>.</p>                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                        |
| PROPOSED<br>REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                        |
| PROPOSED<br>STATEMENT     | <p>Section 10.3 is for design, but refers to Section 10.6.3.1 which is for maintenance. This makes for a confusing duplicative and circular reference. This paragraph <del>should</del> only <u>applies</u> to design and installation, not for testing which is covered in 10.6.3.1. The revision concisely maintains the original requirement to meet the ASME BPV Code.</p> <p>The ASME BPV Code governs pressure vessel construction and the relief devices to protect those vessels. ASME B31 governs piping, so this revision clarifies that this requirement for compliance to ASME BPV is only required for pressure vessels. Devices that protect piping systems should meet the requirements of ASME</p> |                                                                        |

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| SECTION  | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                        |
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| 10.3.2.1 | 276            | Create First Revision                                                                                                                                                                                         |
|          |                | B31, which have different requirements. Otherwise, ASME BPV valves are prone to chatter and fail when installed to protect piping systems. <a href="#">See PI 277 for additional text to apply to piping.</a> |

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| SECTION                       | Public Input #  | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                                                                                                                                                                                                             |
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| New Section<br>after 10.3.2.1 | 277             | Create First Revision                                                                                                                                                                                                                                                                                                                                                                              |
| PI TEXT                       | <b>10.3.2.X</b> | Pressure relief devices for piping and dispensing systems shall meet the requirements of the ASME Pressure Piping Code B31.                                                                                                                                                                                                                                                                        |
| PROPOSED REVISION (FR)        |                 | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                             |
| PROPOSED STATEMENT            |                 | <a href="#">PI 276 modifies 10.3.2.1</a> . The text is modified to clarify that it applies the ASME BPV requirements for pressure vessels only. Pressure relief devices for piping systems should meet the requirements for relief systems in the B31 Piping Code, as referred to in this revision, and not the ASME BPV. Otherwise, relief valves for this purpose are prone to chatter and fail. |

| SECTION                | Public Input #     | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                                                                                                                                                                                                           |
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| 10.3.2.3               | 280                | Create First Revision                                                                                                                                                                                                                                                                                                                                                                            |
| PI TEXT                | <b>10.3.2.2.13</b> | The set pressure of the overpressure protection device for the dispensing system shall not exceed 138 percent of the <del>service</del> -nominal working pressure of the fueling nozzle it supplies.                                                                                                                                                                                             |
| PROPOSED REVISION (FR) |                    | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                           |
| PROPOSED STATEMENT     |                    | This existing paragraph is being moved to be a dependent paragraph under 10.3.2.2 since it further defines the requirement for the relief device.<br>Changed from "service" pressure which is defined as 70 F reference temperature to a new definition of "nominal working pressure" which is used within CSA and other standards for fuel containers that use 59 F as a reference temperature. |

| SECTION  | Public Input #    | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                           |
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| 10.3.2.6 | 281               | Create First Revision                                                                                                            |
| PI TEXT  | <b>10.3.2.6</b>   | Pressure relief valves for <del>GH<sub>2</sub></del> -hydrogen service shall not be fitted with lifting devices.                 |
|          | <b>10.3.2.6.1</b> | The adjustment, if external, shall be provided with a means for sealing the adjustment to resist tampering.                      |
|          | <b>10.3.2.6.2</b> | If at any time it is necessary to break such a seal, the valve shall be removed from service until it has been reset and sealed. |
|          | <b>10.3.2.6.3</b> |                                                                                                                                  |

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| SECTION                | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
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| 10.3.2.6               | 281            | Create First Revision                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|                        |                | Adjustments shall be made only by the manufacturer or other companies having competent personnel and facilities for the repair, adjustment, and testing of such valves.<br><b>10.3.2.6.4</b><br>The organization making such adjustment shall attach a permanent tag with the setting, capacity, and date.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| PROPOSED REVISION (FR) |                | <b>10.3.2.6</b><br>Pressure relief valves for <del>GH<sub>2</sub></del> -hydrogen service shall not be fitted with <u>manual seat</u> lifting devices.<br><b>10.3.2.6.1</b><br>The adjustment, if external, shall be provided with a means for sealing the adjustment to resist tampering.<br><b>10.3.2.6.2</b><br>If at any time it is necessary to break such a seal, the valve shall be removed from service until it has been reset and sealed.<br><b>10.3.2.6.3</b><br>Adjustments shall be made only by the manufacturer or other companies having <u>qualified competent</u> personnel and facilities for the repair, adjustment, and testing of such valves.<br><b>10.3.2.6.4</b><br>The organization making such adjustment shall attach a permanent tag with the setting, capacity, and date. |
| PROPOSED STATEMENT     |                | This is a generic restriction for all hydrogen (LH2 or GH2) relief valves and since LH2 systems may be used for supply to a GH2 dispensing system, it's better to broaden the applicability to "hydrogen" to cover both LH2 and GH2. <u>Qualified person is defined in the standard and the requirement is changing to use the defined term.</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

| SECTION                | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
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| 10.3.5.1               | 158            | Create First Revision                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| PI TEXT                |                | <b>10.3.5 Fuel Lines and Piping Systems.</b><br><b>10.3.5.1</b><br>Pipe, tubing, and fittings shall be suitable for hydrogen service and for maximum <del>pressures</del> and minimum <u>pressures, and maximum temperatures, and flow rates</u> . <del>Piping components in contact with hydrogen shall be compatible with hydrogen service conditions.</del><br><b>10.3.5.1.1</b><br>Cast, ductile, malleable, or high-silicon iron pipe, valves, and fittings shall not be used.<br><u><b>10.3.5.2</b></u><br><u>Piping components in contact with hydrogen shall be compatible with hydrogen service conditions.</u><br><b>10.3.5.3.2*</b><br>Hydrogen gas pipe, tubing, and fittings shall be designed, fabricated, and tested in accordance with ASME B31, <i>Code for Pressure Piping</i> . |
| PROPOSED REVISION (FR) |                | <b>10.3.5 Fuel Lines and Piping Systems.</b><br><b>10.3.5.1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

**Commented [DH1]:** From Staff: Should this section instead be 10.3.5.1.2?

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| SECTION            | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
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| 10.3.5.1           | 158            | Create First Revision                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|                    |                | <p>Pipe, tubing, and fittings shall be suitable for hydrogen service and for maximum <del>pressures</del> and minimum <del>pressures</del>, <del>and maximum</del> temperatures, <del>and flow rates</del>. <del>Piping components in contact with hydrogen shall be compatible with hydrogen service conditions.</del></p> <p><b>10.3.5.1.1</b><br/>Cast, ductile, malleable, or high-silicon iron pipe, valves, and fittings shall not be used.</p> <p><del>10.3.5.2</del><br/><del>Piping components in contact with hydrogen shall be compatible with hydrogen service conditions.</del></p> <p><b>10.3.5.3.2*</b><br/>Hydrogen gas pipe, tubing, and fittings shall be designed, fabricated, and tested in accordance with ASME B31, <i>Code for Pressure Piping</i>.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| PROPOSED STATEMENT |                | <p>The proper sizing of fuel lines is critical to hydrogen fueling systems because it impacts the pressure drop which, in turn, can cause overheating in the vehicle supply container (tank). The second half of 10.3.5.1 is a separate requirement and should be separated.</p> <p><del>Per SAE J2601, Section A.3.4:</del><br/><del>A.3.4 Pressure Drop in Fuel Line from Dispenser to Vehicle</del><br/><del>The pressure drop coefficient used for calculating the mass flow rate is calibrated from the reference pressure drop situation defined in 7.2. The pressure drop under reference conditions determines the value of the coefficient. A high pressure drop leads to two effects that both yield a higher CHSS gas temperature at the end of fueling: First, the fueling is delayed (i.e., the peak mass flow occurs at a later time). This consequently delays the temperature rise inside the CHSS and gives the gas less time to exchange heat with the internal liner surface. Secondly, more Joule-Thomson heating is introduced into the CHSS because a higher station pressure is required to generate a given mass flow rate, and the enthalpy of hydrogen fuel gas increases with pressure.</del></p> |

**Commented [DH2]:** From Staff: Should this section instead be 10.3.5.1.2?

| SECTION                | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                                                                                                                                                                                                                                                                     |
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| 10.3.6.5               | 282            | Create First Revision                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| PI TEXT                |                | <p><b>10.3.6.5</b><br/>The use of hose <del>for in-a</del> hydrogen <del>service</del> dispensing system shall be limited to vehicle fueling hose <del>for the supply of hydrogen or vent recovery, inlet connections to compression or pumping equipment, sections of hose not exceeding 6" in length in a pipeline to provide flexibility where necessary, and connection of hydrogen containers.</del></p>                                              |
| PROPOSED REVISION (FR) |                | <p><b>10.3.6.5</b><br/>The use of hose <del>for in-a</del> hydrogen <del>service in a</del> dispensing system shall be limited to vehicle fueling hose <del>for the supply of hydrogen or vent recovery, inlet connections to compression or pumping equipment, sections of hose not exceeding 186" in length in a pipeline to provide flexibility where necessary, and connection of hydrogen containers.</del></p>                                       |
| PROPOSED STATEMENT     |                | <p>The current language can be interpreted as excluding these other appropriate uses of hoses at hydrogen refueling stations. This language is also consistent with similar requirements in 11.3.6.1.5. The current language is also not limited to hydrogen so would also nominally prevent the use of hose for air/nitrogen and other gases used for other purposes. <u>The 18" length allows for installation of current breakaway connections.</u></p> |

## NFPA 2 - Fueling Task Group Report

| SECTION                         | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
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| New Section<br>after 10.3.6.5.1 | 283                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Create First Revision                                                  |
| PI TEXT                         | <b>10.3.6.5.2</b><br>Vehicle fuel hose length at motor fuel dispensing facilities shall not exceed 18'.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                        |
| PROPOSED<br>REVISION (FR)       | <b>10.3.6.5.2</b><br>Vehicle fuel hose length at motor fuel dispensing facilities shall not exceed 18'<br><u>unless safeguards are provided to protect the hose and surrounding exposures.</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                        |
| PROPOSED<br>STATEMENT           | There is no current limit on the length of vehicle fueling hose at motor fuel stations. From a hose safety and separation distance perspective, a maximum hose length is prudent. Breakaway function can also be negatively affected with a long hose that can easily be entangled or wrapped around adjacent equipment. A hose of 100' length could be used to dispenser hydrogen 100' from the applicable safeguards and required separation distances. 18' was chosen to be consistent with current Chapter 11 hose length restriction and is sufficient to fuel vehicles properly parked in front of a dispenser. NFPA 30 A currently limits fueling hose to 50' but the high pressure hydrogen hoses are of greater safety concern. |                                                                        |

| SECTION                   | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
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| 10.3.6.6.1                | 220                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Create First Revision                                                  |
| PI TEXT                   | <b>10.3.6.6.1</b><br>Such devices shall be arranged to separate using a force not greater than <del>150</del> 225 lb (667 <del>1000</del> N) when applied in any direction that the vehicle would move.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                        |
| PROPOSED<br>REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                        |
| PROPOSED<br>STATEMENT     | <p>Currently the breakaway separation force requirements in applicable national and international standards are inconsistent. A list of standards addressing the breakaway force, and the values currently specified, are as follows.</p> <p>NFPA 2: Breakaway separation 667<br/> ISO 19880-1:2020 Breakaway separation between 220 N and 1000 N<br/> ISO 19880-2* Breakaway separation between 220 N and 1000 N<br/> ISO 19880-3:2018 Breakaway separation between 220 N and 1000 N<br/> CSA HGV 4.4*:2013 Breakaway separation 667<br/> ISO 17268: 2020 Nozzle/Receptacle axial load 1000<br/> SAE J2600*: 2015 Nozzle/Receptacle axial load 1000<br/> SAE J2578: 2014 Drive-away protection force 668</p> <p><del>Industry representatives met and breakaway manufacturers indicated the separation force on the breakaway device can be set to a single range.</del> Station designers and operators noted that they can, and often do, specify a maximum separation force lower than the maximum specified in ISO standards. The value is within the range allowed by the ISO standards, and allows for protection of older equipment designed to 667 N maximum separation force. Therefore, there was agreement that industry would seek to harmonize the breakaway separation force requirements to be between 220 N minimum and 1000 N maximum, with the understanding that a station designer/operator could source breakaway devices set to any range within the stated minimum and maximum force.</p> |                                                                        |

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| SECTION    | Public Input #                                                                                                                                                                                                                           | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
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| 10.3.6.6.1 | 220                                                                                                                                                                                                                                      | Create First Revision                                                  |
|            | The inclusion of a minimum separation force is desired to avoid inadvertent separation where the force is well below the force necessary to cause damage to any of the equipment, including the dispenser, hose, and vehicle receptacle. |                                                                        |

| SECTION                         | Public Input #                                                                                                                                                                                                                                                                                          | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
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| New Section<br>after 10.3.6.6.2 | 284                                                                                                                                                                                                                                                                                                     | Create First Revision                                                  |
| PI TEXT                         | <b>10.3.6.7</b><br>Hose supports shall be constructed to prevent the hose from touching the ground if the hose is not protected from abrasion and damage by a sleeve or cover.                                                                                                                          |                                                                        |
| PROPOSED REVISION (FR)          | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                  |                                                                        |
| PROPOSED STATEMENT              | This language is in Chapter 11 and is prudent for Chapter 10 GH2 systems. Hose abrasion is a recognized concern and hose covers are a frequent safeguard deployed in most dispensing applications. It is important for the hose jacket to remain intact to prevent corrosion and weakening of the hose. |                                                                        |

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 10.3.7.1.1             | 285                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Create First Revision                                                  |
| PI TEXT                | <b>10.3.7.1.1</b><br>Shutoff valves shall have a <del>rated service design</del> pressure not less than the rated service pressure of the <del>entire system portion of the design dispensing system in which they are installed</del> and shall be designed with a minimum safety factor of 3.                                                                                                                                                                                                                                                                                                                                                                                               |                                                                        |
| PROPOSED REVISION (FR) | <b>10.3.7.1.1</b><br>Shutoff valves shall have a <del>rated service design</del> pressure not less than the rated service pressure of the <del>entire system portion of the design dispensing system</del> <u>hydrogen fueling station in which they are installed</u> and shall be designed with a minimum safety factor of 3.                                                                                                                                                                                                                                                                                                                                                               |                                                                        |
| PROPOSED STATEMENT     | Many stations have maximum operating pressures suitable for H70 service and this paragraph as currently written (i.e. "entire") would require all valves to be rated for H70 even if used on the H35 portion of the system.<br>Service pressure is not the correct term to use for this requirement for two reasons: 1) the normal maximum operating pressure of the systems is much higher than service pressure, and 2) service pressure is not defined properly for H2 systems. Design pressure is the term used within ASME B31 for piping systems and components. <u>Valves are designed to have a safety factor in them and reiteration of the safety factor is not necessary here.</u> |                                                                        |

| SECTION                | Public Input #                                                                                                                         | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 10.3.8                 | 288                                                                                                                                    | Create First Revision                                                  |
| PI TEXT                | <b>10.3.8</b><br><del>Transfer</del> <u>Dispensing</u> systems shall be capable of depressurizing to facilitate disconnection.         |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.] |                                                                        |

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| SECTION            | Public Input #                                                                                                                                                                                                                                                         | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 10.3.8             | 288                                                                                                                                                                                                                                                                    | Create First Revision                                                  |
| PROPOSED STATEMENT | Changing from "transfer" to "dispensing" to make language more consistent within this dispensing section of Chapter 10. "Transfer" commonly describes the movement of product from a delivery vehicle into a stationary system that then might be used for dispensing. |                                                                        |

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                 | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 10.3.13.5              | 289                                                                                                                                                                                                                                                                                                                                            | Create First Revision                                                  |
| PI TEXT                | <b>10.3.13.5</b><br>An emergency manual shutdown <a href="#">activation</a> device shall be provided at the dispensing area and also at a location remote from the dispensing area.                                                                                                                                                            |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                         |                                                                        |
| PROPOSED STATEMENT     | The current language is not clear and implies that the actual shutdown device (e.g. valve, disconnect, etc) must be at the dispensing area whereas the intent is that the activation device (e.g. button) used to initiate the shutdown system should be accessible. The actual shutdown device is often located at the remote equipment area. |                                                                        |

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 10.3.13.5.2            | 290                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Create First Revision                                                  |
| PI TEXT                | <del><b>10.3.13.5.2</b></del><br><del>When GH<sub>2</sub> is being produced from the conversion of LH<sub>2</sub>, the emergency shutdown system also shall shut off the liquid supply and power to the LH<sub>2</sub> transfer equipment necessary for the conversion process.</del>                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                        |
| PROPOSED STATEMENT     | Dispensing systems have emergency shutdown system requirements to adequately isolate individual dispensers from the supply system. The 10.3.13.5.1 paragraph immediately before this paragraph is an example. Conversion of LH <sub>2</sub> to GH <sub>2</sub> is an unrelated activity from dispensing and there is no need to stop the LH <sub>2</sub> to GH <sub>2</sub> conversion equipment to stop the flow of hydrogen to those individual dispensers. Most fuel stations have multiple, and frequently geographically dispersed, dispensers where it is unnecessary to shut off the common source to all dispensers, especially when dispensers are isolated with independent systems. |                                                                        |

| SECTION                | Public Input #                                                                                                                                                                                                                | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 10.3.13.7              | 291                                                                                                                                                                                                                           | Create First Revision                                                  |
| PI TEXT                | <b>10.3.13.7</b><br>The <a href="#">dispensing system</a> emergency shutdown system shall include an automatic emergency shutoff valve <del>at to isolate the source of</del> hydrogen <del>storage and supply system</del> . |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                        |                                                                        |
| PROPOSED STATEMENT     | The intent is to clarify that the intent of the automatic shutoff valve is to isolate the dispensing system from the hydrogen supply source. As written, the existing                                                         |                                                                        |

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| SECTION   | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                                                 |
|-----------|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10.3.13.7 | 291            | Create First Revision                                                                                                                                                                                                                  |
|           |                | language implies, but does not require, the automatic shutoff valve to isolate the hydrogen supply. The original "storage and supply system" wording is also vague and is better referred to as the "source" to broaden applicability. |

| SECTION                | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|------------------------|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10.4.5                 | 292            | Create First Revision                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| PI TEXT                |                | <p><b>10.4.5 System Testing.</b></p> <p><b>10.4.5.1*</b><br/>Hydrogen dispensing systems shall be leak tested after final installation <del>to prove them free from leaks at a pressure equal to at least the normal service pressure of that portion of the system.</del></p> <p><del><b>10.4.5.2</b></del><br/><del>This leak test shall be in addition to the</del> <a href="#">in accordance with</a> ASME B31, <i>Code for Pressure Piping</i>, testing required by 10.3.5.2.</p> <p><b>10.4.5.1.13</b><br/>Leakage shall not occur when tested <del>in accordance with the requirements of ASME B31, Code for Pressure Piping,</del> either pneumatically or hydrostatically. The test pressure shall be not less than 110 percent of the rated service pressure when tested pneumatically, using an inert gas as the medium, nor less than 150 percent of the rated service pressure when tested hydrostatically.</p> <p><b>10.4.5.2.4</b><br/><a href="#">The dispensing system shall also be leak tested using hydrogen prior to entering service to prove the system free from leaks at a pressure equal to at least the normal service pressure of that portion of the system. This leak test shall be in addition to the test required in 10.4.5.1.</a> <del>The assembly shall be leak tested using hydrogen.</del></p> <p><b>10.4.5.2.15*</b><br/>Where hydrogen is to be used as the leak test media, the system shall first be purged with an inert gas to ensure that all oxygen <del>content is reduced below 1 percent</del> <del>is removed.</del></p> |
| PROPOSED REVISION (FR) |                | <p><b>10.4.5 System Testing.</b></p> <p><b>10.4.5.1*</b><br/>Hydrogen dispensing systems shall be leak tested <a href="#">for mechanical integrity</a> after final installation <del>to prove them free from leaks at a pressure equal to at least the normal service pressure of that portion of the system.</del></p> <p><del><b>10.4.5.2</b></del><br/><del>This leak test shall be in addition to the</del> <a href="#">in accordance with</a> ASME B31, <i>Code for Pressure Piping</i>, testing required by 10.3.5.2.</p> <p><b>10.4.5.1.13</b><br/>Leakage shall not occur when tested <del>in accordance with the requirements of ASME B31, Code for Pressure Piping,</del> either pneumatically or hydrostatically.</p> <p><b>10.4.5.1.2</b> The test pressure shall be not less than 110 percent of the rated service pressure when tested pneumatically, using an inert gas as the medium, nor less than 150 percent of the rated service pressure when tested hydrostatically.</p> <p><b>10.4.5.2.4</b><br/><a href="#">The dispensing system shall also be leak tested using hydrogen prior to entering service to prove the system free from leaks at a pressure equal to at least the normal service pressure of that portion of the system.</a></p>                                                                                                                                                                                                                                                                                                        |

**Commented [DH3]:** From Staff: You cannot have multiple statements in a single section.

**Commented [DH4]:** From Staff: You cannot have multiple statements in a single section.

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| SECTION            | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|--------------------|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10.4.5             | 292            | Create First Revision                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|                    |                | <del>10.4.5.2.1 This leak test shall be in addition to the test required in 10.4.5.1. The assembly shall be leak tested using hydrogen.</del><br><br><b>10.4.5.2.1.5*</b><br>Where hydrogen is to be used as the leak test media, the system shall first be purged with an inert gas to ensure that all oxygen <del>content is reduced below 1 percent</del> <del>is removed</del> .                                                                                                                                                                                                        |
| PROPOSED STATEMENT |                | The order of the existing testing requirement is confusing and mixes the content of the two required leak tests: 1) Leak test to prove mechanical integrity and 2) Final leak check with hydrogen at maximum operating pressure.<br>Reordering the existing requirements makes it clear which requirements apply to each test. For example, 10.4.5.3 applies to the first test while 10.4.5.2 and 10.4.5.4 apply to the second test.<br>A minor change was made to require an O2 threshold of 1% instead of "all".<br>Per manual of style, 10.4.5.1.1 was split to two separate paragraphs. |

| SECTION                | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                          |
|------------------------|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10.2.3                 | 271            | Create First Revision                                                                                                                                           |
| PI TEXT                |                | <del>10.2.3</del><br><del>Vehicles shall not be considered a source of ignition with respect to the requirements of this chapter.</del>                         |
| PROPOSED REVISION (FR) |                | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                          |
| PROPOSED STATEMENT     |                | Material remains the same but relocate to 10.5.1.1.4.1 in the General section for Dispensing where it fits with other material on ignition sources. See PI 272. |

| SECTION                | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                                                                                     |
|------------------------|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10.2.4                 | 273            | Create First Revision                                                                                                                                                                                                                                                      |
| PI TEXT                |                | <del>10.2.4</del><br><del>Where an overpressure incident that results in operation of the overpressure protection system occurs, the dispenser pressure control system shall be examined and certified by a qualified technician prior to being returned to service.</del> |
| PROPOSED REVISION (FR) |                | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                     |
| PROPOSED STATEMENT     |                | This is a very specific requirement to have in section 10.2 and it's better aligned with related material as a new section 10.5.1.2.3.                                                                                                                                     |

| SECTION                  | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                                                                                                                                                                                                                                                                 |
|--------------------------|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10.5.1.1.1<br>10.5.1.1.2 | 159            | Create First Revision                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| PI TEXT                  |                | <b>10.5.1.1.1* Fueling Hose Integrity Tests.</b><br>Controllers on hydrogen dispensing systems shall be designed to verify the integrity of the fuel hose, breakaway, nozzle, <del>and receptacle by receptacle, and vehicle fuel system and fuel supply container. This shall be done by</del> pressurizing these components to at least the <del>vehicle back pressure and monitoring pressure in the fuel supply container and monitoring the</del> |

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| SECTION                  | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|--------------------------|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10.5.1.1.1<br>10.5.1.1.2 | 159            | Create First Revision                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|                          |                | <p>pressure decay over a period of <del>at least five seconds prior to the start of fueling time sufficient to determine if a leak is present.</del></p> <p><b>10.5.1.1.2</b><br/>Hydrogen dispensing integrity checks once the fueling event has started shall be as follows:</p> <ol style="list-style-type: none"> <li>(1) 350 bar fueling events shall have a second integrity check repeated at 80 to 90 percent of the dispenser nozzle <del>service-pressure-by stopping flow and checking the pressure decay over a period of five seconds.</del></li> <li>(2) 700 bar fueling events with a starting pressure of less than 200 bar shall have a second integrity test at 40 to 50 percent and third integrity test at 80 to 90 percent of the dispenser nozzle <del>service-pressure-by stopping flow and checking the pressure decay over a period of at least five seconds.</del></li> <li>(3) 700 bar fueling events with a starting pressure of greater than 200 bar shall have a second integrity test at 80 to 90 percent of the dispenser nozzle <del>service-pressure-by stopping flow and checking the pressure decay over a period of at least five seconds.</del></li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| PROPOSED REVISION (FR)   |                | <p><b>10.5.1.1.1* Fueling Hose Integrity Tests.</b><br/>Controllers on hydrogen dispensing systems shall be designed to verify the integrity of the fuel hose, breakaway, nozzle, <del>and receptacle by receptacle, and vehicle fuel system, and vehicle fuel supply container.</del></p> <p><u>A.10.5.1.1.1</u><br/>Medium and Heavy Duty (MD/HD) vehicles, Classes 5 to 8, will have large onboard storage systems. Dispensers designed to support MD and HD fueling will have the capability of fueling faster (5 to 10 kg per minute) than light duty vehicles (1-2 kg per minute). The time to equalize and stabilize the hose pressure between the stop valve in the dispenser and the vehicle tank(s) system to determine if there are leaks in the fueling hose assembly and onboard high pressure fuel delivery system can take more time than five seconds.</p> <p><del>10.5.1.1.2 This Verification of integrity shall be done by</del> pressurizing these components to at least the vehicle back pressure and monitoring pressure in the fuel supply container and monitoring the pressure decay prior to the start of the fueling process over a period of <del>at least five seconds prior to the start of fueling time sufficient to determine if a leak is present.</del></p> <p><b>10.5.1.1.2</b><br/>Hydrogen dispensing integrity checks once the fueling event has started shall be as follows:</p> <ol style="list-style-type: none"> <li>(1) 350 bar fueling events shall have a second integrity check repeated at 80 to 90 percent of the dispenser nozzle <del>nominal working service-pressure-by stopping flow and checking the pressure decay over a period of five seconds.</del></li> <li>(2) 700 bar fueling events with a starting pressure of less than 200 bar shall have a second integrity test at 40 to 50 percent and third integrity test at 80 to 90 percent of the dispenser nozzle <del>service-nominal working pressure-by stopping flow and checking the pressure decay over a period of at least five seconds.</del></li> <li>(3) 700 bar fueling events with a starting pressure of greater than 200 bar shall have a second integrity test at 80 to 90 percent of the dispenser nozzle <del>nominal working service</del></li> </ol> |

**Commented [DH5]:** From Staff: You cannot have multiple statements in a single section.

**Commented [AI6]:** 2115 scf=5 4230 scf=10

**Commented [AI7R6]:** 423 scf per kg for Hydrogen

**Commented [AI8]:** This is PI 71 and PI 72

**Commented [DH9]:** From Staff: You cannot have multiple statements in a single section.

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| SECTION                  | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|--------------------------|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10.5.1.1.1<br>10.5.1.1.2 | 159            | Create First Revision                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|                          |                | <del>pressure by stopping flow and checking the pressure decay over a period of at least five seconds.</del>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| PROPOSED STATEMENT       |                | <p>The changes in 10.5.1.1.1 clarify that the integrity test checks for leaks, not only in the hose assembly, but also the vehicle. The use of "back pressure" is not defined, but intended to be the pressure in the fuel supply container (i.e., vehicle tank per 3.3.50.2).</p> <p>The five second detection time was originally determined for light duty vehicle dispensers. Because larger vehicles with larger dispensing systems are entering the market place, the integrity test may require a longer time to determine if a leak is present. For the same sized leak and over the same time period, a system with a larger volume will have a smaller pressure drop compared to a system with a smaller volume. Changing the requirement to allow for different monitoring times will ensure that these systems will be able to find a leak.</p> <p>In 10.5.1.1.2, "service" is changed to "nominal working pressure" because the use of service pressure is "The settled pressure of the fuel container at a uniform gas temperature of 70°F (21°C) and full gas content" (3.3.197.7). Nominal working pressure is a new term defined for H2 fueling.</p> <p>The repetition of the last part of each numbered section ("...by stopping flow...") is not needed because it is discussed in 10.5.1.1.1.</p> |

| SECTION                         | Public Input #      | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                     |
|---------------------------------|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| New Section<br>after 10.5.1.1.4 | 272                 | Create First Revision                                                                                                                                                      |
| PI TEXT                         | <b>10.5.1.1.4.1</b> | <u>Vehicles shall not be considered a source of ignition with respect to requirements of this chapter.</u>                                                                 |
| PROPOSED REVISION (FR)          |                     | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                     |
| PROPOSED STATEMENT              |                     | This requirement currently exists as 10.2.3 but is relocated to 10.5.1.1.4.1 within 10.5 "Dispensing to fit better with other material on sources of ignition. See PI 271. |

| SECTION                         | Public Input #    | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                                                            |
|---------------------------------|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| New Section<br>after 10.5.1.2.2 | 274               | Create First Revision                                                                                                                                                                                                                             |
| PI TEXT                         | <b>10.5.1.2.3</b> | <u>Where an overpressure incident that results in operation of the overpressure protection system occurs, the dispenser pressure control system shall be examined and certified by a qualified technician prior to being returned to service.</u> |
| PROPOSED REVISION (FR)          |                   | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                            |

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| SECTION                         | Public Input #                                                                                                                     | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|---------------------------------|------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| New Section<br>after 10.5.1.2.2 | 274                                                                                                                                | Create First Revision                                                  |
| PROPOSED<br>STATEMENT           | This paragraph is same material, but is relocated from 10.2.4 to be better located with overpressure related material in 10.5.1.2. |                                                                        |

| SECTION                    | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 10.5.1.5<br>A.10.5.1.5.1.1 | 160<br>162                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Resolve Public Input                                                   |
| PI TEXT                    | <p><b>10.5.1.5*</b> <b>Fueling Protocols for Medium- and Heavy-Duty Hydrogen Motor Vehicles.</b></p> <p><b>10.5.1.5.1</b><br/>The dispenser shall use a standard fueling protocol, <u>as their default protocol</u>.</p> <p><b>10.5.1.5.1.1*</b><br/>The <u>dispenser using a standard fueling-automotive</u> protocol shall be <u>listed</u>, approved, <u>or tested to CSA Technical Specification HGV 4.3.5, Test Methods for Hydrogen Fueling Parameter Evaluation for Heavy Duty Vehicles</u>.</p> <p><b>A.10.5.1.5.1.1</b><br/><del>There are currently no standard fueling protocols with high flow rates for medium- and heavy duty hydrogen motor vehicles. It is recommended that a third party approve the protocol based upon the existing requirements for light duty hydrogen motor vehicle fueling protocols.</del><br/><u>CSA Technical Specification HGV 4.3.5, Test Methods for Hydrogen Fueling Parameter Evaluation for Heavy Duty Vehicles</u>, is a standard test method to validate that a dispenser properly applies the fueling protocols in SAE J2601, <u>Fueling Protocols for Light Duty Gaseous Hydrogen Surface Vehicles</u>, and communication protocols in SAE J2799, <u>Hydrogen Surface Vehicle to Station Communications Hardware and Software</u>, and has the proper fault controls in place. CSA TS HGV 4.3.5, <u>Test Methods for Hydrogen Fueling Parameter Evaluation for Heavy Duty Vehicles</u>, is a standard test method to validate that a dispenser properly applies the fueling protocols in SAE J2601/5 <u>High-Flow Prescriptive Fueling Protocols for Gaseous Hydrogen Powered Medium and Heavy-Duty Vehicles</u>.</p> <p><u>Care should be taken that the fueling protocol is validated with the appropriate version of CSA TS HGV 4.3.5.</u></p> <p><b>10.5.1.5.2</b><br/>For all public dispensers and dispensers intended to fuel both light- and medium-/heavy-duty hydrogen motor vehicles, the non-light-duty vehicle protocol shall be treated as a nonstandard fueling protocol and meet the requirements of 10.5.1.4.2.1 through 10.5.1.4.2.3.</p> <p><b>10.5.1.5.2.1</b><br/>All public dispensers and dispensers intended to fuel <del>light</del> <u>medium-/heavy-</u> duty hydrogen motor vehicles that can fuel a hydrogen vehicle using a nonstandard automotive fueling protocol shall have means to prevent the fueling of vehicles not designed to use the dispenser.</p> |                                                                        |
| PROPOSED<br>REVISION (FR)  | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                        |
| PROPOSED<br>STATEMENT      | HGV 4.3.5 has not yet been issued, so the Public Input is not applicable at this time. It is likely to be published before 2 <sup>nd</sup> draft and can be resubmitted as a Public Comment.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                        |

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| SECTION        | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|----------------|----------------|------------------------------------------------------------------------|
| 10.5.1.5       | 160            | Resolve Public Input                                                   |
| A.10.5.1.5.1.1 | 162            |                                                                        |
|                |                |                                                                        |

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                              | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 10.5.2.1.1.1           | 293                                                                                                                                                                                                                                                                                                                                                         | Create First Revision                                                  |
| PI TEXT                | <b>10.5.2.1.1.1</b><br>Compression, gas processing, dispensing equipment, and storage containers connected for public use shall be allowed to be located inside of buildings reserved exclusively for these purposes or in rooms within or attached to buildings used for other purposes in accordance with Chapters 6, <del>7</del> , and <del>7.8</del> . |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                      |                                                                        |
| PROPOSED STATEMENT     | Adding Chapter 8 since many GH2 dispensing systems are also supplied with LH2, so the requirements of Chapter 8 apply.                                                                                                                                                                                                                                      |                                                                        |

| SECTION                | Public Input #                                                                                                                                                                                                                             | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 10.5.2.1.1.2           | 294                                                                                                                                                                                                                                        | Create First Revision                                                  |
| PI TEXT                | <b>10.5.2.1.1.2</b><br>Dispensing equipment shall be installed on foundations with anchoring systems designed to meet the requirements of the adopted building code for the appropriate seismic and wind conditions. <del>{52.9.3.3}</del> |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                     |                                                                        |
| PROPOSED STATEMENT     | Meeting the applicable building code is a general requirement is not needed to be extracted from NFPA 52. Removal of the extract tag is a simplification.                                                                                  |                                                                        |

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                         | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 10.5.2.2.1.4           | 165                                                                                                                                                                                                                                                                                                                                    | Create First Revision                                                  |
| PI TEXT                | <b>10.5.2.2.1.4</b><br>The outdoor installation of hydrogen dispensers <a href="#">for light-duty vehicles</a> shall meet the separation distances shown in Table 10.5.2.2.1.4.<br><br><b>Table 10.5.2.2.1.4 Separation Distances for Outdoor Gaseous Hydrogen Dispensing Systems</b><br><br>...                                       |                                                                        |
| PROPOSED REVISION (FR) | <b>10.5.2.2.1.4</b><br>The outdoor installation of hydrogen dispensers <a href="#">designed for light-duty vehicles</a> shall meet the separation distances shown in Table 10.5.2.2.1.4.<br><br><b>Table 10.5.2.2.1.4 Separation Distances for Outdoor Gaseous Hydrogen Dispensing Systems <a href="#">for Light Duty Vehicles</a></b> |                                                                        |

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| SECTION            | Public Input #                                                                                                                                                                                                                                     | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 10.5.2.2.1.4       | 165                                                                                                                                                                                                                                                | Create First Revision                                                  |
| PROPOSED STATEMENT | The separation distances in this section were created for light-duty vehicle dispensing. A new medium/heavy-duty table is proposed in PI 166. The title of the Table was also edited to refer to dispensers designed for Light Duty Vehicles only. |                                                                        |

| SECTION                                                                                                                                                                                                      | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                                                                         |                                     |                          |                                     |  |                                  |                          |                    |                   |                                      |                                                                                                                                |                    |                     |                                      |                                                          |                    |                     |                                      |                                                         |                    |                     |                                   |                                                                                                                                                                            |                    |                     |                                   |                                                                                                                                                                                                                                                                |                          |                          |                                   |                                    |                   |                     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|--------------------------|-------------------------------------|--|----------------------------------|--------------------------|--------------------|-------------------|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|--------------------|---------------------|--------------------------------------|----------------------------------------------------------|--------------------|---------------------|--------------------------------------|---------------------------------------------------------|--------------------|---------------------|-----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|---------------------|-----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|--------------------------|-----------------------------------|------------------------------------|-------------------|---------------------|
| New Section<br>after 10.5.2.2.1                                                                                                                                                                              | 166                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Create First Revision                                                                                                                                                                                                                                          |                                     |                          |                                     |  |                                  |                          |                    |                   |                                      |                                                                                                                                |                    |                     |                                      |                                                          |                    |                     |                                      |                                                         |                    |                     |                                   |                                                                                                                                                                            |                    |                     |                                   |                                                                                                                                                                                                                                                                |                          |                          |                                   |                                    |                   |                     |
| PI TEXT                                                                                                                                                                                                      | <a href="#">10.5.2.2.1.5</a><br>The outdoor installation of hydrogen dispensers shall meet the separation distances shown in Table 10.5.2.2.1.5.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                |                                     |                          |                                     |  |                                  |                          |                    |                   |                                      |                                                                                                                                |                    |                     |                                      |                                                          |                    |                     |                                      |                                                         |                    |                     |                                   |                                                                                                                                                                            |                    |                     |                                   |                                                                                                                                                                                                                                                                |                          |                          |                                   |                                    |                   |                     |
|                                                                                                                                                                                                              | <a href="#">Table 10.5.2.2.1.5 Separation Distances for Outdoor Gaseous Hydrogen Dispensing Systems</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                |                                     |                          |                                     |  |                                  |                          |                    |                   |                                      |                                                                                                                                |                    |                     |                                      |                                                          |                    |                     |                                      |                                                         |                    |                     |                                   |                                                                                                                                                                            |                    |                     |                                   |                                                                                                                                                                                                                                                                |                          |                          |                                   |                                    |                   |                     |
|                                                                                                                                                                                                              | <table><tr><td>-</td><td>-</td><td colspan="2"><a href="#">Required Separation</a></td></tr><tr><td><a href="#">System Component</a></td><td><a href="#">Exposure</a></td><td><a href="#">ft</a></td><td><a href="#">m</a></td></tr><tr><td><a href="#">Dispensing equipment</a></td><td><a href="#">Nearest important building or line of adjoining property that can be built upon or from any source of ignition</a></td><td><a href="#">20</a></td><td><a href="#">6.0</a></td></tr><tr><td><a href="#">Dispensing equipment</a></td><td><a href="#">Nearest public street or public sidewalk</a></td><td><a href="#">20</a></td><td><a href="#">6.0</a></td></tr><tr><td><a href="#">Dispensing equipment</a></td><td><a href="#">Nearest rail of any railroad main track</a></td><td><a href="#">20</a></td><td><a href="#">6.0</a></td></tr><tr><td><a href="#">Point of transfer</a></td><td><a href="#">Any important building other than buildings of Type I or Type II construction with exterior walls having a fire resistance rating of not less than 2 hours</a></td><td><a href="#">20</a></td><td><a href="#">6.0</a></td></tr><tr><td><a href="#">Point of transfer</a></td><td><a href="#">Buildings of Type I or II construction with exterior walls having a fire resistance rating of not less than 2 hours or walls constructed of concrete or masonry, or of other material having a fire resistance rating of not less than 2 hours</a></td><td><a href="#">No limit</a></td><td><a href="#">No limit</a></td></tr><tr><td><a href="#">Point of transfer</a></td><td><a href="#">Storage containers</a></td><td><a href="#">6</a></td><td><a href="#">2.0</a></td></tr></table> |                                                                                                                                                                                                                                                                | -                                   | -                        | <a href="#">Required Separation</a> |  | <a href="#">System Component</a> | <a href="#">Exposure</a> | <a href="#">ft</a> | <a href="#">m</a> | <a href="#">Dispensing equipment</a> | <a href="#">Nearest important building or line of adjoining property that can be built upon or from any source of ignition</a> | <a href="#">20</a> | <a href="#">6.0</a> | <a href="#">Dispensing equipment</a> | <a href="#">Nearest public street or public sidewalk</a> | <a href="#">20</a> | <a href="#">6.0</a> | <a href="#">Dispensing equipment</a> | <a href="#">Nearest rail of any railroad main track</a> | <a href="#">20</a> | <a href="#">6.0</a> | <a href="#">Point of transfer</a> | <a href="#">Any important building other than buildings of Type I or Type II construction with exterior walls having a fire resistance rating of not less than 2 hours</a> | <a href="#">20</a> | <a href="#">6.0</a> | <a href="#">Point of transfer</a> | <a href="#">Buildings of Type I or II construction with exterior walls having a fire resistance rating of not less than 2 hours or walls constructed of concrete or masonry, or of other material having a fire resistance rating of not less than 2 hours</a> | <a href="#">No limit</a> | <a href="#">No limit</a> | <a href="#">Point of transfer</a> | <a href="#">Storage containers</a> | <a href="#">6</a> | <a href="#">2.0</a> |
|                                                                                                                                                                                                              | -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | -                                                                                                                                                                                                                                                              | <a href="#">Required Separation</a> |                          |                                     |  |                                  |                          |                    |                   |                                      |                                                                                                                                |                    |                     |                                      |                                                          |                    |                     |                                      |                                                         |                    |                     |                                   |                                                                                                                                                                            |                    |                     |                                   |                                                                                                                                                                                                                                                                |                          |                          |                                   |                                    |                   |                     |
|                                                                                                                                                                                                              | <a href="#">System Component</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <a href="#">Exposure</a>                                                                                                                                                                                                                                       | <a href="#">ft</a>                  | <a href="#">m</a>        |                                     |  |                                  |                          |                    |                   |                                      |                                                                                                                                |                    |                     |                                      |                                                          |                    |                     |                                      |                                                         |                    |                     |                                   |                                                                                                                                                                            |                    |                     |                                   |                                                                                                                                                                                                                                                                |                          |                          |                                   |                                    |                   |                     |
|                                                                                                                                                                                                              | <a href="#">Dispensing equipment</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <a href="#">Nearest important building or line of adjoining property that can be built upon or from any source of ignition</a>                                                                                                                                 | <a href="#">20</a>                  | <a href="#">6.0</a>      |                                     |  |                                  |                          |                    |                   |                                      |                                                                                                                                |                    |                     |                                      |                                                          |                    |                     |                                      |                                                         |                    |                     |                                   |                                                                                                                                                                            |                    |                     |                                   |                                                                                                                                                                                                                                                                |                          |                          |                                   |                                    |                   |                     |
|                                                                                                                                                                                                              | <a href="#">Dispensing equipment</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <a href="#">Nearest public street or public sidewalk</a>                                                                                                                                                                                                       | <a href="#">20</a>                  | <a href="#">6.0</a>      |                                     |  |                                  |                          |                    |                   |                                      |                                                                                                                                |                    |                     |                                      |                                                          |                    |                     |                                      |                                                         |                    |                     |                                   |                                                                                                                                                                            |                    |                     |                                   |                                                                                                                                                                                                                                                                |                          |                          |                                   |                                    |                   |                     |
|                                                                                                                                                                                                              | <a href="#">Dispensing equipment</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <a href="#">Nearest rail of any railroad main track</a>                                                                                                                                                                                                        | <a href="#">20</a>                  | <a href="#">6.0</a>      |                                     |  |                                  |                          |                    |                   |                                      |                                                                                                                                |                    |                     |                                      |                                                          |                    |                     |                                      |                                                         |                    |                     |                                   |                                                                                                                                                                            |                    |                     |                                   |                                                                                                                                                                                                                                                                |                          |                          |                                   |                                    |                   |                     |
|                                                                                                                                                                                                              | <a href="#">Point of transfer</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <a href="#">Any important building other than buildings of Type I or Type II construction with exterior walls having a fire resistance rating of not less than 2 hours</a>                                                                                     | <a href="#">20</a>                  | <a href="#">6.0</a>      |                                     |  |                                  |                          |                    |                   |                                      |                                                                                                                                |                    |                     |                                      |                                                          |                    |                     |                                      |                                                         |                    |                     |                                   |                                                                                                                                                                            |                    |                     |                                   |                                                                                                                                                                                                                                                                |                          |                          |                                   |                                    |                   |                     |
|                                                                                                                                                                                                              | <a href="#">Point of transfer</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <a href="#">Buildings of Type I or II construction with exterior walls having a fire resistance rating of not less than 2 hours or walls constructed of concrete or masonry, or of other material having a fire resistance rating of not less than 2 hours</a> | <a href="#">No limit</a>            | <a href="#">No limit</a> |                                     |  |                                  |                          |                    |                   |                                      |                                                                                                                                |                    |                     |                                      |                                                          |                    |                     |                                      |                                                         |                    |                     |                                   |                                                                                                                                                                            |                    |                     |                                   |                                                                                                                                                                                                                                                                |                          |                          |                                   |                                    |                   |                     |
| <a href="#">Point of transfer</a>                                                                                                                                                                            | <a href="#">Storage containers</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <a href="#">6</a>                                                                                                                                                                                                                                              | <a href="#">2.0</a>                 |                          |                                     |  |                                  |                          |                    |                   |                                      |                                                                                                                                |                    |                     |                                      |                                                          |                    |                     |                                      |                                                         |                    |                     |                                   |                                                                                                                                                                            |                    |                     |                                   |                                                                                                                                                                                                                                                                |                          |                          |                                   |                                    |                   |                     |
| PROPOSED REVISION (FR)                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                |                                     |                          |                                     |  |                                  |                          |                    |                   |                                      |                                                                                                                                |                    |                     |                                      |                                                          |                    |                     |                                      |                                                         |                    |                     |                                   |                                                                                                                                                                            |                    |                     |                                   |                                                                                                                                                                                                                                                                |                          |                          |                                   |                                    |                   |                     |
| <a href="#">10.5.2.2.1.5</a><br>The outdoor installation of hydrogen dispensers <a href="#">designed for medium and heavy duty vehicles</a> shall meet the separation distances shown in Table 10.5.2.2.1.5. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                |                                     |                          |                                     |  |                                  |                          |                    |                   |                                      |                                                                                                                                |                    |                     |                                      |                                                          |                    |                     |                                      |                                                         |                    |                     |                                   |                                                                                                                                                                            |                    |                     |                                   |                                                                                                                                                                                                                                                                |                          |                          |                                   |                                    |                   |                     |
| <a href="#">Table 10.5.2.2.1.5 Separation Distances for Outdoor Gaseous Hydrogen Dispensing Systems for Medium and Heavy Duty Vehicles</a>                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                |                                     |                          |                                     |  |                                  |                          |                    |                   |                                      |                                                                                                                                |                    |                     |                                      |                                                          |                    |                     |                                      |                                                         |                    |                     |                                   |                                                                                                                                                                            |                    |                     |                                   |                                                                                                                                                                                                                                                                |                          |                          |                                   |                                    |                   |                     |

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| SECTION                         | Public Input #                                                                                                                                                                                                                                                                                   | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                                                         |                     |          |
|---------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|----------|
| New Section<br>after 10.5.2.2.1 | 166                                                                                                                                                                                                                                                                                              | Create First Revision                                                                                                                                                                                                                          |                     |          |
|                                 |                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                | Required Separation |          |
|                                 | System Component                                                                                                                                                                                                                                                                                 | Exposure                                                                                                                                                                                                                                       | ft                  | m        |
|                                 | Dispensing equipment                                                                                                                                                                                                                                                                             | Nearest important building or line of adjoining property that can be built upon or from any source of ignition                                                                                                                                 | 20                  | 6.0      |
|                                 | Dispensing equipment                                                                                                                                                                                                                                                                             | Nearest public street or public sidewalk                                                                                                                                                                                                       | 20                  | 6.0      |
|                                 | Dispensing equipment                                                                                                                                                                                                                                                                             | Nearest rail of any railroad main track                                                                                                                                                                                                        | 20                  | 6.0      |
|                                 | Point of transfer                                                                                                                                                                                                                                                                                | Any important building other than buildings of Type I or Type II construction with exterior walls having a fire resistance rating of not less than not less than 2 hours                                                                       | 20                  | 6.0      |
|                                 | Point of transfer                                                                                                                                                                                                                                                                                | Buildings of Type I or II construction with exterior walls having a fire resistance rating of not less than 2 hours or walls constructed of concrete or masonry, or of other material having a fire resistance rating of not less than 2 hours | No limit            | No limit |
|                                 | Point of transfer                                                                                                                                                                                                                                                                                | Storage containers                                                                                                                                                                                                                             | 6                   | 2.0      |
| PROPOSED STATEMENT              | The medium-/heavy-duty vehicles require larger dispensing systems which have increased flow rates. In the event of a leak or other incident, more hydrogen could be released or a larger jet fire could occur. Therefore, additional separation distances are necessary to protect the exposure. |                                                                                                                                                                                                                                                |                     |          |

| SECTION                | Public Input #                                                                                                                         | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 10.5.3.4.1.2           | 295                                                                                                                                    | [Choose Motion]                                                        |
| PI TEXT                | <del>10.5.3.4.1.2</del><br>Fuel dispensing indoors shall be in accordance with 10.5.3.4.                                               |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.] |                                                                        |
| PROPOSED STATEMENT     | Redundant with the previous paragraph 10.5.3.4.1.1 "Indoor dispensing to nonpublic users shall meet the provisions of 10.5.3.4"        |                                                                        |

| SECTION      | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|--------------|----------------|------------------------------------------------------------------------|
| 10.5.3.4.3.2 | 300            | Create First Revision                                                  |
| PI TEXT      | 10.5.3.4.3.2   |                                                                        |

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| SECTION                | Public Input #                                                                                                                                                                                   | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 10.5.3.4.3.2           | 300                                                                                                                                                                                              | Create First Revision                                                  |
|                        | Fast-fill fueling indoors shall be permitted in accordance with <a href="#">10.5.2.2.1</a> , 10.5.3.2.3, 10.5.3.4.1, and 10.5.3.4.3.                                                             |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                           |                                                                        |
| PROPOSED STATEMENT     | Related PI 296 changed reference from 10.5.2.2.1 in 10.5.3.4.3.3 to a more applicable reference, so reference to paragraph 10.5.2.2.1 is added to this section to maintain the same requirement. |                                                                        |

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 10.5.3.4.3.3           | 296                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Create First Revision                                                  |
| PI TEXT                | <b>10.5.3.4.3.3</b><br>Fast-fill fueling indoors shall be <del>permitted</del> <a href="#">allowed</a> where storage, gas processing, and compression equipment is located outdoors in compliance with 10.5. <a href="#">3.4.1.8</a> <del>2.2.1</del> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                        |
| PROPOSED STATEMENT     | The reference to 10.5.2.2.1 is not applicable to indoor fast fill fueling when the balance of the fueling equipment is outdoors. The appropriate reference that applies to indoor fast fill fueling with the equipment outdoors is 10.5.3.4.1.8.<br>Paragraph 10.5.2.2.1 is nearly all related to dispensing equipment, not the balance of the fuel station equipment. The better location for inclusion of 10.5.2.2.1 is the paragraph preceding: 10.5.3.4.3.2. PI 300 modifies that paragraph to retain linkage to 10.5.2.2.1 such that it is not deleted.<br>The word "permitted" was changed to "allowed" per similar changes made to several paragraphs for the same wording from the 2023 code cycle. The word "permitting" can be confused with permitting the system with the local AHJ. |                                                                        |

| SECTION      | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 10.5.3.4.3.7 | 301                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Create First Revision                                                  |
| PI TEXT      | <b>10.5.3.4.3.7 Dispensing Equipment for Indoor Fast-Fill of HPITs.</b><br>In addition to the requirements of 10.5.3.2.1, 10.5.3.2.3, and 10.5.3.4.3, the following applies to dispensing equipment for indoor fast-fill of HPITS:<br><br><ol style="list-style-type: none"> <li>(1) <i>Protocol</i>. Gas dispensing equipment for indoor fast-fill of HPITs shall use the fueling protocol of SAE J2601-3, <i>Fueling Protocol for Gaseous Hydrogen Powered Industrial Trucks</i>.</li> <li>(2) <a href="#">Emergency Automatic Shutoff Valve</a>. Hydrogen gas piping used to transport GH<sub>2</sub> between the bulk hydrogen compressed gas storage system and a dispenser at a fast-fill station shall have a valve that closes when either of the following occurs: <ol style="list-style-type: none"> <li>(a) The power supply to the dispenser is shut off.</li> <li>(b) Any emergency shutdown device at the <del>refueling-dispensing system</del><a href="#">station</a> is activated.</li> </ol> </li> <li>(3) <i>Manual Shutoff Valve</i>. A quarter-turn manual shutoff valve shall be provided at a fast-fill station upstream of the breakaway device, where it is readily accessible to the person dispensing hydrogen, unless one of the following occurs:</li> </ol> |                                                                        |

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| SECTION      | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|--------------|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10.5.3.4.3.7 | 301            | Create First Revision                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|              |                | <p>(a) The self-closing valve referred to in 10.5.3.4.3.7(2) is located immediately upstream of the dispenser.</p> <p>(b) The dispenser is equipped with a self-closing valve that closes each time the <del>control arm is turned to the OFF position</del> <u>dispenser operation is stopped</u> or when the ESD is activated.</p> <p>(4) <i>Shutdown.</i> Actuation or failure of the following systems shall automatically shut down the gas flow from the dispenser, stop the flow of gas to the room, and start or continue to run the mechanical ventilation system where mechanical ventilation systems are required:</p> <ul style="list-style-type: none"> <li>(a) Gas detection system</li> <li>(b) Fire alarm system</li> <li>(c) Fire detection system</li> <li>(d) ESD</li> <li>(e) Sensors or controls used to prevent overtemperature or overpressurization of the on-board fuel container</li> <li>(f) Required ventilation systems</li> <li>(g) Dispenser leak monitoring system</li> </ul> <p>(5) <i>Reactivation.</i> Reactivation of the dispenser and gas flow into the room after system shutdown required by 10.5.3.4.3.7(2) or 10.5.3.4.3.7(4) shall be both of the following:</p> <ul style="list-style-type: none"> <li>(a) By manual restart and shall be</li> <li>(b) Conducted by trained personnel</li> </ul> <p>(6) <i>*Gas Detection System.</i> The <del>dispenser enclosure or housing</del> <u>dispensing system</u> shall be equipped with a gas detection system <u>to detect hydrogen leakage above the dispensing area and within the dispenser enclosure</u> that shall comply with all of the following:</p> <ul style="list-style-type: none"> <li>(a) Actuate when a maximum of <del>25.1 percent of the lower flammable limit (LFL)</del> <u>hydrogen</u> is detected</li> <li>(b) Shut down the dispenser, <u>isolate the hydrogen source outside the room, and start or continue</u> <del>stop the flow of gas into the room, and start or continue</del> to run the <u>mechanical</u> ventilation system when <u>installed</u> <del>mechanical ventilation systems are required</del></li> <li>(c) Sound a local alarm and provide visual indication where a maximum of <del>25.1 percent of the lower flammable limit (LFL)</del> <u>hydrogen</u> is detected</li> <li>(d) Remain functional during maintenance operations on the ventilation system.</li> </ul> <p>(7) <i>Electrical.</i> Electrical equipment on dispensers shall be in accordance with 10.4.6.1.</p> <p>(8) <i>Temperature Limits.</i> Dispensing systems shall be provided with a means to prevent the on-board fuel system from exceeding prescribed temperature limits during fueling operations.</p> |

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| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 10.5.3.4.3.7           | 301                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Create First Revision                                                  |
|                        | <p>(9) <i>Pressure Limits.</i> Dispensing systems shall be provided with a means to prevent the on-board fuel system from exceeding prescribed pressure limits during fueling operations.</p> <p>(10) <i>Ignition Source Control.</i> The owner/operator shall not allow hot work/open flames within 15 ft (4.6 m) of the refueling location unless the dispenser is shut down, depressurized, and purged with an inert gas.</p> <p>(11) <del>Defueling.</del> <u>[Move to 10.5.3.4.3.7]</u> If GH<sub>2</sub> is to be removed from the vehicle storage system, GH<sub>2</sub> shall be discharged into a closed transfer system or vented outdoors through a vent pipe system installed and constructed in accordance with CGA G-5.5, <i>Hydrogen Vent Systems</i></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                        |
| PROPOSED STATEMENT     | <p>Added "Emergency" to Automatic Shutoff valve to indicate this valve is in addition to the normal operational valve. An emergency valve provides redundancy for the normal operational valve if failure of the operational valve is the reason for the ESD was activated.</p> <p>Changed to "dispensing station" so it's clear that the ESD referenced is at the dispensing area.</p> <p>All dispensers do not have a "control arm", nor is that a code requirement, so requirement was changed to when the dispenser operation is stopped.</p> <p>Added a requirement that the dispensing area also be covered by the gas detection system since a detector within the enclosure would not detect leaks in the surrounding area from the hose, nozzle, or vehicle being filled.</p> <p>Changed from 25% of LFL to 1% H<sub>2</sub> since there have been numerous questions raised about <u>which H<sub>2</sub> LFL to use the LFL percentage and it has been clarified to specify that it is 1% of H<sub>2</sub>.</u></p> <p>Changed to "isolate the hydrogen source outside the room" to clarify that the isolation valve needs to be outside the room.</p> <p>Relocated the defueling requirement since defueling does not need to be done at the dispenser.</p> |                                                                        |

| SECTION                        | Public Input #                                                                                                                                                                                                                                                                                                                      | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| New Section after 10.5.3.4.3.7 | 304                                                                                                                                                                                                                                                                                                                                 | Create First Revision                                                  |
| PI TEXT                        | <p><b><u>10.5.3.4.3.7 Defueling.</u></b></p> <p><u>If GH<sub>2</sub> is to be removed from the vehicle storage system, GH<sub>2</sub> shall be discharged into a closed transfer system or vented outdoors through a vent pipe system installed and constructed in accordance with CGA G-5.5, <i>Hydrogen Vent Systems</i>.</u></p> |                                                                        |
| PROPOSED REVISION (FR)         | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                              |                                                                        |
| PROPOSED STATEMENT             | This is same content, relocated from 10.5.3.4.3.7, since defueling activity is separate from dispensing. While the defueling connection may be installed at the dispenser, separating into its own paragraph makes the requirement broader to acknowledge that defueling maybe be done elsewhere in the facility.                   |                                                                        |

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| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 10.6.3.1               | 305                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Create First Revision                                                  |
| PI TEXT                | <b>10.6.3.1*</b><br>Pressure relief <del>valves protecting ASME pressure vessels</del> devices designed and installed in accordance with 7.1.5.5.2 to protect pressure vessels and pressure relief devices to protect dispensing systems shall be repaired, adjusted, <u>inspected</u> , and tested in accordance with applicable regulations <u>and design standards</u> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                        |
| PROPOSED REVISION (FR) | <b>10.6.3.1*</b><br>Pressure relief <del>valves protecting ASME pressure vessels</del> devices designed and installed in accordance with 7.1.5.5.2 to protect pressure vessels and pressure relief devices to protect dispensing systems shall be repaired, adjusted, <u>inspected</u> , and tested in accordance with applicable regulations <u>and design standards</u> .<br><del>10.6.3.3 Pressure relief devices designed and installed in accordance with 7.1.5.5.2 shall be examined and tested in accordance with the requirements of the applicable design standard.</del><br><u>10.6.3.3(A) Pressure relief valves or reclosing pressure relief devices designed in accordance with CGA S-1.3 Pressure Relief Device Standards – Part 3 – Stationary Storage Containers for Compressed Gases, shall be examined and tested at least every 5 years or as otherwise provided by the standard.</u> |                                                                        |
| PROPOSED STATEMENT     | The proposed text merges paragraphs 10.6.3.1 and 10.6.3.3. These sections overlap and merging them adds clarity and avoids confusion. Previously these two paragraphs only directly applied to vessel relief devices and not those that are on the balance of the dispensing system. <u>The requirement now matches up the requirements for pressure vessels with its appropriate requirement reference</u> <del>For example, the dispenser relief devices protecting the dispenser and vehicle being filled would not be included.</del><br><del>10.6.3.3 (A) is promoted to a new 10.6.3.3.</del>                                                                                                                                                                                                                                                                                                      |                                                                        |

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| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                      | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 10.6.3.7(A)            | 306                                                                                                                                                                                                                                                                                                                                 | Create First Revision                                                  |
| PI TEXT                | <b>10.6.3.7</b><br>If calibration is required, each hydrogen dispensing system shall indicate expiration date of the current calibration.<br><del>(A) 10.6.3.7.1</del><br>The calibration indicator shall be readily visible to the hydrogen dispensing system user and shall not obscure other display functions of the dispenser. |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                              |                                                                        |
| PROPOSED STATEMENT     | There is a paragraph (A) when there is no (B). Modified to be a dependent paragraph number under 10.6.3.7.                                                                                                                                                                                                                          |                                                                        |

| SECTION                   | Public Input #                  | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|---------------------------|---------------------------------|------------------------------------------------------------------------|
| New Section after 3.3.214 | 42                              | Choose Motion                                                          |
| PI TEXT                   | <b>3.3.215 Risk Assessment.</b> |                                                                        |

Commented [F10]: Heath, PI42 is unrelated to the Fueling Task Group so the group did not provide a recommendation.

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| SECTION                      | Public Input #                                                                                                                                                                                           | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| New Section<br>after 3.3.214 | 42                                                                                                                                                                                                       | Choose Motion                                                          |
|                              | <u>The overall process of risk identification, risk analysis, and risk evaluation.</u>                                                                                                                   |                                                                        |
| PROPOSED<br>REVISION (FR)    | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                   |                                                                        |
| PROPOSED<br>STATEMENT        | [Explain <u>WHY</u> you have made this motion and DO NOT just repeat the revision. Must use technical justification. Be sure to write in the present tense voice (i.e., assume your motion has passed).] |                                                                        |

**Commented [F(10)]:** Heath, PI42 is unrelated to the Fueling Task Group so the group did not provide a recommendation.

| SECTION    | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 11.2.5     | 227                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Create First Revision                                                  |
| 11.2.5.1   | 228                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                        |
| 11.2.5.2   | 229                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                        |
| 11.2.6     | 230                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                        |
| 11.2.6.1   | 231                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                        |
| 11.2.6.1.1 | 232                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                        |
| 11.2.7     | 233                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                        |
| 11.2.7.1   | 234                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                        |
| 11.2.7.2   | 235                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                        |
| 11.2.7.3   | 236                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                        |
| PI TEXT    | <p><b>11.2.5 Personnel Protection.</b><br/>LH<sub>2</sub> refueling <del>sites utilizing or dispensing LH<sub>2</sub> shall provide personnel protection barriers such as</del> <u>sites shall provide protection of personnel and vehicles with LH<sub>2</sub> exposure with walls, cabinets, vacuum jacketing or similar barriers</u> <del>jacketed pipe, and similar barriers to protect the fueling operator and the vehicle being fueled from contact with a release of LH<sub>2</sub>. All facility piping other than the refueling line to the vehicle shall be behind the barrier, to deflect any LH<sub>2</sub> that is released due to an equipment malfunction.</del></p> <p><u><b>11.2.5.1</b></u><br/><u>All facility LH<sub>2</sub> piping and equipment other than the refueling line to the vehicle shall be behind these barriers to deflect LH<sub>2</sub> that has been released due to equipment malfunction.</u></p> <p><u><b>11.2.5.2</b></u><br/><u>The refueling line to the vehicle shall be insulated with a vacuum jacket.</u></p> <p><b>11.2.6 Sources of Ignition.</b><br/>Smoking materials, including matches and lighters, shall not be used within 25 ft (7.6 m) of areas used for <u>LH<sub>2</sub> fueling, servicing vehicle LH<sub>2</sub> fuel systems</u> <del>of internal combustion engines, or receiving or dispensing of delivery of LH<sub>2</sub> to the facility.</del></p> <p><b>11.2.6.1</b><br/>The <u>motors-propulsion equipment</u> of <u>all equipment-vehicles</u> being fueled shall be shut off during the fueling operation <del>except for emergency generators, pumps, communication devices, and so forth, where continuing operation is essential.</del></p> <p><u><b>11.2.6.1.1</b></u><br/><u>Vehicle equipment required for dispensing function or emergency use may continue to operate during fueling operations when approved.</u></p> <p><b>11.2.7 Fire Extinguishers.</b></p> |                                                                        |

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| SECTION                | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|------------------------|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 11.2.5                 | 227            | Create First Revision                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 11.2.5.1               | 228            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 11.2.5.2               | 229            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 11.2.6                 | 230            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 11.2.6.1               | 231            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 11.2.6.1.1             | 232            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 11.2.7                 | 233            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 11.2.7.1               | 234            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 11.2.7.2               | 235            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 11.2.7.3               | 236            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                        |                | <p>Portable fire extinguishers shall be selected, installed, inspected, and maintained in accordance with NFPA 10 and 11.2.7.1 through 11.2.7.3 of this code and 9.2.5.2.5 of NFPA 30A. <del>[30A:9.2.5.2.1] A minimum 10 lb (4.54 kg) ABC dry chemical portable fire extinguisher having an agent discharge rate of at least 1 lb/sec (0.45 kg/sec) shall be provided at the dispensing area in approved locations not more than 50 ft (15.2 m) away from the dispensing area.</del></p> <p><del>11.2.7.1</del><br/>All portable fire extinguishers installed to achieve compliance with this code shall be a minimum of 4.54 kg (10 lb) ABC dry chemical having an agent discharge rate of 0.45 kg/sec (1 lb/sec) or greater. <del>[30A:9.2.5.2.2]</del></p> <p><del>11.2.7.2</del><br/>The maximum travel distance from a minimum 9.1 kg (20 lb) ABC dry chemical extinguisher having an agent discharge rate of 0.45 kg/sec (1 lb/sec) or greater shall be permitted to be 30.5 m (100 ft). <del>[30A:9.2.5.2.3]</del></p> <p><del>11.2.7.3 New Fire Extinguishers.</del><br/>Newly installed fire extinguishers, including replacements or exchanges, shall meet the requirements of 9.2.5.2 of NFPA 30A. <del>[30A:9.2.5.2.4]</del></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| PROPOSED REVISION (FR) |                | <p><b>11.2.5 Personnel Protection.</b><br/>LH<sub>2</sub> refueling sites utilizing or dispensing LH<sub>2</sub> shall provide personnel protection barriers such as <del>sites shall provide protection of personnel and vehicles with LH<sub>2</sub> exposure with</del> walls, cabinets, vacuum <del>jacketing or similar barriers</del> jacketed pipe, and similar barriers to protect the fueling operator and the vehicle being fueled from contact with a release of LH<sub>2</sub>. All facility piping other than the refueling line to the vehicle shall be behind the barrier, to deflect any LH<sub>2</sub> that is released due to an equipment malfunction.</p> <p><u>11.2.5.1</u><br/>All facility LH<sub>2</sub> piping and equipment other than the refueling line to the vehicle shall be behind these barriers to deflect LH<sub>2</sub> that has been released due to equipment malfunction.</p> <p><u>11.2.5.2</u><br/>The refueling line to the vehicle shall be insulated with a vacuum jacket.</p> <p><del>11.2.6.3 Sources of Ignition.</del><br/>Smoking materials, <del>including matches and lighters</del>, shall not be used within 25 ft (7.6 m) of areas used for <u>LH<sub>2</sub> fueling</u>, <del>serving vehicle LH<sub>2</sub> fuel systems of internal combustion engines</del>, or <del>receiving or dispensing of delivery of LH<sub>2</sub> to the facility</del>.</p> <p><b>11.2.6.1</b><br/>The motors <del>propulsion equipment</del> of all equipment <del>vehicles</del> being fueled shall be shut off during the fueling operation except for emergency generators, pumps, communication devices, and so forth, where continuing operation is essential.</p> <p><del>11.2.6.1.1</del></p> |

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| SECTION            | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|--------------------|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 11.2.5             | 227            | Create First Revision                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 11.2.5.1           | 228            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 11.2.5.2           | 229            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 11.2.6             | 230            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 11.2.6.1           | 231            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 11.2.6.1.1         | 232            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 11.2.7             | 233            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 11.2.7.1           | 234            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 11.2.7.2           | 235            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 11.2.7.3           | 236            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|                    |                | <p><u>Only vehicle equipment required for dispensing function or emergency use shall be allowed to continue to operate during fueling operations when approved.</u></p> <p><b>11.2.7 Fire Extinguishers.</b><br/> Portable fire extinguishers shall be selected, installed, inspected, and maintained in accordance with NFPA 10 and 11.2.7.1 through 11.2.7.3 of this code and 9.2.5.2.5 of NFPA 30A. <del>[30A:9.2.5.2.1] A minimum 10 lb (4.54 kg) ABC dry chemical portable fire extinguisher having an agent discharge rate of at least 1 lb/sec (.45 kg/sec) shall be provided at the dispensing area in approved locations not more than 50 ft (15.2 m) away from the dispensing area.</del></p> <p><del><b>11.2.7.1</b></del><br/> <del>All portable fire extinguishers installed to achieve compliance with this code shall be a minimum of 4.54 kg (10 lb) ABC dry chemical having an agent discharge rate of 0.45 kg/sec (1 lb/sec) or greater. [30A:9.2.5.2.2]</del></p> <p><del><b>11.2.7.2</b></del><br/> <del>The maximum travel distance from a minimum 9.1 kg (20 lb) ABC dry chemical extinguisher having an agent discharge rate of 0.45 kg/sec (1 lb/sec) or greater shall be permitted to be 30.5 m (100 ft). [30A:9.2.5.2.3]</del></p> <p><del><b>11.2.7.3 New Fire Extinguishers:</b></del><br/> <del>Newly installed fire extinguishers, including replacements or exchanges, shall meet the requirements of 9.2.5.2 of NFPA 30A. [30A:9.2.5.2.4]</del></p> |
| PROPOSED STATEMENT |                | <p>Change to 11.2.5 aligns to the revised scope of Chapter 11 to apply to LH2 dispensing stations. The intent to require protection from LH2 remains the same, but more concisely. The last sentence is maintained as a new paragraph 11.2.5.1 since it's a separate requirement.</p> <p>A requirement for the refueling line to insulated with a vacuum jacket since other insulation types do not provide sufficient protection to the dispenser operator from hazardous conditions including cryogenic surfaces and creation of liquified air. The vacuum jacket also provides additional double wall protection for the refueling line.</p> <p>Change to 11.2.6 clarifies that this requirement applies to LH2-related Activities, eliminates wording redundancy, and deletes the reference to internal combustion vehicles since that is too narrow.</p> <p>Change to 11.2.6.1 <u>only permits vehicle equipment powering dispensing functions because to minimize the ignition sources and is vehicle agnostic.</u> <del>requires the propulsion equipment (engines, motors, fuel cells, etc) to be shut off during fueling which meets the intent of the previous language. A portion of 11.2.6.1 is moved to newly created 11.2.6.1.1 to keep requirements in independent paragraphs.</del></p> <p>Requirements for fire extinguishing equipment are changed to align with the requirements of Chapter 10.</p>                                                              |

Commented [IA11]: Work with Steve on this

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| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                          | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 11.2.8.6               | 237                                                                                                                                                                                                                                                                                                                                                                                     | Create First Revision                                                  |
| PI TEXT                | <del>11.2.8.6 – Static protection shall be required where LH<sub>2</sub> cargo transport vehicles are unloaded, except where cargo transport vehicles or marine equipment are loaded or unloaded by conductive hose, flexible metallic tubing, or pipe connections through or from tight (top or bottom) outlets where both halves of metallic couplings are electrically bonded.</del> |                                                                        |
| PROPOSED REVISION (FR) |                                                                                                                                                                                                                                                                                                                                                                                         |                                                                        |
| PROPOSED STATEMENT     | Deleted 11.2.8.6 but maintain requirement in new paragraph 11.4.5.4 under "Cargo transport unloading" since it pertains to that activity. See PI 238.                                                                                                                                                                                                                                   |                                                                        |

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                        | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 11.2.9<br>11.2.10      | 239<br>240                                                                                                                                                                                                                                                                                                                                                                            | Create First Revision                                                  |
| PI TEXT                | <b>11.2.9 Piping Systems and Components.</b><br><del>Piping</del> <u>LH<sub>2</sub> piping and piping components</u> shall be in accordance with <u>Chapter 8-8.1.4</u> .<br><br><del>11.2.10 Pressure Relief Devices – Vaporizers.</del><br>The discharge from pressure relief devices serving the vaporizer system shall be connected to a vent pipe system.                        |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                |                                                                        |
| PROPOSED STATEMENT     | Paragraph 8.1.4 is not the only requirement in Chapter 8 that is applicable to piping so this widens to all of Chapter 8. Adds piping components to the requirement to be consistent with the title of this paragraph.<br>A specific reference for relief devices for vaporizers is not required based on other requirements for relief devices provided by Chapter 8 and 11.3.1.5.2. |                                                                        |

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                            | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 11.2.13                | 241                                                                                                                                                                                                                                                                                                                                                                       | Create First Revision                                                  |
| PI TEXT                | <del>11.2.13 LH<sub>2</sub> to GH<sub>2</sub> Systems.</del><br>In addition to the emergency shutdown systems described in Section 11.3, the emergency shutdown system also shall shut off the liquid supply and power to the LH <sub>2</sub> transfer equipment necessary for producing GH <sub>2</sub> from LH <sub>2</sub> .                                           |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                    |                                                                        |
| PROPOSED STATEMENT     | This paragraph is not needed since 11.1.1.3 already exists and directs the user to Chapter 10 requirements for GH <sub>2</sub> dispensing systems. LH <sub>2</sub> and GH <sub>2</sub> dispensing are separate activities and each dispensing system has appropriate controls to shut down the transfer of hydrogen required in an emergency at the respective dispenser. |                                                                        |

| SECTION  | Public Input #                                                                                                                                                | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 11.3.1.1 | 242                                                                                                                                                           | Create First Revision                                                  |
| PI TEXT  | <b>11.3.1.1 System Component Qualifications.</b><br>The following systems and system components shall be listed or approved:<br>(1) Hose and hose connections |                                                                        |

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| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 11.3.1.1               | 242                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Create First Revision                                                  |
|                        | <ul style="list-style-type: none"> <li>(2) <del>Vehicle Dispensing hose vehicle</del> fueling <del>connection</del>connections (nozzle)</li> <li>(3) Electrical equipment used with LH<sub>2</sub> systems</li> <li>(4) <del>Fire and gas detection equipment and alarms</del></li> <li>(4.5) <del>LH<sub>2</sub> dispensers</del>Gas detection equipment and alarms</li> <li>(5) <del>Hydrogen dispensers</del></li> <li>(6) Pressure switches</li> <li>(7) Flow meters</li> </ul>                                                                                                                                                                                                      |                                                                        |
| PROPOSED REVISION (FR) | <b>11.3.1.1 System Component Qualifications.</b><br>The following systems and system components shall be listed or approved: <ul style="list-style-type: none"> <li>(1) Hose and hose connections</li> <li>(2) <del>Vehicle Dispensing hose vehicle</del> fueling <del>connection</del>connections (nozzle)</li> <li>(3) Electrical equipment used with LH<sub>2</sub> systems</li> <li>(4) <del>Fire detection equipment, and gas detection equipment, and associated alarms</del></li> <li>(4.5) <del>LH<sub>2</sub> dispensers</del>Gas detection equipment and alarms</li> <li>(5) <del>Hydrogen dispensers</del></li> <li>(6) Pressure switches</li> <li>(7) Flow meters</li> </ul> |                                                                        |
| PROPOSED STATEMENT     | Clarifies that the vehicle connection specified is on the fueling station, not on the vehicle. Adds fire detection equipment to gas detection requirement which is consistent with consistent with Chapter 10.<br>Clarifies and aligns the dispenser to the scope of Chapter 11.                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                        |

| SECTION                                            | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|----------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 11.3.1.4<br>11.3.1.4.1<br>11.3.1.4.2<br>11.3.1.4.3 | 243<br>244<br>245<br>247                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Create First Revision                                                  |
| PI TEXT                                            | <b>11.3.1.4 Dispensing Device <del>Area</del>Protection.</b><br>The LH2 dispensing <del>systems</del> device shall be protected <u>to minimize damage from vehicles and vandals</u> <del>vehicle collision damage</del> .<br><br><u>11.3.1.4.1</u><br><u>Vehicle fueling areas shall be constructed with a length and width to accommodate the types of vehicles to be fueled.</u><br><br><u>11.3.1.4.2</u>  <br><u>Combustible materials, including asphalt, shall not be used for the construction or surfacing of the fueling area. (See 8.3.2.3.1.5)</u><br><br><u>11.3.1.4.3</u><br><u>The vehicle fueling pad shall be of concrete or a material having a resistivity not exceeding 1 megaoohms as determined by an approved method unless the vehicle is grounded by other means, such as a grounding cable.</u> |                                                                        |
| PROPOSED REVISION (FR)                             | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                        |
| PROPOSED STATEMENT                                 | The title is modified to "area" to better align with the added requirements <del>of material added in PI 244, 245, and 247</del> . 11.3.1.4 is modified to align with Chapter 10 language in 10.4.1.<br>11.3.1.4.1 adds basic requirement to the fueling area to accommodate the vehicles to be fueled, and is aligned with Chapter 10.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                        |

Commented [IA12]: PI 246

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| SECTION                                            | Public Input #                                                                                                                                                                                                                                                                                                                       | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|----------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 11.3.1.4<br>11.3.1.4.1<br>11.3.1.4.2<br>11.3.1.4.3 | 243<br>244<br>245<br>247                                                                                                                                                                                                                                                                                                             | Create First Revision                                                  |
|                                                    | 11.3.1.4.2 is relocated from 11.3.3.1.5.2 since it's appropriate to be in a General category that applies to all LH2 fueling.<br>11.3.1.4.3 consolidates content of Chapter 10 (10.5.2.2.1.3) with the existing concrete requirement of 11.3.3.1.5.2. These requirements are aligned with the new section title broadened to "area". |                                                                        |

| SECTION                                                                      | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 11.3.1.5.2.1<br>11.3.1.5.2.2<br>11.3.1.5.2.3<br>11.3.1.5.2.4<br>11.3.1.5.2.5 | 248<br>250<br>251<br>252<br>255                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Create First Revision                                                  |
| PI TEXT                                                                      | <p><b>11.3.1.5.2 Installation of Pressure Relief Devices on Dispensing Systems.</b></p> <p><b>11.3.1.5.2.1</b><br/>Pressure relief devices <a href="#">for pressure vessels</a> shall be in accordance with <a href="#">8.1.4.7-1.5.5</a>.</p> <p><del><b>11.3.1.5.2.2</b><br/>Pressure relief devices shall be so arranged that they discharge in accordance with Section 6.17 and 7.1.5.5.5.</del></p> <p><b>11.3.1.5.2.3</b><br/>An overpressure protection device <a href="#">meeting the requirements of ASME B31</a>, other than a rupture disc, shall be installed in the fueling transfer system to prevent overpressure in the vehicle.</p> <p><b>11.3.1.5.2.4</b><br/>The set pressure of the overpressure protection device for the dispensing system shall not exceed <del>140</del><a href="#">90</a> percent of the <a href="#">setpoint of the lowest setpoint of the vehicle fuel system pressure relief device</a><del>service pressure of the fueling nozzle it supplies.</del><br/><a href="#">11.3.1.5.2.4.1</a><br/><a href="#">Section 11.3.1.5.2.4 shall be retroactive to all existing facilities.</a></p> <p><del><b>11.3.1.5.2.4.5</b><br/>Pressure relief valves shall be inspected and tested at least every 3 years.</del></p> |                                                                        |
| PROPOSED REVISION (FR)                                                       | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                        |
| PROPOSED STATEMENT                                                           | 11.3.1.5.2.1 is modified to refer to "pressure vessels" to clarify that paragraph <del>7.4.5.5</del> <a href="#">8.1.4</a> addresses relief devices intended for pressure vessels <a href="#">in liquid service</a> , not for process piping. Vessel relief device requirements for are different than those required for piping and require adherence to the B31 Piping Code, not the BPV. For example piping relief devices do not require pop-action and blowdown which can lead to valve chatter and failure.<br>11.3.1.5.2.2 is deleted since it's redundant with 11.3.1.5.2.1 and 11.3.1.5.4, which already refer to the content on this paragraph.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                        |

Commented [IA13]: PI 256

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| SECTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|------------------------------------------------------------------------|
| 11.3.1.5.2.1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 248            | Create First Revision                                                  |
| 11.3.1.5.2.2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 250            |                                                                        |
| 11.3.1.5.2.3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 251            |                                                                        |
| 11.3.1.5.2.4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 252            |                                                                        |
| 11.3.1.5.2.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 255            |                                                                        |
| <p>The 140% setpoint is based on GH2 and GH2 safety standards. It is not appropriate for LH2 systems which will have vehicle fuel tank pressure relieving safety devices, unlike GH2 tanks. <u>90% is based on industry recognized margins below relief devices.</u> The dispensing system must be designed to not lift a safety device on the vehicle during dispensing. <u>This requirement is retroactive because the pressure relief valve setting was for gas and needs to be modified for liquid.</u></p> <p>11.3.1.5.2.5 relocates periodic testing of relief valves from 11.3.1.10.5 and adds "inspection" to align with Chapter 10.</p> |                |                                                                        |

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 11.3.1.8               | 86                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Create First Revision                                                  |
| PI TEXT                | <p><b>11.3.1.8 Emergency Shutdown System.</b></p> <p>An emergency shutdown system (<del>ESD</del>ESS) shall be provided that includes a shut-off valve, <u>and ESD</u> which shall be provided within 10 ft (3.1 m) of the dispenser, for stopping liquid supply and shutting down transfer equipment. <del>An actuator</del><u>The ESD actuators</u> for the <u>ESS</u>valve, <u>shall be</u> distinctly marked for easy recognition with a permanently affixed, legible sign<del>7</del><u>7</u>. <u>The ESS</u> shall be provided with <del>a shutdown control point located near an ESD located near</del> the dispenser and another <del>shutdown control point</del><u>ESD</u> located at a safe, remote location.</p>                                                                                           |                                                                        |
| PROPOSED REVISION (FR) | <p><b>11.3.1.8 Emergency Shutdown System(ESS).</b></p> <p>An emergency shutdown system (<del>ESD</del>ESS) shall be provided that includes a shut-off valve, <u>and an ESD</u> which shall be provided within 10 ft (3.1 m) of the dispenser, for stopping liquid supply and shutting down transfer equipment. <del>An actuator</del><u>The ESD actuators</u> for the <u>ESS</u>valve, <u>shall be</u> distinctly marked for easy recognition with a permanently affixed, legible sign<del>7</del><u>7</u>. <u>11.3.1.8.X The ESD</u> shall be provided with <del>a shutdown control point located near an ESD located near</del> the dispenser and another <del>shutdown control point</del><u>ESD</u> located at <del>a safe</del><u>an accessible</u>, remote location <u>visible from the dispensing area</u>.</p> |                                                                        |
| PROPOSED STATEMENT     | <p>These changes harmonize the use of these terms with what is defined in CSA-HGV-4.1 Hydrogen Dispensers, and CSA-HGV-4.9 Hydrogen Fueling Stations. The harmonized definitions are show below:</p> <p>Emergency shutdown device (ESD)* — a device that activates the emergency shutdown system (ESS).</p> <p>Emergency shutdown system (ESS)* — the system that responds to ESD activation.</p> <p>The requirements are separated to independent paragraphs in accordance with the Manual of Style.</p> <p>The requirement for "safe" location is ambiguous and is better defined to be remote, accessible, and visible from the dispensing area.</p>                                                                                                                                                                |                                                                        |

**Commented [IA14]:** Resolve with 257

**Commented [HD15]:** From Staff: Cannot have multiple mandatory statements in a single section.

**Commented [HD16]:** From Staff: Cannot have multiple mandatory statements in a single section.

| SECTION  | Public Input #                             | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|----------|--------------------------------------------|------------------------------------------------------------------------|
| 11.3.1.8 | 257                                        | Create First Revision                                                  |
| PI TEXT  | <b>11.3.1.8 Emergency Shutdown System.</b> |                                                                        |

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| SECTION                | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|------------------------|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 11.3.1.8               | 257            | Create First Revision                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|                        |                | <p><del>The LH2 dispensing system shall be equipped with an emergency shutdown system. An emergency shutdown system (ESD) shall be provided that includes a shut-off valve, which shall be provided within 10 ft (3.1 m) of the dispenser, for stopping liquid supply and shutting down transfer equipment. An actuator for the valve, distinctly marked for easy recognition with a permanently affixed, legible sign, shall be provided with a shutdown control point located near the dispenser and another shutdown control point located at a safe, remote location.</del></p> <p><u><a href="#">11.3.1.8.2</a></u><br/>Dispensing equipment shall be provided with hydrogen gas detection, leak detection, and flame detection at the fueling area.</p> <p><u><a href="#">11.3.1.8.3</a></u><br/>An emergency manual shutdown device to activate the ESS shall be provided within 20 ft (6.1 m) of the dispensing area and also at a visible location remote, but not more than 100 ft (30.5 m), from the dispensing area.</p> <p><u><a href="#">11.3.1.8.3.1</a></u><br/>The emergency shutdown devices shall be distinctly marked for easy recognition with a permanently affixed legible sign.</p> <p><u><a href="#">11.3.1.8.3.2</a></u><br/>Where multiple emergency shutdown activation devices are provided for a dispensing area, all devices shall be interconnected.</p> <p><u><a href="#">11.3.1.8.4</a></u><br/>The ESS shall include an automatic emergency shut-off valves (ESV) within 10 ft (3.1 m) of the dispenser and at the LH2 storage and supply system.</p> <p><u><a href="#">11.3.1.8.4.1</a></u><br/>These valves shall shut upon activation of the ESD device and also upon activation of the area leak, gas, or fire detection equipment.</p> <p><u><a href="#">11.3.1.8.4.2</a></u><br/>The automatic emergency shut-off valves shall be fail closed.</p> <p><u><a href="#">11.3.1.8.4.3</a></u><br/>Emergency shutoff valves shall also be installed on hydrogen vapor transfer lines if the dispenser is so equipped.</p> <p><u><a href="#">11.3.1.8.5</a></u><br/>Control circuits shall be arranged so that when an ESD is activated or electric power is cut off, systems that shut down shall remain down until manually reset by a qualified technician after a safe condition is restored.</p> <p><u><a href="#">11.3.1.8.6</a></u><br/>Where a dispenser may have more than one fueling position, emergency shutoff valves shall be installed for each fueling position.</p> |
| PROPOSED REVISION (FR) |                | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| PROPOSED STATEMENT     |                | The existing 11.3.1.8 has many requirements included in a single paragraph . The proposed language separates these into separate paragraphs and adds material to make consistent with applicable safety requirements from Chapter 10 (10.3.13.5.1, 10.3.13.5, 10.3.13.7.2). Material from 11.3.3.4.7 has also been relocated here since is appropriate for this section.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

Commented [IA17]: PI 307 Is a move and split out

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| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 11.3.1.9               | 258                                                                                                                                                                                                                                                                                                                                                                           | Create First Revision                                                  |
| PI TEXT                | <b>11.3.1.9 Maximum Delivery Pressure.</b><br>The maximum delivery pressure at the vehicle tank inlet shall not exceed the maximum allowable pressure of the vehicle fuel tanks <u>or 90 percent of the lowest setpoint relief device on the vehicle fuel tank, whichever is lower.</u>                                                                                       |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                        |                                                                        |
| PROPOSED STATEMENT     | The dispensing system should also not exceed 90% of the lowest relief device to prevent venting of hydrogen from these devices during fueling at the fueling station. This requirement may change when fueling protocols and standardization of pressure classes is completed for LH2 fueling but is a prudent safeguard until those protocols are established and published. |                                                                        |

| SECTION                    | Public Input #                                                                                                                                                                                                                                                                                                                                                                                 | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 11.3.1.10.4<br>11.3.1.10.5 | 259<br>256                                                                                                                                                                                                                                                                                                                                                                                     | Create First Revision                                                  |
| PI TEXT                    | <b>11.3.1.10.4</b><br>Where hydrogen is to be used as the leak test media, the system shall first be purged with an inert gas to ensure that all oxygen <u>concentration</u> is removed <u>below 1 percent</u> .<br><br><del>11.3.1.10.5</del><br><del>Pressure relief valves shall be tested at least every 3 years.</del>                                                                    |                                                                        |
| PROPOSED REVISION (FR)     | <b>11.3.1.10.4</b><br>Where hydrogen is to be used as the leak test media, the system shall first be purged with an inert gas to ensure that <del>the</del> all oxygen <u>concentration</u> is <del>removed below</del> <u>no greater than 1 percent in any part of the system.</u><br><br><del>11.3.1.10.5</del><br><del>Pressure relief valves shall be tested at least every 3 years.</del> |                                                                        |
| PROPOSED STATEMENT         | It is impossible to remove "all oxygen", so a threshold should be used. 1% is commonly used as a safe purging level to prevent combustion. Paragraph 11.3.1.10.5 has been relocated to 11.3.1.5.2.5.                                                                                                                                                                                           |                                                                        |

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 11.3.1.11<br>11.3.1.12 | 260<br>261                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Create First Revision                                                  |
| PI TEXT                | <b>11.3.1.11 Shutoff Valve and Breakaway Device.</b><br><del>Hose and arms shall be equipped with a shut-off valve at the fuel end and a breakaway device to minimize release of liquid and vapor in the event that</del><br><br><u>11.3.1.11.1</u><br><u>A shutoff valve shall be installed on the vehicle end of the dispensing hose.</u><br><br><u>11.3.1.11.2</u><br><u>A breakaway device shall be installed to minimize the release of hydrogen if a vehicle pulls away while the hose remains connected.</u> <del>Such a</del><br><br><u>11.3.1.11.3</u><br><u>The breakaway device shall be installed and maintained in accordance with the manufacturer's instructions and to ensure proper activation in every direction that the vehicle may move.</u> |                                                                        |

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| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 11.3.1.11<br>11.3.1.12 | 260<br>261                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Create First Revision                                                  |
|                        | <p><del><b>11.3.1.12 – Emergency Shutoff Valve.</b></del><br/> Where a hose or arm of nominal 3 in. (76 mm) diameter or larger is used for liquid transfer or where one of nominal 4 in. (100 mm) diameter or larger is used for vapor transfer, an emergency shutoff valve shall be installed in the piping of the transfer system within 10 ft (3.0 m) from the nearest end of the hose or arm.</p> <p><del><b>11.3.1.12.1</b></del><br/> Where the flow is away from the hose, a check valve shall be permitted to be used as the shut-off valve.</p> <p><del><b>11.3.1.12.2</b></del><br/> Where either a liquid or vapor line has two or more legs, an emergency shut-off valve shall be installed either in each leg or in the feed line before the legs.</p> |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                        |
| PROPOSED STATEMENT     | Reorganized to separate requirements to independent paragraphs, as well as add requirements for proper activation in every direction of the breakaway material to make it consistent with Chapter 10.<br>Delete 11.3.1.12 material in lieu of the revised language in 11.3.1.8. A check valve should not be used as a shutoff valve and is eliminated as an option.                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                        |

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                              | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 11.3.1.14              | 262                                                                                                                                                                                                                                                                                                                                                         | Create First Revision                                                  |
| PI TEXT                | <p><b>11.3.1.14 Fueling Connections.</b><br/> A An approved fueling connector and mating vehicle receptacle shall be used for reliable, safe, and secure transfer of LH<sub>2</sub> or gas vapor to or from the vehicle with for secure transfer of LH<sub>2</sub> to the vehicle, and gas vapor from the vehicle if so equipped, with minimal leakage.</p> |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                      |                                                                        |
| PROPOSED STATEMENT     | Added requirement that the fueling connector must be approved. There is currently no standard for listing of these types of fueling connectors and adding approval allows use of these devices. Removed subjective language and clarified the action of the dispenser.                                                                                      |                                                                        |

| SECTION                | Public Input #                                                                                                                                                                                                                                                             | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 11.3.1.16.1            | 263                                                                                                                                                                                                                                                                        | Create First Revision                                                  |
| PI TEXT                | <p><b>11.3.1.16.1</b><br/> A warning sign with the following words shall be posted at dispensing stations and compressor or pumping the dispenser and fuel processing areas:</p> <p>STOP MOTOR, NO SMOKING, NO CELL PHONES, FLAMMABLE GAS</p>                              |                                                                        |
| PROPOSED REVISION (FR) | <p><del><b>11.2.6.2 11.3.1.16.1</b></del><br/> A warning sign with the following words shall be posted at dispensing stations and compressor or pumping the dispenser and fuel handling processing areas:</p> <p>STOP MOTOR, NO SMOKING, NO CELL PHONES, FLAMMABLE GAS</p> |                                                                        |

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| SECTION            | Public Input #                                                                   | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|--------------------|----------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 11.3.1.16.1        | 263                                                                              | Create First Revision                                                  |
| PROPOSED STATEMENT | Moved to General 11.2 so this requirement applies to the entire fueling station. |                                                                        |

| SECTION                | Public Input #                                                                                                                         | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 11.3.2                 | 264                                                                                                                                    | Create First Revision                                                  |
| PI TEXT                | <b>11.3.2 Dispensing to the Public.</b><br>Indoor LH <sub>2</sub> <del>fueling</del> dispensing shall be prohibited.                   |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.] |                                                                        |
| PROPOSED STATEMENT     | Dispensing is the more applicable term to be consistent with the Chapter 11 scope.                                                     |                                                                        |

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 11.3.3.1.2             | 265                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Create First Revision                                                  |
| PI TEXT                | <b>11.3.3.1.2</b><br><del>Dispensing devices shall be mounted on a concrete island or shall otherwise be protected against collision damage by means acceptable to the AHJ. Dispensing devices shall be securely bolted in place. [ ] Dispensing devices shall also be located in a position where they cannot be struck by a vehicle that is out of control descending a ramp or other slope. Dispensing devices shall be installed in accordance with the manufacturer's instructions. (30A.6.3.4)</del> |                                                                        |
| PROPOSED REVISION (FR) | Simplifies the paragraph to the basic requirements and eliminates redundant material which is now in 11.3.1.4.                                                                                                                                                                                                                                                                                                                                                                                             |                                                                        |
| PROPOSED STATEMENT     | [Explain WHY you have made this motion and DO NOT just repeat the revision. Must use technical justification. Be sure to write in the present tense voice (i.e., assume your motion has passed).]                                                                                                                                                                                                                                                                                                          |                                                                        |

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 11.3.3.1.5             | 246                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Create First Revision                                                  |
| PI TEXT                | <del><b>11.3.3.1.5</b><br/>A vehicle fueling pad shall be provided in the area where vehicles are to be refueled.<br/><br/><b>11.3.3.1.5.1</b><br/>The pad shall be constructed with a length and width to accommodate the types of vehicles to be fueled and to provide a surface under the fueling hose.<br/><br/><b>11.3.3.1.5.2</b><br/>The vehicle fueling pad shall be of concrete construction.<br/><br/>(A)<br/>Combustible materials, including asphalt, shall not be used for the construction of or surfacing of the fueling pad. (Sec 8.3.2.3.1.5.)</del> |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                        |

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| SECTION            | Public Input #                                                                   | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|--------------------|----------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 11.3.3.1.5         | 246                                                                              | Create First Revision                                                  |
| PROPOSED STATEMENT | These are general requirements and are moved to 11.3. See PI 243, 244, 245, 247. |                                                                        |

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 11.3.3.4.7             | 307                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | [Choose Motion]                                                        |
| PI TEXT                | <p><del>11.3.3.4.7* -</del></p> <p>Fuel dispensing systems shall be provided with one or more clearly identified emergency shutoff devices or electrical disconnects. Such devices or disconnects shall be installed in approved locations but not less than 20 ft (6 m) or more than 100 ft (30 m) from the fuel dispensing devices that they serve. Emergency shutoff devices or electrical disconnects shall disconnect power to all dispensing devices; to all remote pumps serving the dispensing devices; to all associated power, control, and signal circuits; and to all other electrical equipment in the hazardous (classified) locations surrounding the fuel dispensing devices. When more than one emergency shutoff device or electrical disconnect is provided, all devices shall be interconnected. Resetting from an emergency shutoff condition shall require manual intervention and the manner of resetting shall be approved by the authority having jurisdiction. The emergency shutoff device shall disconnect simultaneously from the source of supply, all conductors of the circuits, including the grounded conductor, if any. Equipment grounding conductors shall remain connected. <del>[70:514.11(A)]</del></p> <p><i>Exception: Intrinsically safe electrical equipment need not meet this requirement. <del>[70:514.11(A)]</del></i></p> |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                        |
| PROPOSED STATEMENT     | This paragraph is an extract from NFPA 70 and should be deleted. It includes a large number of requirements in one paragraph. Many of the requirements are not applicable to H2 dispensing stations or are already included in other sections. This paragraph is not included in Chapter 10 for the same reasons. Also, the requirements in the paragraph are general in nature and should be in 11.3.1, particularly 11.3.1.8, and limited to Outdoor Public Fueling. Several PI's have been submitted to relocate material from existing 11.3.3.4.7 to 11.3.1.8. Associated Annex material should also be deleted.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                        |

**Commented [HD18]:** From Staff: Is intended to delete the associated annex section as well or to move it?

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                              | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 11.3.4.6.1             | 267                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Create First Revision                                                  |
| PI TEXT                | <p><b>11.3.4.6.1</b></p> <p>The <u>outdoor</u> dispensing of LH<sub>2</sub> <del>in the open</del> from a transport vehicle to a motor vehicle located at a separate fleet fueling area in connection with commercial, industrial, governmental, or manufacturing establishments and intended for fueling vehicles used in connection with their businesses shall be allowed if all of the requirements of 11.3.4.6.1 through 11.3.4.6.9 have been met.</p> |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                      |                                                                        |
| PROPOSED STATEMENT     | The term “outdoor” is consistent with other language and is a more applicable term than “in the open”.                                                                                                                                                                                                                                                                                                                                                      |                                                                        |

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| SECTION                  | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 11.3.4.6.4<br>11.3.4.6.5 | 268<br>269                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Create First Revision                                                  |
| PI TEXT                  | <p><b>11.3.4.6.4</b><br/>Smoking materials, <del>including matches, lighters,</del> and other sources of ignition, <del>including torches,</del> shall not be used within 25 ft (7.6 m) of the dispensing of LH<sub>2</sub> <del>in the open</del> from a transport vehicle to a motor vehicle.</p> <p><b>11.3.4.6.5</b><br/><del>Fire extinguishers shall be provided and meet the requirements of 11.2.7.</del><br/><del>Each area where dispensing of LH<sub>2</sub> in the open from a transport vehicle to a motor vehicle shall be provided with one or more listed fire extinguishers that have a minimum capability of 40-B:C.</del></p> <p><del><b>11.3.4.6.5.1</b></del><br/><del>The fire extinguishers shall be within the dispensing operation.</del></p> <p><del><b>11.3.4.6.5.2</b></del><br/><del>Fire extinguishers shall be inspected and maintained under NFPA 10.</del></p> |                                                                        |
| PROPOSED REVISION (FR)   | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                        |
| PROPOSED STATEMENT       | <p>"In the open" is undefined and not a clear term <a href="#">in the context of this requirement</a>.</p> <p>Fire extinguisher language should be consistent, aligned with Chapter 10, and consolidated in 11.2.7.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                        |

| SECTION                | Public Input #                                                                                                                         | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 11.3.4.6.9             | 266                                                                                                                                    | Create First Revision                                                  |
| PI TEXT                | <del><b>11.3.4.6.9</b></del><br><del>The transfer area shall meet the requirements of 10.4.1.1.</del>                                  |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.] |                                                                        |
| PROPOSED STATEMENT     | This material is redundant with the requirements in the General section of this chapter and new material in 11.3.1.4.                  |                                                                        |

| SECTION | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 11.4    | 270                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Create First Revision                                                  |
| PI TEXT | <p><b>11.4 Storage.</b><br/><del><b>11.4.1 General:</b></del><br/>The storage of LH<sub>2</sub> <del>in bulk and non-bulk LH<sub>2</sub> installations</del> shall be in accordance with the applicable requirements of Chapters 6 and 8.</p> <p><del><b>11.4.2 Indoor Storage:</b></del><br/><del>Indoor storage of LH<sub>2</sub> to be used for vehicle fueling purposes shall be prohibited.</del> <a href="#">LH<sub>2</sub> delivery locations from the cargo tanker to the LH<sub>2</sub> storage system shall be sited in accordance with Chapter 8.</a></p> <p><a href="#">11.4.2.1</a><br/><a href="#">Separation distances between the delivery location and exposures shall be measured from the maximum extension of the transfer hose.</a></p> <p><del><b>11.4.3 Outdoor Storage:</b></del></p> |                                                                        |

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| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 11.4                   | 270                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Create First Revision                                                  |
|                        | <p><del><b>11.4.3.1 Ullage Space.</b></del><br/>All cryogenic containers, vessels, and tanks shall provide and maintain ullage space to prevent overfilling of the vessel.</p> <p><del><b>11.4.3.2 Stationary Storage Tanks.</b></del><br/><del><b>11.4.3.2.1</b></del><br/>Points of transfer shall be located not less than 25 ft (7.6 m) from the nearest important building not associated with the LH<sub>2</sub> facility, from the line of adjoining property that can be built upon, or from fixed sources of ignition.</p> <p><del><b>11.4.3.2.2</b></del><br/>Points of transfer shall include the maximum length of the off-loading LH<sub>2</sub> bulk supply tanker, and off-loading hoses. (See also 8.3.4.5.)</p> <p><del><b>11.4.4 Underground Storage. (Reserved)</b></del><br/><del><b>11.4.3.5 Cargo Transport Unloading.</b></del><br/><del><b>11.4.3.1.5.1</b></del><br/>Cargo transport unloading shall comply with 7.3.4.2 and 8.3.4.5.</p> <p><del><b>11.4.3.2.5.2</b></del><br/>The delivery vehicle shall be located so that all parts of the vehicle are on the premises when delivery is made. [30A:9.2.2.4]</p> <p><del><b>11.4.3.3.5.3</b></del><br/>The hydrogen site shall be designed with a traffic pattern for the cargo transport vehicle.</p> |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                        |
| PROPOSED STATEMENT     | Storage requirements should be minimized, simplified, and made consistent by referring to Chapter 8. Points of transfer language is clarified to make the original intent clear that the hose must be addressed when calculating separation distances.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                        |

| SECTION                    | Public Input #                                                                                                                                                                                                                                                                                                | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| New Section after 11.4.5.3 | 238                                                                                                                                                                                                                                                                                                           | [Choose Motion]                                                        |
| PI TEXT                    | <p><b>11.4.5.4</b><br/><u>Static protection shall be required where LH2 cargo transport vehicles are unloaded, except where cargo transport vehicles are unloaded by conductive hose, flexible metallic tubing, and pipe connections where both halves of metallic couplings are electrically bonded.</u></p> |                                                                        |
| PROPOSED REVISION (FR)     | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                        |                                                                        |
| PROPOSED STATEMENT         | Related to PI-237. Maintain same requirement with minor clarifications but move to new section 11.4.5.4 under "Cargo transport unloading" since this requirement pertains to that activity. Reference to a tight connection (top and bottom) was removed since it adds confusion to the requirement.          |                                                                        |

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| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                             | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 18.2.5.1.2             | 167                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | [Choose Motion]                                                        |
| PI TEXT                | <b>18.2.5.1.2</b><br>Repairs that would be required to be performed in a major repair garage shall be permitted to be performed in a minor repair garage if the vehicle is defueled in accordance with 18.3.2 to less than <del>400</del> <u>1000</u> scf ( <del>11.4</del> <u>28.5</u> Nm <sup>3</sup> ) and the fuel supply container is sealed and not damaged.                                                                                                         |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                     |                                                                        |
| PROPOSED STATEMENT     | Medium-heavy-duty vehicles can contain over 40,000 scf of hydrogen in much larger fuel supply containers. The original volume of 400 scf could lead to low pressures in the container which could damage the liner or allow air to leak. The increase to less than 1000 scf allows for increased pressure in the system. Although fuel supply containers are not considered part of the maximum allowable quantity, for reference the MAQ for flammable gases is 1000 scf. |                                                                        |

| SECTION                   | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| New Section after 3.3.214 | 278                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Create First Revision                                                  |
| PI TEXT                   | 3.3.197.X Nominal Working Pressure: The settled pressure of a fuel container at a uniform gas temperature of 59 F (15 C) and full gas content and for which the container, under normal conditions, has been constructed                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                        |
| PROPOSED REVISION (FR)    | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                        |
| PROPOSED STATEMENT        | Service Pressure as defined by NFPA 2 in 3.3.197.7 with a 70 F reference point is incorrect for H2 fuel vessels. H2 fuel container standards use a reference temperature of 59 F (15C). It is not advisable to change the definition of Service Pressure in NFPA 2 since Service Pressure is also a DOT term for containers which uses 70 F as the reference point. Changing the Service Pressure definition could be confusing for those vessels used for hazmat transportation. A better approach would be to use a different term, "nominal working pressure", for H2 fuel containers @ 59 F. NWP is also in common use and is defined in CSA standards for this purpose. Service pressure remains the correct term and definition for DOT vessels and NWP is the correct term and definition for fuel containers. |                                                                        |

NFPA 2 - Chapter 9 Explosion Protection Task Group Task Group Report

|            |                                                                                                                                                                                                                                                                                                                |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DOC #      | 2                                                                                                                                                                                                                                                                                                              |
| TG #/NAME  | Chapter 9 Explosion Protection Task Group                                                                                                                                                                                                                                                                      |
| TG CHAIR   | Bob Boyd                                                                                                                                                                                                                                                                                                       |
| TG MEMBERS | John J. Anicello, Nicholas Bartlett*, Larry M. Danner, Rob Early, Stephen Goyette, Dave Farese*, Marty Gresho, Elizabeth Krasowski, Chris LaFleur, Sunil Lakshmipathy, Jessica Robertson*, Alexandra Schluneker, Amy Chunzhi Shen*, Achim Wechsung, Nathan Weyandt, Steve Wheaton<br><br>*Non-committee member |

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| Annex K                | 174, 213                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Create First Revision                                                  |
| PI TEXT                | See PI submission for language.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                        |
| PROPOSED STATEMENT     | <p>The original Annex K was included in the 2011 (inaugural) Edition of NFPA 2 so that its content could be provided to the public. Chapter 9 was Reserved. The 2024 Explosion Protection Task Group (EPTG) found that the old Annex material was being misused and did not lead to the availability of explosion vents as designers and manufactures were confused.</p> <p>Amy Chunzhi Shen from Air Projects had developed the NEW Annex K material for submittal to NFPA-68 technical committee but was too late for the PI period and Dave Farese has suggested it for NFPA-2 as submitted in PI 174. The EPTG found that the proposed annex material is very informative on how to work with NFPA-68. Chapter 9 points to the NEW Annex K to enable the design and use of explosion vents and blow out panels with enclosures that contain hydrogen systems</p> |                                                                        |

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| Chapter 9              | 175                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <a href="#">Create First Revision</a>                                  |
| PI TEXT                | See PI submission for language.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                        |
| PROPOSED REVISION (FR) | <p><b>Chapter 9 Explosion Control</b></p> <p><b>9.1* General</b></p> <p>Explosion control shall be provided for buildings and hydrogen equipment enclosures where the amount of GH2 or LH2 exceeds the maximum allowable quantities per control area or where required by the hazard analysis in accordance with 9.2.</p> <p><b>A.9.1</b></p> <p>Explosion control is provided to prevent formation of flammable mixtures, prevent ignition, protect against deflagration, and prevent detonation conditions from developing when there is the potential to exceed 1 percent hydrogen concentration in enclosures.</p> |                                                                        |

| SECTION   | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
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| Chapter 9 | 175            | <a href="#">Create First Revision</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|           |                | <p>NFPA 69 provides guidance on the use of suppression, ventilation systems, and the limiting of oxidants as a means to prevent the occurrence of an explosion.</p> <p>NFPA 68 provides guidance on the use of deflagration venting systems in buildings and other enclosures. The primary purpose of a venting system is to relieve the overpressure produced in an explosion to limit the potential damage to the building where the explosion occurs. Although some structural damage can be anticipated, the use of relief venting is expected to prevent massive building failure and collapse. In cases where detonation is probable, venting is often used in conjunction with barricade construction where the pressure-resistant portions of the building have been constructed to resist the pressures anticipated should an explosive event occur.</p> <p>When relief vents are to be used as a means to provide deflagration relief, the fundamental requirements of the adopted building code for structural elements, including snow, wind, and seismic events, should be considered. In some instances, the requirements for wind resistance can impose more rigorous requirements on the relief vents than required by the engineering analysis used to determine the relief pressure. Users must demonstrate that the relief vents will not become airborne or release in such a manner as to create secondary hazards within or external to the building in which they are installed. Specific designs might require approval by the AHJ.</p> <p><b>9.1.1</b></p> <p>Explosion prevention shall be in accordance with 9.3</p> <p><b>9.1.2</b></p> <p>Where provided, explosion protection by the use of deflagration venting shall be in accordance with this chapter and NFPA 68.</p> <p><b>A.9.1.2</b></p> <p><del>While deflagration venting may help prevent transition to detonation, it is not considered a reliable method to limit damage caused by detonation pressures once transition occurs.</del></p> <p><b>9.1.3</b></p> <p>Deflagration prevention and control for occupied enclosures shall prevent the structural failure of the enclosure and minimize injury to personnel in adjacent areas outside of the enclosure. [69:4.2.1.1]</p> <p><b>9.1.4</b></p> <p>Deflagration prevention and control for unoccupied enclosures shall prevent the rupture of the enclosure. [69:4.2.1.2]</p> <p><b>9.1.5</b></p> <p>Deflagration prevention and control shall be arranged to avoid injury to personnel. [69:4.2.1.3]</p> <p><b>9.1.6</b></p> |

**Commented [RB1]:** This annex note is better suited to be located at 9.2.3

| SECTION   | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
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| Chapter 9 | 175            | <a href="#">Create First Revision</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|           |                | <p>Deflagration prevention and control systems shall be designed to limit damage of the protected enclosure. [69:4.2.2.1]</p> <p><b>9.1.7</b></p> <p>Deflagration prevention and control systems shall be arranged to avoid ignition of adjacent property. [69:4.2.2.2]</p> <p><b>9.1.6</b></p> <p>Deflagration prevention and control systems shall be designed to avoid damage to adjacent property. [69:4.2.2.3]</p> <p><b>9.1.8</b></p> <p>Deflagration prevention and control shall be designed to avoid projectile damage to adjacent property. [69:4.2.2.4]</p> <p><b>9.2 Hazard Analysis.</b></p> <p><b>9.2.1*</b></p> <p>A documented hazard analysis acceptable to the authority having jurisdiction shall be conducted to determine the level of explosion protection to be provided.</p> <p>A.9.2.1. See Annex K</p> <p><b>9.2.2</b></p> <p>The documented hazard analysis shall consider the expected leak rates and ventilation system employed.</p> <p><b>9.2.2.1</b></p> <p>The documented hazard analysis shall specify the explosion prevention and control requirements in accordance with this chapter <b>or NFPA 69.</b></p> <p><b>9.2.2.2*</b></p> <p>When required, the documented hazard analysis shall specify the deflagration venting requirements in accordance with this chapter and NFPA 68.</p> <p>A. <b>9.2.2.2</b></p> <p><b>For guidance on using NFPA 68 with hydrogen refer to Annex K</b></p> |

| SECTION   | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
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| Chapter 9 | 175                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <a href="#">Create First Revision</a>                                  |
|           | <p><b>9.2.3</b></p> <p>The risk of detonations shall not be mitigated by deflagration venting.</p> <p><a href="#">A.9.2.3</a></p> <p><a href="#">While deflagration venting may help prevent transition to detonation, it is not considered a reliable method to limit damage caused by detonation pressures once transition occurs.</a></p> <p><b>9.2.4</b></p> <p>The documented hazard analysis shall identify the explosion hazard scenarios that were considered.</p> <p><b>9.2.4.1</b></p> <p>The explosion prevention and control systems design basis shall be based on the explosion hazard scenarios of 9.2.4.</p> <p><b>9.2.4.2</b></p> <p>The determined explosion prevention and control systems shall be documented in the hazard analysis.</p> <p><b>9.3 * Methods of Explosion Prevention.</b></p> <p>The methods recognized in this code shall be grouped based on the prevention or limitation of damage after combustion occurs. [69:6.1]</p> <p><b>9.3.1 Methods Based on the Prevention of Combustion.</b></p> <p>The following shall be considered methods based on preventing combustion:</p> <ul style="list-style-type: none"> <li>(1) Oxidant concentration reduction</li> <li>(2) Combustible concentration reduction</li> </ul> <p>[69:6.1.1]</p> <p><b>9.3.2* Methods Based on the Prevention or Limitation of Damage.</b></p> <p>The following shall be considered methods based on preventing or limiting damage:</p> <ul style="list-style-type: none"> <li>(1) Predeflagration detection and ignition control systems</li> <li>(2) Deflagration suppression</li> <li>(3) Isolation methods</li> <li>(4) Deflagration pressure containment</li> </ul> |                                                                        |

| SECTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |                                                                          |       |                           |              |           |                                                |     |                                    |     |     |            |     |     |              |      |  |  |  |  |  |                                               |  |  |                           |  |  |                                                |  |                                    |  |  |  |  |  |  |  |              |              |           |              |  |  |            |  |  |              |  |  |  |  |  |  |                         |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |         |         |       |  |  |  |  |  |  |  |  |  |  |  |          |   |        |       |       |    |    |    |    |     |     |     |     |     |     |     |     |     |          |     |    |     |      |    |    |    |    |     |     |     |     |     |     |     |     |     |     |   |         |        |       |     |     |     |     |     |       |     |     |     |     |     |     |     |        |   |     |     |     |     |     |     |     |     |       |     |     |     |     |    |    |    |       |  |     |     |       |      |     |     |     |     |     |     |     |     |     |     |     |      |
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| Chapter 9                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 175            | <a href="#">Create First Revision</a>                                  |                                                                          |       |                           |              |           |                                                |     |                                    |     |     |            |     |     |              |      |  |  |  |  |  |                                               |  |  |                           |  |  |                                                |  |                                    |  |  |  |  |  |  |  |              |              |           |              |  |  |            |  |  |              |  |  |  |  |  |  |                         |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |         |         |       |  |  |  |  |  |  |  |  |  |  |  |          |   |        |       |       |    |    |    |    |     |     |     |     |     |     |     |     |     |          |     |    |     |      |    |    |    |    |     |     |     |     |     |     |     |     |     |     |   |         |        |       |     |     |     |     |     |       |     |     |     |     |     |     |     |        |   |     |     |     |     |     |     |     |     |       |     |     |     |     |    |    |    |       |  |     |     |       |      |     |     |     |     |     |     |     |     |     |     |     |      |
| <div>[69:6.1.2]</div> <div><div><b>A.9.3.2</b><br/><a href="#">Table A.9.3.2 shows the detection limits for layers of protection used to minimize the risk of ignition and deflagration of hydrogen / air mixtures. The first layer is personal protection hand held sensors detecting hydrogen in the 10 to 1000 ppm levels. The second layer is the flammable gas detectors that monitor compartments or areas for leaks and alarm at the 1 to 3 ppm range of hydrogen in air, and shut off sources of hydrogen if at less than the flammable limit. The third layer of protection is the use of blowout panels, i.e. deflagration venting.</a></div><div><table><tr><th colspan="18">Flammable and Explosive mixtures of Hydrogen and Air inside an enclosure</th></tr><tr><th colspan="2" rowspan="2"></th><th colspan="3" rowspan="2">Portable Personal Monitors<br/>(0 to 1000 ppm)</th><th colspan="3">Emergency Shutdown System</th><th colspan="2" rowspan="2">Flammable<br/><br/>still mixes<br/>turbulent jets</th><th colspan="8">Explosive Range of Hydrogen in Air</th></tr><tr><th>Alarm Action</th><th>Alarm Action</th><th>Shut Down</th><th colspan="3">Deflagration</th><th colspan="3">Detonation</th><th colspan="2">Deflagration</th></tr><tr><th colspan="2"></th><th colspan="3"></th><th colspan="3">FLAMMABLE GAS DETECTION</th><th colspan="2"></th><th colspan="3"></th><th colspan="3"></th><th colspan="3"></th></tr><tr><th colspan="2"></th><th colspan="3"></th><th>20% LFL</th><th>50% LFL</th><th>"LFL"</th><th colspan="2"></th><th colspan="3"></th><th colspan="3"></th><th colspan="3"></th></tr><tr><td>hydrogen</td><td>%</td><td>0.001%</td><td>0.01%</td><td>0.10%</td><td>1%</td><td>2%</td><td>4%</td><td>5%</td><td>10%</td><td>11%</td><td>12%</td><td>17%</td><td>18%</td><td>30%</td><td>59%</td><td>60%</td><td>70%</td></tr><tr><td>hydrogen</td><td>ppm</td><td>10</td><td>100</td><td>1000</td><td>1%</td><td>2%</td><td>4%</td><td>5%</td><td>10%</td><td>11%</td><td>12%</td><td>17%</td><td>18%</td><td>30%</td><td>59%</td><td>60%</td><td>70%</td></tr><tr><td>air</td><td>%</td><td>99.999%</td><td>99.99%</td><td>99.9%</td><td>99%</td><td>98%</td><td>96%</td><td>95%</td><td>90%</td><td>89.5%</td><td>88%</td><td>83%</td><td>82%</td><td>70%</td><td>41%</td><td>40%</td><td>30%</td></tr><tr><td>oxygen</td><td>%</td><td>21%</td><td>21%</td><td>21%</td><td>21%</td><td>21%</td><td>20%</td><td>20%</td><td>19%</td><td>18.8%</td><td>18%</td><td>17%</td><td>17%</td><td>15%</td><td>9%</td><td>8%</td><td>6%</td></tr><tr><td>H2/O2</td><td></td><td>0.0</td><td>0.0</td><td>0.005</td><td>0.05</td><td>0.1</td><td>0.2</td><td>0.3</td><td>0.5</td><td>0.6</td><td>0.7</td><td>1.0</td><td>1.1</td><td>2.0</td><td>6.8</td><td>7.2</td><td>11.1</td></tr></table></div></div> |                |                                                                        | Flammable and Explosive mixtures of Hydrogen and Air inside an enclosure |       |                           |              |           |                                                |     |                                    |     |     |            |     |     |              |      |  |  |  |  |  | Portable Personal Monitors<br>(0 to 1000 ppm) |  |  | Emergency Shutdown System |  |  | Flammable<br><br>still mixes<br>turbulent jets |  | Explosive Range of Hydrogen in Air |  |  |  |  |  |  |  | Alarm Action | Alarm Action | Shut Down | Deflagration |  |  | Detonation |  |  | Deflagration |  |  |  |  |  |  | FLAMMABLE GAS DETECTION |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 20% LFL | 50% LFL | "LFL" |  |  |  |  |  |  |  |  |  |  |  | hydrogen | % | 0.001% | 0.01% | 0.10% | 1% | 2% | 4% | 5% | 10% | 11% | 12% | 17% | 18% | 30% | 59% | 60% | 70% | hydrogen | ppm | 10 | 100 | 1000 | 1% | 2% | 4% | 5% | 10% | 11% | 12% | 17% | 18% | 30% | 59% | 60% | 70% | air | % | 99.999% | 99.99% | 99.9% | 99% | 98% | 96% | 95% | 90% | 89.5% | 88% | 83% | 82% | 70% | 41% | 40% | 30% | oxygen | % | 21% | 21% | 21% | 21% | 21% | 20% | 20% | 19% | 18.8% | 18% | 17% | 17% | 15% | 9% | 8% | 6% | H2/O2 |  | 0.0 | 0.0 | 0.005 | 0.05 | 0.1 | 0.2 | 0.3 | 0.5 | 0.6 | 0.7 | 1.0 | 1.1 | 2.0 | 6.8 | 7.2 | 11.1 |
| Flammable and Explosive mixtures of Hydrogen and Air inside an enclosure                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                |                                                                        |                                                                          |       |                           |              |           |                                                |     |                                    |     |     |            |     |     |              |      |  |  |  |  |  |                                               |  |  |                           |  |  |                                                |  |                                    |  |  |  |  |  |  |  |              |              |           |              |  |  |            |  |  |              |  |  |  |  |  |  |                         |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |         |         |       |  |  |  |  |  |  |  |  |  |  |  |          |   |        |       |       |    |    |    |    |     |     |     |     |     |     |     |     |     |          |     |    |     |      |    |    |    |    |     |     |     |     |     |     |     |     |     |     |   |         |        |       |     |     |     |     |     |       |     |     |     |     |     |     |     |        |   |     |     |     |     |     |     |     |     |       |     |     |     |     |    |    |    |       |  |     |     |       |      |     |     |     |     |     |     |     |     |     |     |     |      |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                | Portable Personal Monitors<br>(0 to 1000 ppm)                          |                                                                          |       | Emergency Shutdown System |              |           | Flammable<br><br>still mixes<br>turbulent jets |     | Explosive Range of Hydrogen in Air |     |     |            |     |     |              |      |  |  |  |  |  |                                               |  |  |                           |  |  |                                                |  |                                    |  |  |  |  |  |  |  |              |              |           |              |  |  |            |  |  |              |  |  |  |  |  |  |                         |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |         |         |       |  |  |  |  |  |  |  |  |  |  |  |          |   |        |       |       |    |    |    |    |     |     |     |     |     |     |     |     |     |          |     |    |     |      |    |    |    |    |     |     |     |     |     |     |     |     |     |     |   |         |        |       |     |     |     |     |     |       |     |     |     |     |     |     |     |        |   |     |     |     |     |     |     |     |     |       |     |     |     |     |    |    |    |       |  |     |     |       |      |     |     |     |     |     |     |     |     |     |     |     |      |
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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                |                                                                        |                                                                          |       | FLAMMABLE GAS DETECTION   |              |           |                                                |     |                                    |     |     |            |     |     |              |      |  |  |  |  |  |                                               |  |  |                           |  |  |                                                |  |                                    |  |  |  |  |  |  |  |              |              |           |              |  |  |            |  |  |              |  |  |  |  |  |  |                         |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |         |         |       |  |  |  |  |  |  |  |  |  |  |  |          |   |        |       |       |    |    |    |    |     |     |     |     |     |     |     |     |     |          |     |    |     |      |    |    |    |    |     |     |     |     |     |     |     |     |     |     |   |         |        |       |     |     |     |     |     |       |     |     |     |     |     |     |     |        |   |     |     |     |     |     |     |     |     |       |     |     |     |     |    |    |    |       |  |     |     |       |      |     |     |     |     |     |     |     |     |     |     |     |      |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                |                                                                        |                                                                          |       | 20% LFL                   | 50% LFL      | "LFL"     |                                                |     |                                    |     |     |            |     |     |              |      |  |  |  |  |  |                                               |  |  |                           |  |  |                                                |  |                                    |  |  |  |  |  |  |  |              |              |           |              |  |  |            |  |  |              |  |  |  |  |  |  |                         |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |         |         |       |  |  |  |  |  |  |  |  |  |  |  |          |   |        |       |       |    |    |    |    |     |     |     |     |     |     |     |     |     |          |     |    |     |      |    |    |    |    |     |     |     |     |     |     |     |     |     |     |   |         |        |       |     |     |     |     |     |       |     |     |     |     |     |     |     |        |   |     |     |     |     |     |     |     |     |       |     |     |     |     |    |    |    |       |  |     |     |       |      |     |     |     |     |     |     |     |     |     |     |     |      |
| hydrogen                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | %              | 0.001%                                                                 | 0.01%                                                                    | 0.10% | 1%                        | 2%           | 4%        | 5%                                             | 10% | 11%                                | 12% | 17% | 18%        | 30% | 59% | 60%          | 70%  |  |  |  |  |  |                                               |  |  |                           |  |  |                                                |  |                                    |  |  |  |  |  |  |  |              |              |           |              |  |  |            |  |  |              |  |  |  |  |  |  |                         |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |         |         |       |  |  |  |  |  |  |  |  |  |  |  |          |   |        |       |       |    |    |    |    |     |     |     |     |     |     |     |     |     |          |     |    |     |      |    |    |    |    |     |     |     |     |     |     |     |     |     |     |   |         |        |       |     |     |     |     |     |       |     |     |     |     |     |     |     |        |   |     |     |     |     |     |     |     |     |       |     |     |     |     |    |    |    |       |  |     |     |       |      |     |     |     |     |     |     |     |     |     |     |     |      |
| hydrogen                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | ppm            | 10                                                                     | 100                                                                      | 1000  | 1%                        | 2%           | 4%        | 5%                                             | 10% | 11%                                | 12% | 17% | 18%        | 30% | 59% | 60%          | 70%  |  |  |  |  |  |                                               |  |  |                           |  |  |                                                |  |                                    |  |  |  |  |  |  |  |              |              |           |              |  |  |            |  |  |              |  |  |  |  |  |  |                         |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |         |         |       |  |  |  |  |  |  |  |  |  |  |  |          |   |        |       |       |    |    |    |    |     |     |     |     |     |     |     |     |     |          |     |    |     |      |    |    |    |    |     |     |     |     |     |     |     |     |     |     |   |         |        |       |     |     |     |     |     |       |     |     |     |     |     |     |     |        |   |     |     |     |     |     |     |     |     |       |     |     |     |     |    |    |    |       |  |     |     |       |      |     |     |     |     |     |     |     |     |     |     |     |      |
| air                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | %              | 99.999%                                                                | 99.99%                                                                   | 99.9% | 99%                       | 98%          | 96%       | 95%                                            | 90% | 89.5%                              | 88% | 83% | 82%        | 70% | 41% | 40%          | 30%  |  |  |  |  |  |                                               |  |  |                           |  |  |                                                |  |                                    |  |  |  |  |  |  |  |              |              |           |              |  |  |            |  |  |              |  |  |  |  |  |  |                         |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |         |         |       |  |  |  |  |  |  |  |  |  |  |  |          |   |        |       |       |    |    |    |    |     |     |     |     |     |     |     |     |     |          |     |    |     |      |    |    |    |    |     |     |     |     |     |     |     |     |     |     |   |         |        |       |     |     |     |     |     |       |     |     |     |     |     |     |     |        |   |     |     |     |     |     |     |     |     |       |     |     |     |     |    |    |    |       |  |     |     |       |      |     |     |     |     |     |     |     |     |     |     |     |      |
| oxygen                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | %              | 21%                                                                    | 21%                                                                      | 21%   | 21%                       | 21%          | 20%       | 20%                                            | 19% | 18.8%                              | 18% | 17% | 17%        | 15% | 9%  | 8%           | 6%   |  |  |  |  |  |                                               |  |  |                           |  |  |                                                |  |                                    |  |  |  |  |  |  |  |              |              |           |              |  |  |            |  |  |              |  |  |  |  |  |  |                         |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |         |         |       |  |  |  |  |  |  |  |  |  |  |  |          |   |        |       |       |    |    |    |    |     |     |     |     |     |     |     |     |     |          |     |    |     |      |    |    |    |    |     |     |     |     |     |     |     |     |     |     |   |         |        |       |     |     |     |     |     |       |     |     |     |     |     |     |     |        |   |     |     |     |     |     |     |     |     |       |     |     |     |     |    |    |    |       |  |     |     |       |      |     |     |     |     |     |     |     |     |     |     |     |      |
| H2/O2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                | 0.0                                                                    | 0.0                                                                      | 0.005 | 0.05                      | 0.1          | 0.2       | 0.3                                            | 0.5 | 0.6                                | 0.7 | 1.0 | 1.1        | 2.0 | 6.8 | 7.2          | 11.1 |  |  |  |  |  |                                               |  |  |                           |  |  |                                                |  |                                    |  |  |  |  |  |  |  |              |              |           |              |  |  |            |  |  |              |  |  |  |  |  |  |                         |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |         |         |       |  |  |  |  |  |  |  |  |  |  |  |          |   |        |       |       |    |    |    |    |     |     |     |     |     |     |     |     |     |          |     |    |     |      |    |    |    |    |     |     |     |     |     |     |     |     |     |     |   |         |        |       |     |     |     |     |     |       |     |     |     |     |     |     |     |        |   |     |     |     |     |     |     |     |     |       |     |     |     |     |    |    |    |       |  |     |     |       |      |     |     |     |     |     |     |     |     |     |     |     |      |
| <div><b>A.9.3.2(1)</b><br/>Annex L contains guidance relative to the detection of hydrogen.</div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                |                                                                        |                                                                          |       |                           |              |           |                                                |     |                                    |     |     |            |     |     |              |      |  |  |  |  |  |                                               |  |  |                           |  |  |                                                |  |                                    |  |  |  |  |  |  |  |              |              |           |              |  |  |            |  |  |              |  |  |  |  |  |  |                         |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |         |         |       |  |  |  |  |  |  |  |  |  |  |  |          |   |        |       |       |    |    |    |    |     |     |     |     |     |     |     |     |     |          |     |    |     |      |    |    |    |    |     |     |     |     |     |     |     |     |     |     |   |         |        |       |     |     |     |     |     |       |     |     |     |     |     |     |     |        |   |     |     |     |     |     |     |     |     |       |     |     |     |     |    |    |    |       |  |     |     |       |      |     |     |     |     |     |     |     |     |     |     |     |      |
| <div><b>9.3.3* Limitations.</b><br/><br/>The limitations specific to each method shall be considered and are specified in the corresponding chapter for each method. [69:6.2]</div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                |                                                                        |                                                                          |       |                           |              |           |                                                |     |                                    |     |     |            |     |     |              |      |  |  |  |  |  |                                               |  |  |                           |  |  |                                                |  |                                    |  |  |  |  |  |  |  |              |              |           |              |  |  |            |  |  |              |  |  |  |  |  |  |                         |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |         |         |       |  |  |  |  |  |  |  |  |  |  |  |          |   |        |       |       |    |    |    |    |     |     |     |     |     |     |     |     |     |          |     |    |     |      |    |    |    |    |     |     |     |     |     |     |     |     |     |     |   |         |        |       |     |     |     |     |     |       |     |     |     |     |     |     |     |        |   |     |     |     |     |     |     |     |     |       |     |     |     |     |    |    |    |       |  |     |     |       |      |     |     |     |     |     |     |     |     |     |     |     |      |
| <div><b>A.9.3.3.</b><br/>Damage resulting from detonations cannot be prevented or limited by deflagration suppression or deflagration pressure containment.</div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                |                                                                        |                                                                          |       |                           |              |           |                                                |     |                                    |     |     |            |     |     |              |      |  |  |  |  |  |                                               |  |  |                           |  |  |                                                |  |                                    |  |  |  |  |  |  |  |              |              |           |              |  |  |            |  |  |              |  |  |  |  |  |  |                         |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |         |         |       |  |  |  |  |  |  |  |  |  |  |  |          |   |        |       |       |    |    |    |    |     |     |     |     |     |     |     |     |     |          |     |    |     |      |    |    |    |    |     |     |     |     |     |     |     |     |     |     |   |         |        |       |     |     |     |     |     |       |     |     |     |     |     |     |     |        |   |     |     |     |     |     |     |     |     |       |     |     |     |     |    |    |    |       |  |     |     |       |      |     |     |     |     |     |     |     |     |     |     |     |      |
| <div><b>9.3.4 Factors to Be Considered.</b><br/><br/>The following factors shall be considered in the selection of one of the methods and the design of the system:</div> <div><div><div>(1) Effectiveness of each method</div><div>(2) Reliability of the system</div><div>(3) Personnel hazards inherent in each method [69:6.3]</div></div></div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |                                                                        |                                                                          |       |                           |              |           |                                                |     |                                    |     |     |            |     |     |              |      |  |  |  |  |  |                                               |  |  |                           |  |  |                                                |  |                                    |  |  |  |  |  |  |  |              |              |           |              |  |  |            |  |  |              |  |  |  |  |  |  |                         |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |         |         |       |  |  |  |  |  |  |  |  |  |  |  |          |   |        |       |       |    |    |    |    |     |     |     |     |     |     |     |     |     |          |     |    |     |      |    |    |    |    |     |     |     |     |     |     |     |     |     |     |   |         |        |       |     |     |     |     |     |       |     |     |     |     |     |     |     |        |   |     |     |     |     |     |     |     |     |       |     |     |     |     |    |    |    |       |  |     |     |       |      |     |     |     |     |     |     |     |     |     |     |     |      |
| <div><b>9.3.5 System Reliability</b><br/><br/>The reliability of the system chosen shall be assessed using the following factors:</div> <div><div><div>(1) System design basis</div><div>(2) Possibility of electrical and mechanical malfunction (see 15.5.5.1 of NFPA 69 for safety system controls and instrumentation reliability requirements)</div></div></div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                |                                                                        |                                                                          |       |                           |              |           |                                                |     |                                    |     |     |            |     |     |              |      |  |  |  |  |  |                                               |  |  |                           |  |  |                                                |  |                                    |  |  |  |  |  |  |  |              |              |           |              |  |  |            |  |  |              |  |  |  |  |  |  |                         |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |         |         |       |  |  |  |  |  |  |  |  |  |  |  |          |   |        |       |       |    |    |    |    |     |     |     |     |     |     |     |     |     |          |     |    |     |      |    |    |    |    |     |     |     |     |     |     |     |     |     |     |   |         |        |       |     |     |     |     |     |       |     |     |     |     |     |     |     |        |   |     |     |     |     |     |     |     |     |       |     |     |     |     |    |    |    |       |  |     |     |       |      |     |     |     |     |     |     |     |     |     |     |     |      |

| SECTION            | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
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| Chapter 9          | 175            | <a href="#">Create First Revision</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|                    |                | <p>(3) Dependence on sophisticated activating systems<br/> (4) Need for special installation, training, operating, testing, and maintenance procedures<br/> (5) <del>Further limitations as presented in each chapter</del><br/> (6) <del>[69:6.3.1]</del></p> <p><b>9.3.6 Installation, Inspection, and Maintenance of Explosion Protection Systems</b></p> <p>The installation, inspection, and maintenance of explosion necessary for proper function of and operation of deflagration prevention and control systems shall be in accordance with this standard and Chapter 15 of NFPA 69.</p> <p><b>9.4 Deflagration Venting</b></p> <p>When required by 9.2, deflagration venting shall be provided in accordance with this chapter and NFPA 68.</p> <p><b>9.4.1</b><br/> Deflagration venting shall not be permitted for management of detonations.</p> <p><b>9.4.2*</b><br/> Where the hazard consists of a hydrogen in air mixture, the vent size shall be based on the fundamental burning velocity of the mixture.</p> <p><b>A.9.4.2</b><br/> See annex K.1 of NFPA 68 for the Burning Velocity of Hydrogen</p> <p><b>9.4.3*</b><br/> Where the gas mixture composition is not certain, the vent size shall be based on the component having the highest fundamental burning velocity. <del>[68:6.2.1.2]</del></p> <p><b>A.9.7.3</b><br/> See annex K for more information on design deflagration venting for hydrogen enclosures.</p> <p><b>9.4.3.1*</b><br/> Deflagration venting, required by 9.2 shall be designed for 18 percent hydrogen in air.</p> <p><b>A.9.4.3.1</b><br/> Hydrogen concentrations exceeding 18 vol percent to 20 vol percent can readily undergo a deflagration to detonation transition in large enclosures, particularly those with congestion.</p> |
| PROPOSED STATEMENT |                | <p><del>The original Annex K that was included in the 2011 (inaugural) Edition of NFPA 2 so that its content could be provided to the public. Chapter 9 was Reserved. The 2024 Explosion Protection Task Group (EPTG) found that the old Annex K content was being misused and did not lead to the availability of explosion vents as designers and manufactures were confused. Amy Chunzhi Shen from Air Projects had developed</del></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

**Commented [DH2]:** Is this referencing specific chapters in NFPA 69?

| SECTION   | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-----------|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Chapter 9 | 175            | <a href="#">Create First Revision</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|           |                | <p><del>the NEW Annex K material for submittal to NFPA-68 technical committee but was too late for the PI period and Dave Farese has suggested it for NFPA-2 as submitted as NEW Annex K content. First Revision xx</del></p> <p><del>The 2024 EPTG found that the proposed annex material is very informative on how to work with NFPA-68.</del> Chapter 9 points enables the design and use of explosion vents and blow out panels for enclosures that contain hydrogen systems and captures (extracts) key requirements from NFPA-68 and NFPA-69 for explosion prevention and control, including deflagration venting. The explosion protection calculations of NFPA 68 require a deflagration vent that is larger than the available vent area.</p> <p>The calculated deflagration vent area per NFPA 68 for a stoichiometric mixture of hydrogen is in many cases larger than the available vent area for the enclosure. The additional benefit from vent sized for more than 18% diminishes rapidly based on the increased likelihood of DDT. The numbers in table 9.3.2 come from the information Amy Shen paper and Thomas Jordan Karlsruhe Institute of technology research. Key requirements are extracted from NFPA 69 to point the user to basic explosion prevention requirements.</p> |

| SECTION    | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|------------|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3.3.51.2   | 107            | <a href="#">Create First Revision</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| A.3.3.51.2 | 106            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| PI TEXT    |                | <p><b>3.3.51.2* Explosion Control.</b><br/>A means of <del>either</del> preventing an explosion through the use of explosion suppression, fuel reduction, or oxidant reduction systems or a means to prevent the structural collapse of a building in the event of an explosion through the use of deflagration venting, barricades, or related construction methods.</p> <p><b>A.3.3.51.2 Explosion Control.</b><br/><a href="#">Explosion control is provided to prevent formation of flammable mixtures, prevent ignition, protect against deflagration, and prevent detonation conditions from developing when there is the potential to exceed 1 percent hydrogen concentration in enclosures.</a></p> <p><a href="#">NFPA 69 provides guidance on the use of suppression, ventilation systems, and the limiting of oxidants as a means to prevent the occurrence of an explosion.</a></p> <p>NFPA 68 provides guidance on the use of deflagration venting systems in buildings and other enclosures. The primary purpose of a venting system is to relieve the overpressure produced in an explosion to limit the potential damage to the building where the explosion occurs. Although some structural damage can be anticipated, the use of relief venting is expected to prevent massive building failure and collapse. In cases where detonation is probable, venting is often used in conjunction with barricade construction where the pressure-resistant portions of the building have been constructed to resist the pressures anticipated should an explosive event occur. Design of barricade systems is highly specialized and the subject of military standards applicable to the subject. <del>NFPA-69 provides guidance on the use of</del></p> |

| SECTION                | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|------------------------|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3.3.51.2<br>A.3.3.51.2 | 107<br>106     | <a href="#">Create First Revision</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|                        |                | <del>suppression, ventilation systems, and the limiting of oxidants as a means to prevent the occurrence of an explosion.</del> When relief vents are to be used as a means to provide explosion relief, the fundamental requirements of the adopted building code for structural elements, including snow, wind, and seismic events, should be considered. In some instances, the requirements for wind resistance can impose more rigorous requirements on the relief vents than required by the engineering analysis used to determine the relief pressure. In such cases, users must demonstrate that the relief vents will not become airborne or release in such a manner as to create secondary hazards within or external to the building in which they are installed. Specific designs might require approval by the AHJ. |
| PROPOSED REVISION (FR) |                | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| PROPOSED STATEMENT     |                | <p>When we read the word "either" in the definition it seems to imply you can do either (1) try to prevent an explosion or (2) manage the explosion the best you can. The 2024 EP TG wanted to stress that one must always try to prevent an explosion and if the risk assessment shows an explosion is a likely possibility, then add deflagration venting. The word <b><i>either</i></b> is confusing and the definition reads better without the word either.</p> <p>For the annex note, the The 2024 EP TG felt it was important pull the sentence regarding NFPA 69 out of the pargraph regarding NFPA 68 and put that first. We then added the new first paragraph to clarify the intent of prevention first and protection as a secondary layer</p>                                                                         |

| SECTION | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|---------|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3.3.81  | 169            | <a href="#">Create First Revision</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| PI TEXT |                | <p><b>3.3.81* Explosion Control.</b><br/> <del>See 3.3.51.2.</del><br/> <a href="#">A means of preventing an explosion through the use of explosion suppression, fuel reduction, or oxidant reduction systems or a means to prevent the structural collapse of a building in the event of an explosion through the use of deflagration venting, barricades, or related construction methods.</a></p> <p><b><a href="#">A.3.3.51.2 Explosion Control.</a></b><br/> <a href="#">Explosion control is provided to prevent formation of flammable mixtures, prevent ignition, protect against deflagration, and prevent detonation conditions from developing when there is the potential to exceed 1 percent hydrogen concentration in enclosures.</a></p> <p><a href="#">NFPA 69 provides guidance on the use of suppression, ventilation systems, and the limiting of oxidants as a means to prevent the occurrence of an explosion.</a></p> <p><a href="#">NFPA 68 provides guidance on the use of deflagration venting systems in buildings and other enclosures. The primary purpose of a venting system is to relieve the overpressure produced in an explosion to limit the potential damage to the building where the explosion occurs. Although some structural damage can be anticipated,</a></p> |

| SECTION                | Public Input #                                                                                                                                                                        | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3.3.81                 | 169                                                                                                                                                                                   | <a href="#">Create First Revision</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|                        |                                                                                                                                                                                       | <a href="#">the use of relief venting is expected to prevent massive building failure and collapse. In cases where detonation is probable, venting is often used in conjunction with barricade construction where the pressure-resistant portions of the building have been constructed to resist the pressures anticipated should an explosive event occur. Design of barricade systems is highly specialized and the subject of military standards applicable to the subject. When relief vents are to be used as a means to provide explosion relief, the fundamental requirements of the adopted building code for structural elements, including snow, wind, and seismic events, should be considered. In some instances, the requirements for wind resistance can impose more rigorous requirements on the relief vents than required by the engineering analysis used to determine the relief pressure. In such cases, users must demonstrate that the relief vents will not become airborne or release in such a manner as to create secondary hazards within or external to the building in which they are installed. Specific designs might require approval by the AHJ.</a> |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| PROPOSED STATEMENT     | This First Revision and PI 170 and PI 215 move the definition and annex note for <b>explosion control</b> “out from under control” and points to the new location of the definition . |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 3.3.51.1<br>A.3.3.51.2 | 170<br>215                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Create First Revision                                                  |
| PI TEXT                | <p><b>3.3.51.2* Explosion Control.</b><br/> A means of either preventing an explosion through the use of explosion suppression, fuel reduction, or oxidant reduction systems or a means to prevent the structural collapse of a building in the event of an explosion through the use of deflagration venting, barricades, or related construction methods. <a href="#">See 3.3.81</a></p> <p><del><b>A.3.3.51.2 Explosion Control.</b><br/> NFPA 68 provides guidance on the use of deflagration venting systems in buildings and other enclosures. The primary purpose of a venting system is to relieve the overpressure produced in an explosion to limit the potential damage to the building where the explosion occurs. Although some structural damage can be anticipated, the use of relief venting is expected to prevent massive building failure and collapse. In cases where detonation is probable, venting is often used in conjunction with barricade construction where the pressure-resistant portions of the building have been constructed to resist the pressures anticipated should an explosive event occur. Design of barricade systems is highly specialized and the subject of military standards applicable to the subject. NFPA 69 provides guidance on the use of suppression, ventilation systems, and the limiting of oxidants as a means to prevent the occurrence of an explosion. When relief vents are to be used as a means to provide explosion relief, the fundamental requirements of the adopted building code for structural elements, including snow, wind, and seismic events, should be considered. In some instances, the requirements for wind resistance can impose more rigorous requirements on the relief vents than required by the engineering analysis used to determine the relief pressure. In such cases, users must demonstrate that the relief vents will not become airborne or release in such a manner as to create secondary hazards within or external to the building in which they are installed. Specific designs might require approval by the AHJ.</del></p> |                                                                        |

| SECTION                | Public Input #                                                                                                                                                            | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 3.3.51.1<br>A.3.3.51.2 | 170<br>215                                                                                                                                                                | Create First Revision                                                  |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                    |                                                                        |
| PROPOSED STATEMENT     | This First Revision and PI 169 moves the definition and annex note for <b>explosion control</b> “out from under control” and points to the new location of the definition |                                                                        |

| SECTION                | Public Input #                                                                                                                                        | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| New Definition         | 171                                                                                                                                                   | Create First Revision                                                  |
| PI TEXT                | <b>3.3.X Deflagration.</b><br>Propagation of a combustion zone at a velocity that is less than the speed of sound in the unreacted medium. [68, 2023] |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                |                                                                        |
| PROPOSED STATEMENT     | The term appears in the new proposed language in Chapter 9 and needs to be defined.                                                                   |                                                                        |

| SECTION                | Public Input #                                                                                                                                         | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| New Definition         | 172                                                                                                                                                    | Create First Revision                                                  |
| PI TEXT                | <b>3.3.X Detonation.</b><br>Propagation of a combustion zone at a velocity that is greater than the speed of sound in the unreacted medium. [68, 2023] |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                 |                                                                        |
| PROPOSED STATEMENT     | The term appears in the new proposed language in Chapter 9 and needs to be defined.                                                                    |                                                                        |

| SECTION                | Public Input #                                                                                                                                                                                                                                                                          | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| New Definition         | 173                                                                                                                                                                                                                                                                                     | Create First Revision                                                  |
| PI TEXT                | <b>3.3.XX Enclosure.</b><br>A confined or partially confined volume. [68, 2023]<br><br><b>A.3.3.XX Enclosure.</b><br>Examples of enclosures include a room, building, vessel, silo, bin, pipe, or duct. [68, 2023]                                                                      |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                  |                                                                        |
| PROPOSED STATEMENT     | <del>The term appears in the new proposed language in Chapter 9 and needs to be defined.</del> The term enclosure appears multiple times in NFPA 2 not in the context of explosion protection and cannot be added without further evaluation of where the term is used in the document. |                                                                        |

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 6.10                   | 157                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Create First Revision                                                  |
| PI TEXT                | <p><b>6.10* Explosion Control.</b></p> <p><b>6.10.1</b><br/>Explosion control shall be provided where the quantity of GH<sub>2</sub> or LH<sub>2</sub> in storage or use exceeds the quantity thresholds requiring special provisions as listed in Table 6.4.1.1.1 or where otherwise required.</p> <p><b>6.10.2</b><br/>Where explosion control is required, it shall be provided <u>using the methods in Chapter 9</u>.<br/><del>by one or both of the following methods:</del></p> <p><del>(1) — Explosion prevention in accordance with 6.10.3</del><br/><del>(2) — Deflagration venting in accordance with 6.10.4</del></p> <p><b>6.10.3* Explosion Prevention:</b><br/><del>Where provided, explosion prevention shall be in accordance with one or more of the methods specified in NFPA 69.</del></p> <p><b>6.10.4 Deflagration Venting:</b><br/><del>Where provided, explosion protection by the use of deflagration venting shall be in accordance with NFPA 68.</del></p> |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                        |
| PROPOSED STATEMENT     | Instead of NFPA-2 references to 6.10 Explosion Control, we want to direct the user to Chapter 9 Explosion Protection which includes Explosion Prevention and Control                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                        |

| SECTION                | Public Input #                                                                                                                                                             | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 7.1.23.15.1            | 108                                                                                                                                                                        | <a href="#">Create First Revision</a>                                  |
| PI TEXT                | <p><b>7.1.23.15.1</b><br/>Where required by Table 7.1.23.9.1, explosion control shall be provided in accordance with <del>Section 6.10</del><a href="#">Chapter 9</a>.</p> |                                                                        |
| PROPOSED REVISION (FR) | Redirect the user to Chapter 9 Explosion Protection which includes Explosion Prevention and Control                                                                        |                                                                        |
| PROPOSED STATEMENT     | <a href="#">The cross reference to section 6.10 is being changed to chapter 9 which now contains the explosion protection requirements.</a>                                |                                                                        |

| SECTION                | Public Input #                                                                                                                                              | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 7.3.2.2.2.3            | 109                                                                                                                                                         | <a href="#">Create First Revision</a>                                  |
| PI TEXT                | <p><b>7.3.2.2.2.3*</b><br/>Explosion control shall be provided in accordance with the requirements of <del>Section 6.10</del><a href="#">Chapter 9</a>.</p> |                                                                        |
| PROPOSED REVISION (FR) | <a href="#">The cross reference to section 6.10 is being changed to chapter 9 which now contains the explosion protection requirements.</a>                 |                                                                        |
| PROPOSED STATEMENT     | Redirect the user to Chapter 9 Explosion Protection which includes Explosion Prevention and Control                                                         |                                                                        |

| SECTION                | Public Input #                                                                                                                                                                                                                                  | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 7.3.2.2.3.3            | 110                                                                                                                                                                                                                                             | <a href="#">Create First Revision</a>                                  |
| PI TEXT                | <b>7.3.2.2.3.3</b><br>Explosion control shall be provided in accordance with the requirements of <a href="#">Chapter 9</a> <del>Section 6.10</del> .                                                                                            |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                          |                                                                        |
| PROPOSED STATEMENT     | <a href="#">The cross reference to section 6.10 is being changed to chapter 9 which now contains the explosion protection requirements. Redirect the user to Chapter 9 Explosion Protection which includes Explosion Prevention and Control</a> |                                                                        |

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 7.3.2.5                | 111                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <a href="#">Create First Revision</a>                                  |
| PI TEXT                | <b>7.3.2.5 Courts.</b><br>Where a bulk gas system is located in a court or enclosed court, the installation shall meet all of the following requirements:<br><br><ol style="list-style-type: none"> <li>(1) Courts shall have natural or mechanical ventilation in accordance with Section 6.18.</li> <li>(2) Explosion control shall be provided in accordance with the requirements of <del>Section 6.10</del><a href="#">Chapter 9</a>.</li> <li>(3) The distance from any part of the system to exterior building walls and related exposures shall meet the requirements of Table 7.3.2.3.1.2(B)(a), Table 7.3.2.3.1.2(B)(b), or Table 7.3.2.3.1.2(B)(c).</li> <li>(4) Fire barrier walls shall meet the requirements of 7.3.2.3.1.4(A)(1) through 7.3.2.3.1.4(A)(4) and 7.3.2.3.1.4(A)(7) through 7.3.2.3.1.4(A)(9).</li> <li>(5) Vents and ventilation exhausts shall terminate above the walls or outside of the court.</li> </ol> |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                        |
| PROPOSED STATEMENT     | <a href="#">The cross reference to section 6.10 is being changed to chapter 9 which now contains the explosion protection requirements. Redirect the user to Chapter 9 Explosion Protection which includes Explosion Prevention and Control</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                        |

| SECTION                | Public Input #                                                                                                                                                                                                                                  | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 8.3.2.2.2.1(B)         | 112                                                                                                                                                                                                                                             | <a href="#">Create First Revision</a>                                  |
| PI TEXT                | <b>8.3.2.2.2.1(B)</b><br>Explosion control shall be provided in accordance with the requirements of <a href="#">Chapter 9</a> <del>Section 6.10</del> .                                                                                         |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                          |                                                                        |
| PROPOSED STATEMENT     | <a href="#">The cross reference to section 6.10 is being changed to chapter 9 which now contains the explosion protection requirements. Redirect the user to Chapter 9 Explosion Protection which includes Explosion Prevention and Control</a> |                                                                        |

NFPA 2 - Chapter 9 Explosion Protection Task Group Task Group Report

| SECTION                | Public Input #                                                                                                                                                                                                                                  | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 8.3.2.2.3.2            | 113                                                                                                                                                                                                                                             | <a href="#">Create First Revision</a>                                  |
| PI TEXT                | <b>8.3.2.2.3.2(B)</b><br>Explosion control shall be provided in accordance with the requirements of <a href="#">Chapter 9 Section 6.10</a> .                                                                                                    |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                          |                                                                        |
| PROPOSED STATEMENT     | <a href="#">The cross reference to section 6.10 is being changed to chapter 9 which now contains the explosion protection requirements. Redirect the user to Chapter 9 Explosion Protection which includes Explosion Prevention and Control</a> |                                                                        |

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                            | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 10.5.3.4.1.4           | 114                                                                                                                                                                                                                                                                                                                                                                       | <a href="#">Create First Revision</a>                                  |
| PI TEXT                | <b>10.5.3.4.1.4</b><br>Deflagration vents shall be permitted to consist of any of the following:<br><br>(1) Walls of light material<br>(2) Lightly fastened hatch covers<br>(3) Lightly fastened, outward-opening doors in exterior walls<br>(4) Lightly fastened walls or roofs<br>(5) Other methods in accordance with <del>NFPA 69</del> and <a href="#">Chapter 9</a> |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                    |                                                                        |
| PROPOSED STATEMENT     | <a href="#">Redirect the user to Chapter 9 Explosion Protection which includes Explosion Prevention and Control</a> Other NFPA 69 methods are now detailed in chapter 9 and that is being cross referenced in this section.                                                                                                                                               |                                                                        |

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| L.4                    | 70                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <a href="#">Create First Revision</a>                                  |
| PI TEXT                | <b>L.4 Number of Gas Detectors to Effectively Detect Hydrogen at Fueling Locations.</b><br>In assessing the number of gas detectors required to detect a hydrogen release <u>at a fueling location</u> , the following should be considered:<br><br>(1) A minimum of one gas detector should be deployed per dispenser.<br>(2) If a canopy is used to protect the dispensing operation, <del>the a minimum of one</del> gas detector should be placed directly above the <del>dispensers</del> dispenser.<br>(3) Additional gas detectors can be placed along the length of the canopy to increase the probability of detecting a release. |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                        |
| PROPOSED STATEMENT     | <a href="#">The section is specific for hydrogen fueling locations and that is being added to provide specificity to the application.</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                        |

| SECTION | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                 |
|---------|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| L.4     | 70             | <a href="#">Create First Revision</a>                                                                                                                                                  |
|         |                | <a href="#">The During a the 2024 Explosion Protection TG review of relevant text this section was found to need the changes in this First Revision xx to better inform the reader</a> |

## NFPA 2 - Home Fueling Appliances Task Group Report

|            |                                                                                                                                        |
|------------|----------------------------------------------------------------------------------------------------------------------------------------|
| DOC #      | 2                                                                                                                                      |
| TG #/NAME  | Home Fueling Appliances                                                                                                                |
| TG CHAIR   | Bryan Gordon                                                                                                                           |
| TG MEMBERS | Spencer Quong, Nathan Weyandt, William Collins, Mark Fasel*, Sara Marxen, Chris McWhinney, and Gary Stottler*<br>*Non-committee member |

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 10.5.4                 | 153                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Resolve Public Input                                                   |
| PI TEXT                | <del>10.5.4 Indoor Nonpublic Residential Fueling (Reserved)</del>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                        |
| PROPOSED REVISION (FR) | See original PI submitted                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                        |
| PROPOSED STATEMENT     | This PI is submitted in conjunction with PI-155. Moving section 10.5.4 Indoor Non Public Residential Fueling to its own dedicated section in Chapter 10 similar to the approach used by compact hydrogen fueling stations (CHFS). This approach will allow future revisions to dedicated specific requirements to residential applications which must account for specific offsets from residential dwellings, specific maintenance requirements, power limitations experienced in residential dwellings, and potential modes of hydrogen production including delivery, on site generation, etc. |                                                                        |

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| New Section after 10.8 | 155                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Resolve Public Input                                                   |
| PI TEXT                | <u>10.X Indoor Nonpublic Residential Home Refueling Appliances (Reserved)</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                        |
| PROPOSED REVISION (FR) | See original PI text                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                        |
| PROPOSED STATEMENT     | This PI is submitted in conjunction with PI-154. Moving section 10.5.4 Indoor Non Public Residential Fueling to its own dedicated section in Chapter 10 similar to the approach used by compact hydrogen fueling stations (CHFS). This approach will allow future revisions to dedicated specific requirements to residential applications which must account for specific offsets from residential dwellings, specific maintenance requirements, power limitations experienced in residential dwellings, and potential modes of hydrogen production including delivery, on site generation, etc. |                                                                        |

NFPA 2 - Hydrogen as a Combustion Fuel Task Group Report

|             |                                                                                                                                                                 |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 21<br>DOC # | 2                                                                                                                                                               |
| TG #/NAME   | Hydrogen as a Combustion Fuel                                                                                                                                   |
| TG CHAIR    | Joseph DiGiacomo                                                                                                                                                |
| TG MEMBERS  | Larry Danner, Brian Ladds, Elizabeth Krasowski, Franklin Switzer*, Kevin Carlisle*, Mark Hannum*, Phil Domenicucci*, and Allen Adriani<br>*Non-committee member |

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 1.3.3                  | 56                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <a href="#">Resolve Public Input</a>                                   |
| PI TEXT                | <b>1.3.3 Exemptions.</b><br>This code shall not apply to the following: <ol style="list-style-type: none"> <li>(1) Design or components related to the transport of hydrogen or propulsion of hydrogen motor vehicles, including onboard hydrogen storage systems</li> <li>(2) Mixtures of GH<sub>2</sub> and other gases with a hydrogen concentration of less than <del>95</del><u>25</u> percent by volume when in accordance with NFPA 55</li> <li>(3) The storage, handling, use, or processing of metal hydride materials outside of metal hydride storage systems defined in Chapter 3</li> </ol> |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                        |
| PROPOSED STATEMENT     | The Proposed revision is incorrectly worded in that it attempts to make a “global” change to the definition of what is considered “hydrogen” for the purposes of NFPA 2. A separate Committee action on 1.3.3 correctly provides an Exemption that is specific to the equipment types considered in Chapter 14.                                                                                                                                                                                                                                                                                          |                                                                        |

| SECTION                 | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| New Section after 6.5.1 | 53                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <a href="#">Create First Revision</a>                                  |
| PI TEXT                 | <b><u>6.5.X Fuel Gas Supply Piping Systems.</u></b><br><u>(a) Fuel supply piping systems which are upstream of the first equipment isolation valve shall follow the guidance of section 6.5.1.</u><br><u>(b) Fuel train appliance downstream of the equipment isolation valve shall meet the requirements of Chapter 14.</u>                                                                                                                                                                                                                                                                                                                  |                                                                        |
| PROPOSED REVISION (FR)  | <b><u>6.5.X Fuel Gas Supply Piping Systems- for Industrial Combustion Applications.</u></b><br><u>Industrial combustion applications include an equipment isolation valve that separates the fuel supply from the equipment fuel train that shall meet separate requirements as follows:</u><br><u>(a) The <del>Fuel-fuel</del> supply piping systems <del>which are</del> upstream of the first equipment isolation valve shall follow the guidance of section 6.5.1.</u><br><u>(b) The equipment <del>Fuel-fuel</del> train <del>appliance</del> downstream of the equipment isolation valve shall meet the requirements of Chapter 14.</u> |                                                                        |
| PROPOSED STATEMENT      | The requirements of the IFGC imposed in Section 6.5.1 prohibit separable connections (flanges, threaded, etc.) for piping systems containing hydrogen within                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                        |

**Commented [DH1]:** From Staff: You cannot have listed items without a charging statement. Either a charging statement needs to be added or these items need to be split into two separate sections.

| SECTION                    | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|----------------------------|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| New Section<br>after 6.5.1 | 53             | <a href="#">Create First Revision</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|                            |                | <p>a building and requires all welded / brazed connections. While welded / brazed piping provides the best mitigation to prevent leaks and should be used when possible, the complex fuel trains associated with the industrial equipment applications covered by Chapter 14 (furnaces, ovens, turbines, etc.) which include multiple valves and flow paths cannot be assembled using only welded / brazed connections.</p> <p>This change provides an appropriate “separation” point (the “equipment isolation valve”) between the supply piping and the complex industrial equipment fuel train that complies with specific requirements provided for such equipment in Chapter 14 and the associated equipment specific NFPA standards referenced in Chapter 14.</p> |
| SECTION                    | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| New Section<br>after 3.3   | 54             | <a href="#">Create First Revision</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| PI TEXT                    |                | <p><b>3.3.X Fuel Supply Piping System.</b><br/> <u>(a) Fuel supply piping.</u><br/> <u>Piping systems upstream of the first equipment isolation valve.</u><br/> <u>(b) Fuel train appliance piping.</u><br/> <u>Piping downstream of the first equipment isolation valve.</u></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| PROPOSED<br>REVISION (FR)  |                | <p><del>3.3.X Fuel Supply Piping System.</del><br/> <del>(a) 3.3.X.1 Fuel supply Supply pipingPiping.</del><br/> <u>Piping systems upstream of the first equipment isolation valve.</u><br/> <del>(b) 3.3.X.2 Equipment Fuel train-Train appliance pipingPiping.</del><br/> <u>Piping downstream of the first equipment isolation valve.</u><br/> <u>3.3.X.3 Equipment Isolation Valve.</u></p> <p><a href="#">A.3.3.X.3 Figure A.3.3.X.3 depicts the isolation valve as the separation point between the Fuel Supply Piping and the Equipment Fuel Train Piping.</a></p>                                                                                                                                                                                               |
| PROPOSED<br>STATEMENT      |                | <p>This change goes hand-in hand with the 6.5.1 revision in by providing a proper definition of Equipment Fuel Train piping as opposed to the Fuel Supply Piping</p> <p>The requirements of the IFGC imposed in Section 6.5.1 prohibit separable connections (flanges, threaded, etc.) for piping systems containing hydrogen within a building and requires all welded / brazed connections. While welded / brazed piping provides the best mitigation to prevent leaks and should be used when possible, the complex fuel trains associated with the industrial equipment applications covered by Chapter 14 (furnaces, ovens, turbines, etc.) which include multiple valves and flow paths cannot be assembled using only welded / brazed</p>                        |

Commented [DL(V2)]: Add Annex drawing

Commented [DL(V3)]: Extract definition from NFPA 86 3.3.82.3 and A.8.7.2.3 - also check chapter 15

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## NFPA 2 - Hydrogen as a Combustion Fuel Task Group Report

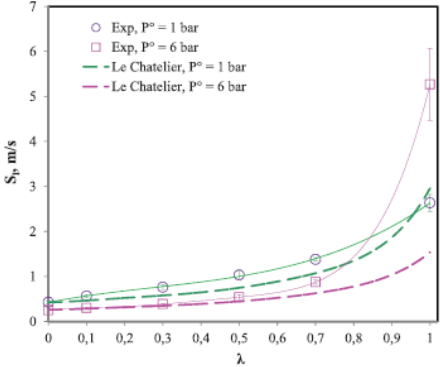
| SECTION                  | Public Input #                                                                                                                                                                                                                                                                                                                                                                    | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| New Section<br>after 3.3 | 54                                                                                                                                                                                                                                                                                                                                                                                | <a href="#">Create First Revision</a>                                  |
|                          | <p>connections.</p> <p>This change provides an appropriate “separation” point (the “equipment isolation valve”) between and definition of the supply piping and the complex industrial equipment fuel train that complies with specific requirements provided for such equipment in Chapter 14 and the associated equipment specific NFPA standards referenced in Chapter 14.</p> |                                                                        |

| SECTION                   | Public Input #                                                                                                                                                            | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|---------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| Chapter 14<br>and Annex   | <del>224</del><br>225                                                                                                                                                     | [Choose Motion]                                                        |
| PI TEXT                   | See PI Text in table at the end of this document.                                                                                                                         |                                                                        |
| PROPOSED<br>REVISION (FR) | Use the language provided in the table at the end of this document to provide any updates to the language provided in the Public Inputs.                                  |                                                                        |
| PROPOSED<br>STATEMENT     | These PIs require several substantiations to explain the technical reasons made to Chapter 14. Provide substantiations in the table provided at the end of this document. |                                                                        |

**Commented [DH4]:** From Staff: PI-224 makes several changes to Chapter 14 which all need substantiations. I have reflected the Chapter 14 revisions in the table at the end of this document. Use that table to provide TG substantiations.

| SECTION                      | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| New Section<br>after 3.3.121 | 222<br>226                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <a href="#">Create First Revision</a>                                  |
| PI TEXT                      | <p><b><u>3.3.X Hydrogen-Enriched Fuel.</u></b><br/> <u>A gas fuel that contains a hydrogen concentration greater than 25 percent by volume. [37, 2024]</u></p> <p><b><u>A.3.3.X Hydrogen-Enriched Fuel.</u></b><br/> <u>The 25 percent threshold is based on the minimum public domain (e.g., NFPA, IEC) guidance regarding a hydrogen content in natural gas where the flammability properties of the mixture are considered the same as natural gas. IEC 60079-20-1, Explosive atmospheres — Part 20-1: Material characteristics for gas and vapour classification — Test methods and data, indicates that industrial methane (e.g., natural gas) is classified as Group IIA if it does not contain more than 25 percent by volume of hydrogen. The upper limit for a hydrogen-enriched fuel is 95 percent, at which point it is considered “pure” hydrogen as defined in NFPA 2. [37, 2024]</u></p> |                                                                        |
| PROPOSED<br>REVISION (FR)    | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                        |
| PROPOSED<br>STATEMENT        | <p>The fuel being supplied to various combustion process equipment is being shifted from natural gas to blends of natural gas and hydrogen as part of the global shift to hydrogen fuel. These blends currently range from 5% to greater than 30% hydrogen and current installations are designed to use increasing hydrogen content with 50% near term and 100% in the long term.</p> <p>There are two factors to be considered:</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                        |

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| SECTION                      | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| New Section<br>after 3.3.121 | 222<br>226                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <a href="#">Create First Revision</a>                                  |
|                              | <ul style="list-style-type: none"><li>Guidance regarding the hazardous area classification of hydrogen mixtures should a leak occur have indicated concentrations greater than 25% must be considered as “hydrogen” for the selection of electrical equipment. It is from that basis that 25% is used as the limit hydrogen concentration for inclusion of such mixtures in NFPA 2.</li><li>The hazard of increased pressure waves should a leak of a hydrogen enriched fuel be ignited, while that increase is rather minimal at the 25% Hydrogen concentration, the impact increases with the % of hydrogen and above 50% hydrogen the slope of that increase is steeper as approximated by the laminar burning velocity for the mixture:</li></ul> <div><p><b>Fig. 4.</b> Laminar burning velocity, <math>S_L</math>, obtained from measured pressure time history (symbol) and calculated using a Le Chatelier's Rule-like formula, as a function of fuel composition, <math>\lambda</math>, for different initial pressures.</p><p>REF: Figure 4 Laminar Burning Velocity from “Explosion behavior of hydrogen-methane/air mixtures”, Ernesto Salzano et al, Journal of Loss Prevention in the Process Industries, 2012.</p><p>Since the industrial processes included in Chapter 14 are those that will specifically be using such mixtures as compared to the “pure hydrogen” uses (such as Automotive Fuel and Power Cells) it is essential to define a mixture class at less than the baseline 95% that is appropriate for the Chapter 14 industrial applications to provide the appropriate mitigation for the associated increased hazards.</p><p>For clarity, this discussion was taken on by an NFPA 37 Task Group that developed the definition of “Hydrogen Enriched Fuel” for the 2024 edition and that definition is being proposed for NFPA 2 to ensure consistency.</p></div> |                                                                        |

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## NFPA 2 - Hydrogen as a Combustion Fuel Task Group Report

| SECTION                      | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| New Section<br>after 3.3.215 | 223                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <a href="#">Create First Revision</a>                                  |
| PI TEXT                      | <b>3.3.XX Safety Blowout.</b><br>A device or combination of devices that quench a flame, relieve pressure, and provide a means for automatic shutoff of the air-gas mixture flow in the event of a flashback in air-fuel gas mixture piping. [86, 2023]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                        |
| PROPOSED REVISION (FR)       | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                        |
| PROPOSED STATEMENT           | <p>In the review of the NFPA documents associated with the technologies, we discovered the concept of fuel premixed with air to be included in NFPA 85, NFPA 86 and NFPA 87. With respect to the premix situation, a “Safety Blowout” is identified as a mitigation in NFPA 86. In developing the text in Chapter 14 which provides the appropriate additional considerations due to the hydrogen flammability and potential deflagration characteristics it was deemed appropriate to include a discussion of the premix situation to include the application of the Safety Blowout.</p> <p>Since the Safety Blowout term is used in the 14.3.1.6 discussion of fuel premix considerations, inclusion of the definition extracted from NFPA 86 is deemed necessary.</p> |                                                                        |

| Chapter 14 Revisions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Public Input No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 224 | Substantiation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>14.1 Scope.</b><br>This chapter shall apply to equipment that uses hydrogen <a href="#">or a hydrogen enriched</a> <del>as a fuel source for combustion-fuel-to-provide-heat used for the processing of materials and related equipment applications outlined in 14.3.</del>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |     | The purpose of the Chapter 14 rewrite is to identify technologies using “hydrogen” for the combustion process other than Thermal Spray which is the focus of the legacy Chapter 14. This expansion of Chapter 14 provides users of these technologies with essential additional information for the safe installation and operation of the equipment when hydrogen or a hydrogen enriched fuel is used. The additional technologies identified include: <ul style="list-style-type: none"> <li>- NFPA 37,</li> <li>- NFPA 85,</li> <li>- NFPA 86,</li> <li>- NFPA 87,</li> </ul> |
| <b>14.1.1* Applicability</b><br>The requirements of this chapter shall apply to the use of GH <sub>2</sub> <a href="#">or a hydrogen enriched fuel</a> as part of a manufacturing process using thermal spraying or as a fuel in heating applications.<br><br><b>A.14.1.1</b><br>Examples of the use of hydrogen used as a fuel involving flame, include, but would not be limited to, combustion of the gas in a torch used in welding or heating operations where the gas is used to provide a flame and accompanied by a reducing atmosphere. The melting of quartz or glass frequently involves the use of hydrogen combustion operations.<br><br><a href="#">Several European countries are pre-mixing hydrogen up to 20% concentration in the distribution pipelines. Although this is outside the scope of NFPA 2, it is worth noting for awareness.</a><br><br><a href="#">There is a move to start mixing hydrogen into the fuel supply for industrial Internal Combustion Engines and Gas Turbines. In Europe, this will be provided by way of the pipeline premixed fuel and the vision is for additional hydrogen to be added from a “local” source, up to 100% hydrogen, as</a> |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |     | The fuel being supplied to the identified equipment is being shifted from natural gas to blends of                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

NFPA 2 - Hydrogen as a Combustion Fuel Task Group Report

| Chapter 14 Revisions |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Public Input No.     | 224                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Substantiation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|                      | <p><a href="#">hydrogen availability increases. For Gas Turbines, this path was formalized in January 2020 by the European Turbine Network (ETN Global) Hydrogen Working Group in their report "The Path Towards a Zero-Carbon Gas Turbine" which is available at <a href="https://etn.global/news-and-events/news/hydrogen-gas-turbines-report/">https://etn.global/news-and-events/news/hydrogen-gas-turbines-report/</a>. With this direction in mind, a Task Group was formed to develop initial guidance for the use of "Hydrogen Enriched Fuels" in the 2024 edition of NFPA 37.</a></p> <p><a href="#">The provisions for premixed hydrogen in pipelines will also affect all other gas consumers such as Boilers and Combustion Systems (NFPA 85), Ovens and Furnaces (NFPA 86), and Fluid Heaters (NFPA 87).</a></p> <p><b>14.1.1.1.1</b><br/>This chapter also shall apply to new installations and to alterations or extensions to existing equipment <a href="#">that introduces hydrogen gas or a hydrogen enriched fuel to the installation.</a></p> <p><b>14.1.1.1.2</b><br/>The storage, use, and handling of GH<sub>2</sub> in any quantity shall also comply with the requirements of Chapters 1 and 4 and the applicable requirements of Chapters 5 through 8.</p> <p><b>14.1.1.2.1</b><br/><a href="#">Where an LH<sub>2</sub> source is used to supply the combustion process, the storage and vaporization to GH<sub>2</sub> shall be in accordance with Chapter 8.</a></p> <p><del><b>14.1.1.3</b><br/>The requirements of Chapters 4 and 6 through 8 shall be applicable to all hydrogen systems.</del></p> <p><del><b>14.1.1.3.4</b><br/>Use-specific requirements for hydrogen or hydrogen <a href="#">enriched fuels</a> mixtures used <a href="#">as a fuel</a> for <a href="#">thermal spray equipment</a> and for <a href="#">heating the</a> applications in 14.3 shall apply.</del></p> <p><del><b>14.1.1.4.5</b><br/>Where there is a conflict between a fundamental requirement and a use-specific requirement, the use-specific requirement shall be applicable.</del></p> | <p>natural gas and hydrogen as part of the global shift to hydrogen fuel. These blends currently range from 5% to greater than 30% hydrogen and current installations are designed to use increasing hydrogen content with a 50% near term goal and a 100% capability in the long term.</p> <p>The Scope and Applicability sections are updated to recognize:</p> <ul style="list-style-type: none"> <li>- The expanded group of technologies being addressed, and</li> <li>- The range of natural gas – hydrogen blends being used in those technologies which have additional hazards beyond those for Natural Gas but are unique from the "pure" hydrogen uses addressed in other chapters of NFPA 2.</li> </ul> |
|                      | <p><b>14.2 General. (Reserved)</b></p> <p><b>14.3 Use.</b></p> <p><b>14.3.1 General.</b></p> <p><del><b>14.3.1.1.2.2*</b> <a href="#">Electrical Equipment.</a></del></p> <p>The area <del>containing the in which the thermal spray equipment is installed identified in 14.3.2, 14.3.3, and 14.3.4 below using hydrogen gas or hydrogen enriched fuel</del> shall be classified in accordance with Article 500 or Article 505 of NFPA 70.</p> <p><del><b>A.14.3.1.1.2.2</b><br/>NFPA 497 provides guidance on the classification of areas.</del></p> <p><del><b>14.3.1.1.1.2.2.1</b><br/>Electrical <a href="#">wiring and</a> equipment shall <a href="#">be in accordance</a> <del>comply with the requirements</del> <a href="#">Articles 500, 501, and 504 of NFPA 70</a> <a href="#">or with Article</a></del></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <p>The "Use" section that previously dealt with only Thermal Spray is expanded to recognize the additional technologies and, during that process, a group of safety related functions were identified as "generic". These safety functions are each provided in the 14.3.1 General section.</p> <p>First is a refined and explicit reference to NFPA 70 for electrical</p>                                                                                                                                                                                                                                                                                                                                          |

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| Chapter 14 Revisions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                    |
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| Public Input No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 224                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Substantiation                                                                                     |
| <p><del>505 of NFPA 70</del> For the electrical classification of the area in which it is installed.</p> <p><b>14.3.1.2.3 Ventilation.</b></p> <p><del>14.3.1.2.3.1</del></p> <p>The area containing the <del>thermal spray</del> equipment <u>identified in 14.3.2 and 14.3.3 below using hydrogen gas or a hydrogen enriched fuel</u> shall be ventilated <u>in accordance with 6.16</u> to prevent flammable gas buildup from potential system leaks.</p> <p><del>14.3.1.2.3.2</del></p> <p><del>Mechanical exhaust ventilation systems required by Section 6.18 or for operation of the equipment shall be interlocked with the thermal spraying equipment to prevent the flow of gases without the ventilation system operating.</del></p> <p><b>14.3.1.2.14*</b></p> <p>The ceiling of rooms in which <del>thermal spray</del> equipment <u>using hydrogen gas or a hydrogen enriched fuel</u> is installed shall be constructed in a manner to prevent the accumulation of hydrogen gas.</p> <p><b>A.14.3.1.2.14</b></p> <p>Features such as solid beams that form a tight fit with the roof deck should be avoided. The intakes for the ventilation system should be located at high points in the ceiling to prevent the trapping of hydrogen in the thermal spraying area.</p> <p><b>14.3.1.2.25</b></p> <p>Venting systems discharging hydrogen to the atmosphere shall be piped to a designated point outside the building in accordance with Section 6.17.</p> | <p>classification to more clearly define what portions of the National Electrical Code should be applied.</p> <p>NFPA 37 provides explicit ventilation guidance for Stationary Combustion Engines and Gas Turbines and Section 14.3.4 requires NFPA 37 compliance, the ventilation guidance here is rewritten to be applicable across the “other” technologies and ties the NFPA 2, Section 6.16 ventilation guidance for application to the NFPA 85, NFPA 86 and NFPA 87 technologies.</p>                        | <p>Formatted: English (United States)</p> <p>Formatted: Font: (Default) +Body (Calibri), 11 pt</p> |
| <p><b>14.3.1.3 Gas Detection System.</b></p> <p><del>14.3.1.3.1 2.6.1*</del></p> <p>A hydrogen gas detection system <u>in accordance with 6.13</u> shall be installed <del>in</del> for the room or area where <del>thermal spray</del> the equipment <u>identified in 14.3.2 and 14.3.3 below using</u> hydrogen gas <del>or a hydrogen enriched fuel</del> is installed.</p> <p><del>A.14.3.1.3.2.6.1</del></p> <p>The gas detection <del>should be located</del> <u>location(s)</u> in the spray area, at the gas controller, and at the gas supply when the source of supply is <del>located indoors</del> shall be determined by a risk assessment considering <u>the effectiveness of the following detection location options:-</u></p> <p>(1) <u>in the immediate area of open combustion applications,</u></p> <p>(2) <u>in the immediate area of potential equipment leak sources</u></p> <p>(3) <u>in a location where leaked gas is expected to accumulate</u></p> <p>(4) <u>integrated with the ventilation system exhaust</u></p> <p><b>14.3.1.3.3*</b></p> <p>The gas detection risk assessment shall also define the alarm and action concentration values for the installation.</p> <p><b>A.14.3.1.3.3</b></p> <p>The maximum gas concentration value for action should be no higher than 25 percent of the Lower Flammability Limit.</p>                                                                                                                  | <p>The previous generalized Gas Detection function was found insufficient for application to the NFPA 85, NFPA 86 and NFPA 87 technologies due to the complexity and variability of these installations, consequently conducting installation specific risk assessments to define the configuration of the detection system is necessary.</p> <p>NFPA 37 provides explicit gas detection guidance for Stationary Combustion Engines and Gas Turbine enclosures and Section 14.3.4 requires NFPA 37 compliance.</p> |                                                                                                    |

| Chapter 14 Revisions |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
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|                      | <p><b><u>14.3.1.4 External Flame Detection.</u></b></p> <p><b><u>14.3.1.4.1*</u></b></p> <p><u>External equipment flame detection shall be provided where the equipment identified in 14.3.2 and 14.3.3 below using hydrogen gas or a hydrogen enriched fuel is installed.</u></p> <p><b><u>A.14.3.1.4.1</u></b></p> <p><u>If ignited, external leakage of hydrogen or hydrogen enriched fuels from the piping and gas control system supplying the equipment can result in an invisible flame and risk of personnel injury.</u></p> <p><b><u>14.3.1.4.1.1</u></b></p> <p><u>Detection of an external flame shall result shutdown of the system.</u></p> <p><b><u>14.3.1.4.1.2*</u></b></p> <p><u>The type, number and location of the flame detection devices shall be determined based on the following considerations:</u></p> <p>(1) <u>Detector effectiveness for the gas composition in use</u></p> <p>(2) <u>The optical view capability of the detectors,</u></p> <p>(3) <u>Restrictions to the device views due to building features or equipment between the detector and potential fire locations</u></p> <p>(4) <u>Shielding from sunlight (direct or reflected) that can result in false detection</u></p> <p>(5) <u>Selection of detector type</u></p> <p><b><u>A.14.3.1.4.1.2</u></b></p> <p><u>The historical detection technology for hydrogen flames is Ultraviolet (UV) or Ultraviolet/Infrared (UV/IR). These systems are susceptible to "false detection" due to sun light, either direct or reflected, and other sources such as welding and activities that result in sparks. In recent years, a Multi-Spectrum IR (MIR) technology has been developed that reduces the potential for false alarms. Additionally, detectors that are specific to the fuel being burned (e.g., natural gas, hydrogen, etc.) are available and some detectors are capable of selectively detecting fires from various fuels.</u></p> <p><b><u>14.3.1.4.2*</u></b></p> <p><u>Hydrogen fire warning devices and evacuation routes in the event of a fire shall be defined considering the following:</u></p> <p>(1) <u>Locations that require personnel in the proximity of equipment using hydrogen gas or a hydrogen enriched fuel where a fire may occur</u></p> <p>(2) <u>The evacuation route from such locations shall not pass through other fire risk areas</u></p> <p>(3)* <u>Visibility of the device(s) for persons in the fire risk area</u></p> | <p>Due to the nearly invisible optical characteristic of burning hydrogen (including mixtures approaching 95%) and, considering the NFPA 85, NFPA 86 and NFPA 87 related equipment can have significantly high surface temperatures, there is an increased potential for ignition of leaks. It is noted this hazard is not considered elsewhere in NFPA 2.</p> <p>Given the complexity and variability of the industrial installations associated with the NFPA 85, NFPA 86 and NFPA 87 related equipment, conducting installation specific risk assessments to define the location of the detectors configuration of the detection system is necessary.</p> <p>An industrial plant with ovens, furnaces, heaters, etc. can have multiple units in a single space. To avoid personnel inadvertently entering a location (oven "A") that has a hydrogen fed fire while making an emergency evacuation from another location (Oven "B", "C", etc.), signaling devices to define the clear escape path are required.</p> |

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| Chapter 14 Revisions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
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| <p><a href="#">A.14.3.1.4.2(3)</a><br/>Multiple devices along the exit path may be required.</p> <p><a href="#">(4) The warning device location identifies the appropriate exit path(s) away from the associate fire risk area</a></p> <p><a href="#">A.14.3.1.4.2</a><br/>Combination visual and aural warning devices are essential. The local warning devices are independent from other fire and hazard warning devices (e.g., general fire alarm, toxic gas, etc.) and the visual and aural signals must be distinct from the other local hazard warning devices to ensure no confusion as to the hazard that is being highlighted.</p> <p><a href="#">14.3.1.4.3</a><br/>The flame detection system shall be connected to the fire alarm system required by 6.12.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |     | <p>While this fire detection capability is distinct from the fire detection function defined in Section 6.12, it is complimentary to and must be integrated with the Section 6.12 required alarm system.</p> <p>NFPA 37 provides explicit fire detection guidance for Stationary Combustion Engines and Gas Turbines and Section 14.3.4 requires NFPA 37 compliance.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <p><a href="#">14.3.1.5* Emergency Shutoff.</a><br/>The following requirements shall apply to the “low pressure” applications identified in 14.3.2 and 14.3.3 below that are supplied with a gas pressure of 345 kPa (50 psig) or less.</p> <p><a href="#">A.14.3.1.5</a><br/>Given the flammability characteristics of hydrogen versus natural gas with respect to the gas supply pressure, the 345 kPa (50 psig) low pressure limit defined in NFPA 54, 1.1.1.1(C) is used for the equipment identified in this chapter. Where the fuel supply is greater than 345 kPa (50 psig) the specific requirements for Combustion Engines and Gas Turbines defined in NFPA 37 as modified in <del>14.3.34</del> are applicable.</p> <p><a href="#">14.3.1.5.1</a><br/>Two safety shutoff valves shall be provided on the piping used to supply hydrogen or hydrogen enriched fuel to the equipment.</p> <p><a href="#">14.3.1.5.1.1</a><br/>Where there is a separate gas supply to a combustion system pilot flame device, two safety shutoff valves shall be included for the pilot gas supply.</p> <p><a href="#">14.3.1.5.2*</a><br/>The two safety shutoff valves shall require a manual reset after the cause of the activation has been resolved.</p> <p><a href="#">A.14.3.1.5.1.2</a><br/>The reset may be either a physical reset of the valve actuation or clearing of the “fault” in the control system that returns the valve to the normal operation state.</p> |     | <p>The foreseen technologies that are addressed in Chapter 14 fall into two pressure categories:</p> <ul style="list-style-type: none"> <li>- “Low pressure” - a gas supply use that is typically regulated to less than 10 psig at the building exterior supply entry point.</li> <li>- “High pressure” - a gas supply provided at greater than 345 kPa (50 psig) that may be regulated or provided at pipeline pressure.</li> </ul> <p>While NFPA 54 considers gas pressure up to 125 psig, the NFPA 54 alternate gas supply pressure break point of 345 kPa (50 psig) is appropriate for the categories of equipment being considered in Chapter 14</p> <p>It is noted that, in general, Flame Spray and the applications falling under NFPA 85, NFPA 86 and NFPA 87 use gas supplies in the “low pressure” class. One known exception is the HRSG duct burner system under NFPA 85. These systems are associated with a Gas</p> |

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|                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <p>Turbine and typically share the line pressure fuel source.</p> <p>For many Stationary Combustion Engines and all Gas Turbines using gas fuel the provided fuel is at greater than 345 kPa (50 psig). However, NFPA 37 provides explicit emergency shutoff guidance regardless of the fuel supply pressure and Section 14.3.4 requires NFPA 37 compliance.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|                      | <p><b>14.3.1.5.2.1 For pressures up to and including 103 kPa (15 psig).</b></p> <p>(A) <u>A listed safety shutoff valve that meets the requirements of ANSI Z21.21, Automatic Valves for Gas Appliances or UL 429, Electrically Operated Valves shall be used.</u></p> <p>(B) <u>Where a listed safety shutoff valve is not available for the application, the selected valve shall have a Class VI leakage rating per ANSI FC 70-2, Control Valve Seat Leakage, as declared by valve manufacturer.</u></p> <p><b>A.14.3.1.5.2.1(B)</b><br/> <u>It is recommended that the valve manufacturer consider independent testing laboratory verification and certification of the valve leakage using 10% minimum helium – nitrogen blend.</u></p> | <p>A review of the safety shutoff valves available shows valves listed to ANSI Z21.21 or UL 429 should be available for many, if not all of the applications that fall into the foreseen technologies supplied with “low pressure” that are addressed in Chapter 14.</p> <p>However, some of the applications may require large valves (Din 150 / 6 inch or greater) to provide the demanded fuel flow and it is noted that suitable listed valved may not be available; therefore, the alternative guidance for valve selection is provided.</p> <p>Due to hydrogen’s low molecular size, valve leakage using traditional test gases have been shown to be insufficient for assuring the leak tightness for hydrogen gas. The annex provides guidance on the recommended helium – nitrogen blend to overcome this situation.</p> |
|                      | <p><b>14.3.1.5.2.2 For pressures greater than 103 kPa (15 psig).</b></p> <p>(A) <u>A listed safety shutoff valve that meets the requirements of ANSI Z21.21, Automatic Valves for Gas Appliances or UL 429, Electrically Operated Valves, shall be used. Such valves shall</u></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <p>A review of the safety shutoff valves available shows valves listed to ANSI Z21.21 or UL 429 may be</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

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|                      | <p><del>be listed for use with hydrogen gas or be certified by the valve manufacturer for use with hydrogen gas or hydrogen enriched gas.</del></p> <p>(B) <del>Where a listed safety shutoff valve is not available for the application, a valve certified by the manufacturer for use with hydrogen gas or hydrogen enriched gas or one specified by the equipment manufacturer for the particular fuel shall be used.</del></p> <p>(C)* <del>Where a non-listed safety shutoff valve is used, it shall have a Class VI leakage rating per ANSI FC 70-2, Control Valve Seat Leakage, as declared by valve manufacturer.</del></p> <p><b>A.14.3.1.5.2(C)</b>  <br/> <del>See A.14.3.1.5.2.1(B). It is recommended that the valve manufacturer consider independent testing laboratory verification and certification of the valve leakage using 10% minimum helium – nitrogen blend.</del></p> <p><del><b>14.3.1.5.3*</b></del><br/> <del>At least one safety shutoff valve shall be located external to the equipment chamber, separate dedicated enclosure or building.</del></p> <p><b>A.14.3.1.5.3</b><br/> A "separate dedicated enclosure" is a structure that has no separate rooms and only the hydrogen consuming equipment is located within the enclosure or building.</p> <p><del><b>14.3.1.5.4*</b></del><br/> <del>Valve seat leakage testing of safety shutoff valves and valve proving systems shall be performed in accordance with the manufacturer's instructions. (86: 7.4.10)</del></p> <p><b>A.14.3.1.5.4</b><br/> See NFPA 86 Annex section A.7.4.10 for additional guidance.</p> | <p>available for some of the technologies supplied with high pressure that are addressed in Chapter 14.</p> <p>However, this is dependent on the flow requirements for the equipment involved; large Gas Turbines can be supplied via a DIN 200 (8 inch) or larger valve at 38 barg (550 psig) or greater. The equipment manufacturers are working with valve vendors to identify valves of sufficient reliability and capability combined with hydrogen compatibility for these applications</p> <p>Where the supplier or manufacturer defines a non-listed valve for an application it must still meet the minimum requirements provided in the alternative guidance for valve selection.</p> |
|                      | <p><b>14.3.1.5.3*</b>  <br/> At least one safety shutoff valve shall be located external to the equipment chamber, separate dedicated enclosure or building.</p> <p><b>A.14.3.1.5.3</b><br/> A "separate dedicated enclosure" is a structure that has no separate rooms and only the hydrogen consuming equipment is located within the enclosure or building.</p> <p><b>14.3.1.5.4*</b><br/> Valve seat leakage testing of safety shutoff valves and valve proving systems shall be performed in accordance with the manufacturer's instructions. (86: 7.4.10)</p> <p><b>A.14.3.1.5.4</b><br/> See NFPA 86 Annex section A.7.4.10 for additional guidance.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <p>In recognition of the fact that the equipment fuel train will have multiple mechanical connections that may become a leak source and consistent with the Chapter 6 guidance that points to minimizing potential leak sources in enclosed spaces, the inclusion of an automated safety shutoff valve external to the space is required to minimize the quantity of gas that may be released within the space.</p> <p>The valve leakage test from NFPA 86 was identified as the best leakage guidance for Chapter 14</p>                                                                                                                                                                       |

**Commented [DH6]:** From Staff: This new annex has duplicate language to A.14.3.1.5.2.1(B). Recommend not duplicating language and instead adopting language similar to the below:

**A.14.3.1.5.2.2(C)**  
See A.14.3.1.5.2.1(B).

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|                      | <p><b><u>14.3.1.6 Pre-Mixed Air-Fuel Gas Mixtures.</u></b><br/> <b><u>14.3.1.6.1*</u></b><br/> Where a low pressure pre-mixed air-fuel gas (hydrogen or hydrogen enriched fuel) mixture is provided to the equipment identified in 14.3.2 and 14.3.3 below, a flame arrestor shall be provided in piping systems that distribute the mixture.</p> <p><b><u>A.14.3.1.6.1</u></b><br/> Two basic configurations for the flame arrestor are recognized. One is to provide a separate flame arrestor at each burner, the other is to provide a flame arrestor at each group of burners. The single a flame arrestor for a group of burners is more practical if a system consists of many closely spaced burners.</p> <p><b><u>14.3.1.6.2</u></b><br/> The flame arrestor shall be installed at the equipment burner inlet(s), and the manufacturer's installation guidelines shall be followed.</p> <p><b><u>14.3.1.6.3</u></b><br/> A separate, manually operated gas valve shall be provided at the inlet to the air gas mixer for shutting off the flow of fuel to the mixer after a flashback has occurred.</p> <p><b><u>14.3.1.6.4</u></b><br/> The valve(s) required by 14.3.1.6.3 shall not be reopened after a flashback has occurred until the flame arrestor has cooled sufficiently to prevent reignition of the flammable mixture and has been properly reset.</p> <p><b><u>14.3.1.6.5*</u></b><br/> A safety blowout shall be installed in accordance with the manufacturer's instructions near the outlet of the mixing equipment that produces the flammable air-fuel gas mixture at a pressure greater than 0.5 kPa (2 in. w.c.).</p> <p><b><u>A.14.3.1.6.5</u></b><br/> It is recommended to include a safety blowout regardless of the mixture pressure. Acceptable safety blowouts are available from some manufacturers of air-fuel mixing machines. They incorporate all the following components and design features:</p> <ul style="list-style-type: none"> <li>(1) Flame arrestor</li> <li>(2) Blowout disk</li> <li>(3) Provision for automatically shutting off the supply of air-gas mixture to the burners in the event of a flashback passing through an automatic fire check</li> </ul> | <p>The concept of air-fuel gas mixtures being provided to burner assemblies is recognized in NFPA 85, NFPA 86 and NFPA 87. IN NFPA 87, the hazards associated with "back-fire" events is formally recognized along with flame arresters in all three documents and safety blowouts recognized in NFPA 86 and NFPA 87.</p> <p>Although NFPA 51B (the standard cited for Thermal Spraying systems by the American Welding Society) does NOT discuss premixing of the air-fuel gas; however, it is realistic for premixing to be used for such applications and therefore this discussion is equally applicable to the Section 14.3.2 Thermal Spraying guidance</p> <p>While the text developed here is primarily based on the guidance in NFPA 87, it has been modified considering the additional hazard concerns associated with hydrogen and hydrogen enriched fuels. Therefore, this text is "stand-alone" rather than extracted.</p> |

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| <p><b>14.3.2 Open Combustion Applications.</b><br/> <b>14.3.2.1 Thermal Spraying Equipment.</b><br/> <b>14.3.2.1.1 General.</b><br/> Thermal spraying equipment shall meet the requirements of 14.3.1.</p> <p><b>14.3.2.1.2* Indoor Installations of Thermal Spraying Equipment.</b></p> <p><b>A.14.3.2.1.2</b><br/> Thermal spraying is typically conducted with robotic equipment in isolated chambers or otherwise protected areas to isolate persons from hazards such as noise, intense ultraviolet light, process gases, and vapors. The equipment includes multiple flexible piping or hoses, which pass through the chamber walls to deliver the gas from a control source to the process device or gun. The flexible portions of the fuel delivery system represent potential leak sources.</p> <p>NFPA 497 provides guidance on the classification of areas.</p> <p><b>14.3.2.1.2.1*</b><br/> Thermal spray equipment shall be installed, inspected, and maintained in accordance with the manufacturer's instructions to minimize the potential for leaks of the gas delivery system.</p> <p><b>A.14.3.2.1.2.1</b><br/> System preventive maintenance typically includes regular leak checks and the replacement of hoses in accordance with the manufacturer's recommendations. An increase in the frequency might be warranted based on maintenance experience.</p>                                                         | <p>The term "Open Combustion Applications" was developed to differentiate these systems from combustion that is contained within the industrial equipment; specifically, Thermal Spraying Systems. A separate numbering sequence is provided as part of that differentiation.</p> <p>The remaining text here is renumbered from the existing chapter 14 to enable integration with the additional topics taken from NFPA 37, NFPA 85, NFPA 86 and NFPA 87.</p>                                                                                                                                        |                |
| <p><b>14.3.2.1.3.2-6 Gas Detection System.</b><br/> <b>14.3.1.2.6.2</b><br/> Activation of the gas detection system <u>at the alarm concentration determined by the risk assessment in accordance with 14.3.1.3</u> shall result in the following:</p> <ol style="list-style-type: none"> <li>(1) The thermal spray system shall be prevented from starting <del>if hydrogen is detected at a concentration exceeding 25 percent of the lower flammable limit (LFL).</del></li> <li>(2) The thermal spray system shall be shut down <del>upon detection of hydrogen during operation at a concentration exceeding 25 percent of the LFL.</del></li> </ol> <p><b>14.3.2.1.4.1-2.7 Emergency Shutoff.</b><br/> <b>14.3.2.1.4.1.2.7.1</b><br/> <del>Automatic emergency</del>The two safety shutoff valves <u>specified in 14.3.1.5</u> shall <del>be provided on the piping used to supply hydrogen gas to the thermal spraying equipment.</del></p> <p><b>14.3.1.2.7.2</b><br/> <del>Activation of the valves shall</del> shut off the flow of hydrogen <u>gas or hydrogen enriched fuel</u> in the event of the following:</p> <ol style="list-style-type: none"> <li>(1) Loss of ventilation systems required by 14.3.1.2.3-2</li> <li>(2) Detection of hydrogen at a concentration exceeding <u>the action concentration determined by the risk assessment in accordance with 14.3.1.3</u> <del>25 percent of the LFL</del></li> </ol> | <p>Section 14.3.1.3 requires a risk assessment for the purposed of identifying the use specific gas concentration action level due to a hazardous accumulation of hydrogen or a hydrogen enriched fuel, the specific concentration previously cited in Chapter 14 is replaced with a reference to the value derived from the Risk assessment.</p> <p>The gas detection function is configured to prevent initiation of a flame when an ignitable atmosphere exists in the or to terminate the thermal spray operation if unburned fuel is detected space to avoid a potential deflagration event.</p> |                |

| Chapter 14 Revisions |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
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| Public Input No.     | 224                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Substantiation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|                      | (3) Activation of emergency stop functions <a href="#">specified by the equipment manufacturer</a> <del>provided with the manufacturer's equipment</del><br><a href="#">14.3.2.2 Outdoor Installations of Thermal Spray Equipment. (Reserved)</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | With the identification of a specific gas isolation shutoff valve configuration in Section 14.3.1.5, this section is revised to detail the specific actions for the shutoff valves associated with a Thermal Spray installation.<br><br>Given the integral relationship between a gas leak and the provided ventilation to control the hazardous atmosphere in an enclosed space specific guidance is provided here:<br><ul style="list-style-type: none"> <li>• Specific action for loss of the ventilation function required by in Section 14.3.1.5,</li> <li>• The action point from the risk assessment required by Section 14.3.1.3 for a gas buildup,</li> <li>• And any specific requirements from the manufacturer.</li> </ul> |
|                      | <del>14.3.2.2.3 Outdoor Installations of Thermal Spray Equipment. (Reserved)</del><br><a href="#">14.3.3 Atmospheric Combustion Applications.</a><br><a href="#">14.3.3.1 Boilers and Combustion Systems.</a><br><a href="#">14.3.3.1.1 General.</a><br><a href="#">Boilers and Combustion System installations using hydrogen gas or a hydrogen enriched fuel for heating shall comply with NFPA 85 and meet the requirements of 14.3.3.1.</a><br><br><a href="#">14.3.3.1.2*</a><br><a href="#">Indoor Installations of Boilers and Combustion Systems.</a><br><br><a href="#">A.14.3.3.1.2</a><br><a href="#">The categories of equipment identified in NFPA 85 that may use a gaseous fuel, to include hydrogen or a hydrogen enriched fuel, are:</a><br><ol style="list-style-type: none"> <li>(1) Single Burner Boilers</li> <li>(2) Multiple Burner Boilers</li> <li>(3) Warm-Up Burners and Lances for Fluidized Bed Boilers</li> <li>(4) Duct Burners included in a Heat Recovery Steam Generator</li> <li>(5) An Auxiliary Boiler associated with a Stoker</li> </ol> | For "Atmospheric Combustion" applications, (REF: NFPA 85, NFPA 86 and NFPA 87), the fuel is provided by way of a "burner" assembly that provides heat for the system with the atmosphere at the burner typically being within +/- 3 to 4" W.C. of "atmospheric" pressure.<br><br>Because of the application unique differences between NFPA 85, NFPA 86 and NFPA 87. Section 14.3.3. is broken into three subsections, each associated with one of the NFPA standards to provide critical hydrogen related considerations for the specific                                                                                                                                                                                             |

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| Chapter 14 Revisions |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
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| Public Input No.     | 224                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Substantiation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|                      | <a href="#">This guidance can also be applied to the equipment covered by ASME/CSD-1 Controls and Safety Devices for Automatically Fired Boilers.</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | category of equipment associated with the Code / Standard. The three subsections permit clear communication of the requirements associated with the various systems associated with the three documents. Not doing so could lead to uncertainty / misinterpretation on the part of manufacturers and / or Authorities Having Jurisdiction.<br><br>The first subsection, 14.3.3.1, Boilers and Combustion Systems is specific to NFPA 85 and Chapter 14 requires compliance to that source Code. |
|                      | <a href="#">14.3.3.1.2.1*</a><br><a href="#">Boilers and Heat Recovery Steam Generator (HRSG) Duct Burner Systems shall be installed, inspected, and maintained in accordance with the manufacturer's instructions to minimize the potential for leaks of the gas delivery system.</a><br><br><a href="#">A.14.3.3.1.2.1</a><br><del>System preventive maintenance typically includes regular leak checks and the replacement of hoses in accordance with the manufacturer's recommendations. An increase in the frequency might be warranted based on maintenance experience. Additional guidance for leak checks is provided at 14.3.1.5.4. Also, see A.14.3.2.1.2.1.</del>                                                                                                                                                                                                                                              | The focus of Chapter 14 is the combustion system(s) of the equipment using hydrogen or a hydrogen enriched fuel. This clause reconfirms the NFPA 85 requirement to comply with the manufacturer's installation and operating instructions with respect to the leak tightness of the equipment to mitigate leakage of the fuel and potential external fires / deflagrations.                                                                                                                     |
|                      | <a href="#">14.3.3.1.2.2 Gas Detection System for the room or area.</a><br><a href="#">Activation of the gas detection system at the alarm concentration determined by the risk assessment in accordance with 14.3.1.3 shall result in the following:</a><br><a href="#">(1) Boiler and HRSG Duct Burner Systems shall be prevented from starting.</a><br><a href="#">(2) If running, Boiler and HRSG Duct Burner Systems shall be shut down.</a><br><br><a href="#">14.3.3.1.2.3 Emergency Shutoff.</a><br><a href="#">The two safety shutoff valves specified in 14.3.1.5 shall shut off the flow of hydrogen gas or hydrogen enriched fuel in the event of the following:</a><br><a href="#">(1) Loss of ventilation systems required by 14.3.1.2</a><br><a href="#">(2) Detection of hydrogen at a concentration exceeding the action concentration determined by the risk assessment in accordance with 14.3.1.3.</a> | Once again, the Gas Detection system activation point is related to the risk assessment required in Section 14.3.1.3 and the function is provided to mitigate a potential deflagration event due to leaked fuel.<br><br>Again, the relationship between a gas leak and the provided ventilation to control the hazardous atmosphere requires:                                                                                                                                                   |

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**A.14.3.3.1.2.1**  
*Additional guidance for leak checks is provided by 14.3.1.5.4. Also, see A.14.3.2.1.2.1.*

**Commented [DL(V11R10)]:** Thank you, change agreed. Also, a "typo" was corrected "a" ==> "at"

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| Chapter 14 Revisions |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
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| Public Input No.     | 224                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Substantiation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|                      | <p>(3) Activation of emergency stop functions specified by the equipment manufacturer</p> <p><b>14.3.3.1.3 Outdoor Installations of Boilers and Combustion Systems. (Reserved)</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <ul style="list-style-type: none"> <li>Specific action for loss of the ventilation function required by Section 14.3.1.5,</li> <li>The action point from the risk assessment required by Section 14.3.1.3 for a gas buildup,</li> <li>And any specific requirements from the manufacturer.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                      | <p><del>14.3.3.1.3 Outdoor Installations of Boilers and Combustion Systems. (Reserved)</del></p> <p><b>14.3.3.2 Ovens and Furnaces</b></p> <p><b>14.3.3.2.1 General.</b></p> <p>Ovens and Furnace installations using hydrogen gas or a hydrogen enriched fuel shall comply with NFPA 86 and meet the requirements of 14.3.3.2.</p> <p><b>14.3.3.2.2 Indoor Installations of Ovens and Furnaces.</b></p> <p><b>14.3.3.2.2.1</b></p> <p>Ovens and Furnaces using hydrogen gas or a hydrogen enriched fuel shall be installed, inspected, and maintained in accordance with the manufacturer's instructions to minimize the potential for leaks of the gas delivery system.</p> <p><b>A.14.3.3.2.2.1</b></p> <p><del>System preventive maintenance typically includes regular leak checks and the replacement of hoses in accordance with the manufacturer's recommendations. An increase in the frequency might be warranted based on maintenance experience. See A.14.3.2.1.2.1.</del></p> <p><del>14.3.3.2.2.2</del></p> <p><del>Gas Detection System for the room or area. Activation of the gas detection system at the alarm concentration determined by the risk assessment in accordance with 14.3.1.3 shall result in the following:</del></p> <p><del>(1) Ovens and Furnaces shall be prevented from starting.</del></p> <p><del>(2) Ovens and Furnaces shall be shut down.</del></p> <p><b>14.3.3.2.2.2 Gas Detection System for the room or area.</b></p> <p>Activation of the gas detection system at the alarm concentration determined by the risk assessment in accordance with 14.3.1.3 shall result in the following:</p> <p>(1) Ovens and Furnaces shall be prevented from starting.</p> <p>(2) Ovens and Furnaces shall be shut down.</p> <p><b>14.3.3.2.2.3* Emergency Shutoff.</b></p> <p>The two safety shutoff valves specified in 14.3.1.5 shall shut off the flow of hydrogen gas or hydrogen enriched fuel in the event of the following:</p> <p>(1) Loss of ventilation systems required by 14.3.1.2</p> <p>(2) Detection of hydrogen at a concentration exceeding the action concentration determined by the risk assessment in accordance with 14.3.1.3.</p> | <p>The second subsection, 14.3.3.2, Ovens and Furnaces is specific to NFPA 86 and requires compliance to that source Standard.</p> <p>This clause reconfirms the NFPA 86 requirement to comply with the manufacturer's installation and operating instructions with respect to the leak tightness of the equipment to mitigate leakage of the fuel and potential external fires / deflagrations in support of the Chapter 14 intent.</p> <p>Once again, the Gas Detection system activation point is related to the risk assessment required in Section 14.3.1.3 and the function is provided to mitigate a potential deflagration event due to leaked fuel.</p> <p>Again, the relationship between a gas leak and the provided</p> |

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**A.14.3.2.2.1**  
See A.14.3.2.1.2.1.

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| Chapter 14 Revisions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                       |
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| Public Input No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 224                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Substantiation                                                                                                                                                                                                                                        |
| <p><u>(3) Activation of emergency stop functions specified by the equipment manufacturer.</u></p> <p><u><b>A.14.3.3.2.2.3</b> NFPA 86 permits a single safety shutoff valve for radiant tube-fired burner systems based on an explosion resistance validation of the assembly. The explosion pressure from a hydrogen or hydrogen enriched fuel can be significantly greater than for other fuels, and the validation must consider the fuel being used for the installation.</u></p> <p><u><b>14.3.3.2.3 Outdoor Installations of Ovens and Furnaces. (Reserved)</b></u></p> | <p>ventilation to control the hazardous atmosphere requires:</p> <ul style="list-style-type: none"> <li>• Specific action for loss of the ventilation function required by Section 14.3.1.5,</li> <li>• The action point from the risk assessment required by Section 14.3.1.3 for a gas buildup,</li> </ul> <p>And any specific requirements from the manufacturer.</p> <p>It is noted that NFPA 86 has a unique configuration related to safety shutoff functions for radiant tube burners that must be considered. This is an example of why the separate sections for the NFPA 85, NFPA 86 and NFPA 87 related requirements.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <p><b>Formatted:</b> Indent: Left: 0"</p> <p><b>Commented [DL(V16)]:</b> Moved up since this is part of the NFPA 86 Ovens and Furnaces discussion</p> <p><b>Formatted:</b> Font: (Default) Verdana, Bold, Font color: Custom Color(RGB(30,41,96))</p> |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <p><del><b>14.3.3.2.3 Outdoor Installations of Ovens and Furnaces. (Reserved)</b></del></p> <p><u><b>14.3.3.3 Fluid Heater Systems</b></u></p> <p><u><b>14.3.3.3.1 General.</b></u></p> <p><u>Fluid Heater system installations employing hydrogen or a hydrogen enriched fuel as a heating fuel shall comply with NFPA 87 and meet the requirements of 14.3.3.3.</u></p> <p><u><b>14.3.3.3.2 Indoor Installations of Fluid Heater Systems.</b></u></p> <p><u><b>14.3.3.3.2.1*</b></u></p> <p><u>Fluid Heater systems shall be installed, inspected, and maintained in accordance with NFPA 87 and the manufacturer's instructions to minimize the potential for leaks of the gas delivery system.</u></p> <p><u><b>A.14.3.3.3.2.1</b></u></p> <p><u>System preventive maintenance typically includes regular leak checks and the replacement of hoses in accordance with the manufacturer's recommendations. An increase in the frequency might be warranted based on maintenance experience. NFPA 87 Chapter 7 provides specific guidance for system maintenance. Also, see A.14.3.2.1.2.1.</u></p> |                                                                                                                                                                                                                                                       |
| <u><b>14.3.3.3.2.2 Gas Detection System for the room or area.</b></u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <p>Activation of the gas detection system at the alarm concentration determined by the risk assessment in accordance with 14.3.1.3 shall result in the following:</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <p>This fully parallels the Section 14.3.3.1.2.2 and 14.3.3.2.2.2 Gas Detection system activation per the risk assessment required in Section</p>                                                                                                     |

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**A.14.3.3.1.2.1**  
Chapter 7 of NFPA 87 provides specific guidance for system maintenance.. Also, see A.14.3.2.1.2.1.

**Commented [DL(V18R17)]:** Agreed, thank you

| Chapter 14 Revisions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                             |
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| Public Input No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 224                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Substantiation                                                                                                                                                                                                                                                                                                                                                                                                              |
| <p><a href="#">(1) The heating system burners and pilots shall be prevented from starting.</a><br/> <a href="#">(2) The heating system burners and pilots shall be shut down.</a></p> <p><b>14.3.3.3.2.3* Emergency Shutoff.</b><br/> The two safety shutoff valves specified in 14.3.1.5 shall shut off the flow of hydrogen gas or hydrogen enriched fuel in the event of the following:</p> <p><a href="#">(1) Loss of ventilation systems required by 14.3.1.2</a><br/> <a href="#">(2) Detection of hydrogen at a concentration exceeding the action concentration determined by the risk assessment in accordance with 14.3.1.3.</a><br/> <a href="#">(3) Activation of emergency stop functions specified by the equipment manufacturer.</a></p> <p><b>14.3.3.3.3 Outdoor Installations of Fluid Heater Systems. (Reserved)</b></p> | <p>14.3.1.3 and specific actions to mitigate a potential deflagration event due to leaked fuel.</p> <p>The relationship between a gas leak and the provided ventilation again requires:</p> <ul style="list-style-type: none"> <li>Specific action for loss of the ventilation function required by Section 14.3.1.5,</li> <li>The action point from the risk assessment required by Section 14.3.1.3 for a gas buildup,</li> <li>And any specific requirements from the manufacturer.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <p><b>Formatted:</b> Indent: Left: 0", First line: 0"</p> <p><b>Commented [DL(V19):</b> Moved up since this is part of the NFPA 87 Fluid Heater Systems discussion</p> <p><b>Formatted:</b> Font: (Default) Verdana, Bold, Font color: Custom Color(RGB(30,41,96))</p>                                                                                                                                                      |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <p><b>14.3.3.3.3 Outdoor Installations of Fluid Heater Systems. (Reserved)</b></p> <p><b>14.3.4* High Pressure Combustion Applications.</b><br/> These are combustion applications that use hydrogen or hydrogen enriched fuel at greater than 345 kPa (50 psig). The following applications are considered in this category:</p> <p><a href="#">(1) Combustion Engines with a gaseous fuel injection system at greater than 345 kPa (50 psig)</a><br/> <a href="#">(2) Gas Turbines</a></p> <p><b>A.14.3.4</b></p> <p><a href="#">a) Reciprocating engines have demonstrated operation at 100 percent hydrogen</a><br/> <a href="#">b) Today's gas turbines are fully capable of operating on 20 percent hydrogen</a><br/> <a href="#">c) Gas turbines have demonstrated reliable operation at hydrogen concentrations of 50 percent and greater using "Synqas", Refinery Gas and Coke Oven Gas; these uses have been limited primarily to industrial settings that, in general, fall into the "petrochemical plant" category.</a><br/> <a href="#">d) The gas turbine industry has committed to achieving the ability to run on 100 percent hydrogen by 2030</a></p> |                                                                                                                                                                                                                                                                                                                                                                                                                             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <p><b>14.3.4.1* General.</b><br/> The installation and operation of Combustion Engines and Gas Turbines shall be in accordance with NFPA 37 and meet the requirements of 14.3.1.1.</p> <p><b>A.14.3.4.1</b><br/> NFPA 37 provides detailed information and requirements related to:</p> <p><a href="#">(1) Ventilation of system enclosures</a><br/> <a href="#">(2) Gas detection and emergency action</a></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <p>The identified high pressure applications are limited to Combustion Engines and Gas Turbines. It is note that are limited, existing industrial operations of such systems using hydrogen and hydrogen enriched fuels.</p> <p>The identified high pressure applications are limited to Combustion Engines and Gas Turbines which are the focus of NFPA 37 and Chapter 14 requires compliance to that source Standard.</p> |

| Chapter 14 Revisions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
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| Public Input No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 224 | Substantiation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <p>(3) Fire detection and suppression</p> <p><b>14.3.4.2 Gas Supply.</b><br/> The supply of a Hydrogen Enriched Fuel can take two forms:<br/> (1) Pipeline supplied premixed hydrogen enriched fuel<br/> (2) Locally mixed fuel</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |     | <p>Changed away from “premixed” to avoid confusion with the premixing of air / oxygen and flammable gas as discussed in previous sections.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <p><b>14.3.4.2.1 Hydrogen Mixing.</b><br/> Where the Hydrogen Enriched Fuel mixing is provided locally, the mixing function shall comply with the manufacturer’s requirements related to:<br/> (1) Maximum hydrogen content in the mixture<br/> (2) Shutdown sequence for abnormal or emergency operating conditions</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |     | <p>The availability of hydrogen may not be available at a sufficient flow rate to support large Combustion Engines and Gas Turbines at “full power”. In this situation, mixing of hydrogen and natural gas is envisioned as the interim solution until the hydrogen production is a sufficient rate to achieve full power on hydrogen alone.</p> <p>The control systems must “tailor” the equipment operation on such mixtures dependent on the heating value and other properties of the mixture. This entry recognizes the fact that the Engine or Turbine manufacturer establishes the mixture ratios that provide for safe operation of the Engine or Turbine and the method of integrating the mixture control as part of the overall Engine or Turbine operation.</p> |
| <p><b>14.3.4.2.2 Emergency Shutoff.</b><br/> In addition to the two Automatic Safety Shutoff Valve (ASSV) and associated vent valve arrangement required by NFPA 37 for a combustion engine or gas turbine, the hydrogen or hydrogen enriched fuel supply shall comply with the following:<br/> (1) The ASSVs shall be in accordance with 14.3.1.5.2.2<br/> (2) A vent valve shall be located between the two ASSVs<br/> (3) One of the two ASSVs required by NFPA 37 for an engine other than a Gas turbine shall be located external to the engine package and any associated building<br/> (4) Automatic vent valves shall be provided between all shutoff valves starting downstream of the second ASSV<br/> (5) The gas train shall be provided with an inert purge function to remove the residual hydrogen or hydrogen enriched fuel downstream of the second ASSV<br/> (6) The vent(s) for the hydrogen or hydrogen enriched fuel shall be in accordance with 7.1.16.</p> |     | <p>The combustion process in a Combustion Engine or Gas Turbine requires more consideration that simply turning the fuel supply on or off, the Engine / Turbine speed and operation of associated accessory systems must be properly coordinated. Additionally, experience has shown residual energy in the form of fuel in the equipment fuel train must be disposed of (vented) as a function of the operating mode; hence vent</p>                                                                                                                                                                                                                                                                                                                                       |

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| Chapter 14 Revisions |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|----------------------|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Public Input No.     | 224 | Substantiation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|                      |     | <p>valves are added to the fuel train arrangement.</p> <p>Fuel train venting and, depending on the installation details, purge of the fuel train as part of the shutdown sequence has been identified following hazardous system events such as fuel train piping burn through. Such scenarios are exacerbated with the addition of hydrogen into the fuel. To ensure such events are mitigated, the use of active fuel train inert gas purge is included</p> <p>These requirements are in addition to those identified in NFPA 37 for a safe shutdown of the Engine or Turbine.</p> |

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NFPA 2 - NFPA 2/55 Joint Alignment Task Group Report

|            |                                                                                                                                                                                                                                                      |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DOC #      | 2                                                                                                                                                                                                                                                    |
| TG #/NAME  | NFPA 2/55 Joint Alignment                                                                                                                                                                                                                            |
| TG CHAIR   | Rob Early**                                                                                                                                                                                                                                          |
| TG MEMBERS | John Anicello**, Bob Carpenter†, Brian Ehrhart**, Kenneth Fegley*, Jef Frick†, Stephen Goyette*, Martin Gresho**, John Mullen*, Richard Palluzi†, Spencer Quong*, and Dimitri Sokolik†<br>*NFPA 2 TC Member, †NFPA 55 TC Member, and **Non-TC Member |

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                  | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 7.1.4.1.3              | 14                                                                                                                                                                                                                                                                                                                                                                                                                                              | Create First Revision                                                  |
| PI TEXT                | <b>7.1.4.1.3 Classification.</b><br>The hazard classification of the metal hydride storage system, <del>as required by 5.1.1 and 5.1.3 of NFPA 55</del> , shall be based on the GH <sub>2</sub> stored without regard to the metal hydride content.                                                                                                                                                                                             |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                          |                                                                        |
| PROPOSED STATEMENT     | The scope of NFPA 2 has been revised to contain all requirements for hydrogen storage, use, and handling. The scope of NFPA 55 has been revised so that it no longer contains requirements for hydrogen storage, use, and handling. This first revision removes the references to NFPA 55, sections 5.1.1 and 5.1.3, because those sections no longer exist in NFPA 55 and because NFPA 2's scope does not include referencing NFPA 55 content. |                                                                        |

| SECTION                                        | Public Input #                                                                                                                                                                                                                                                                                                     | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |              |                   |  |    |   |                       |    |     |            |    |     |           |   |   |           |    |     |           |    |     |                                                |    |     |           |    |    |
|------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-------------------|--|----|---|-----------------------|----|-----|------------|----|-----|-----------|---|---|-----------|----|-----|-----------|----|-----|------------------------------------------------|----|-----|-----------|----|----|
| 7.2.1.1                                        | 19                                                                                                                                                                                                                                                                                                                 | Create First Revision                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |              |                   |  |    |   |                       |    |     |            |    |     |           |   |   |           |    |     |           |    |     |                                                |    |     |           |    |    |
| PI TEXT                                        | <b>7.2.1.1* Incompatible Materials.</b><br>GH <sub>2</sub> cylinders, containers, and tanks shall be separated in accordance with Table 7.2.1.1.<br><b>Table 7.2.1.1 Separation of Gas Cylinders, Containers, and Tanks by Hazard Class from Non-Bulk GH<sub>2</sub> Cylinders, Containers, Tanks, and Systems</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |              |                   |  |    |   |                       |    |     |            |    |     |           |   |   |           |    |     |           |    |     |                                                |    |     |           |    |    |
|                                                |                                                                                                                                                                                                                                                                                                                    | <table> <tr> <th rowspan="2">Gas Category</th><th colspan="2">GH<sub>2</sub>*</th></tr> <tr> <th>ft</th><th>m</th></tr> <tr> <td>Toxic or highly toxic</td><td>20</td><td>6.1</td></tr> <tr> <td>Pyrophoric</td><td>20</td><td>6.1</td></tr> <tr> <td>Flammable</td><td>—</td><td>—</td></tr> <tr> <td>Oxidizing</td><td>20</td><td>6.1</td></tr> <tr> <td>Corrosive</td><td>20</td><td>6.1</td></tr> <tr> <td>Unstable reactive Class 2, Class 3, or Class 4</td><td>20</td><td>6.1</td></tr> <tr> <td>Other gas</td><td>NR</td><td>NR</td></tr> </table> | Gas Category | GH <sub>2</sub> * |  | ft | m | Toxic or highly toxic | 20 | 6.1 | Pyrophoric | 20 | 6.1 | Flammable | — | — | Oxidizing | 20 | 6.1 | Corrosive | 20 | 6.1 | Unstable reactive Class 2, Class 3, or Class 4 | 20 | 6.1 | Other gas | NR | NR |
| Gas Category                                   | GH <sub>2</sub> *                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |              |                   |  |    |   |                       |    |     |            |    |     |           |   |   |           |    |     |           |    |     |                                                |    |     |           |    |    |
|                                                | ft                                                                                                                                                                                                                                                                                                                 | m                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |              |                   |  |    |   |                       |    |     |            |    |     |           |   |   |           |    |     |           |    |     |                                                |    |     |           |    |    |
| Toxic or highly toxic                          | 20                                                                                                                                                                                                                                                                                                                 | 6.1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |              |                   |  |    |   |                       |    |     |            |    |     |           |   |   |           |    |     |           |    |     |                                                |    |     |           |    |    |
| Pyrophoric                                     | 20                                                                                                                                                                                                                                                                                                                 | 6.1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |              |                   |  |    |   |                       |    |     |            |    |     |           |   |   |           |    |     |           |    |     |                                                |    |     |           |    |    |
| Flammable                                      | —                                                                                                                                                                                                                                                                                                                  | —                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |              |                   |  |    |   |                       |    |     |            |    |     |           |   |   |           |    |     |           |    |     |                                                |    |     |           |    |    |
| Oxidizing                                      | 20                                                                                                                                                                                                                                                                                                                 | 6.1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |              |                   |  |    |   |                       |    |     |            |    |     |           |   |   |           |    |     |           |    |     |                                                |    |     |           |    |    |
| Corrosive                                      | 20                                                                                                                                                                                                                                                                                                                 | 6.1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |              |                   |  |    |   |                       |    |     |            |    |     |           |   |   |           |    |     |           |    |     |                                                |    |     |           |    |    |
| Unstable reactive Class 2, Class 3, or Class 4 | 20                                                                                                                                                                                                                                                                                                                 | 6.1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |              |                   |  |    |   |                       |    |     |            |    |     |           |   |   |           |    |     |           |    |     |                                                |    |     |           |    |    |
| Other gas                                      | NR                                                                                                                                                                                                                                                                                                                 | NR                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |              |                   |  |    |   |                       |    |     |            |    |     |           |   |   |           |    |     |           |    |     |                                                |    |     |           |    |    |

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| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 7.2.1.1                | 19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Create First Revision                                                  |
|                        | NR: No separation required.<br><i>*See flammable gas column from Table 7.1.10.2 of NFPA 55.</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                        |
| PROPOSED STATEMENT     | The scope of NFPA 2 has been revised to contain all requirements for hydrogen storage, use, and handling. The scope of NFPA 55 has been revised so that it no longer contains requirements for hydrogen storage, use, and handling. Separation distances for non-bulk hydrogen storage systems were originally extracted into NFPA 2 from NFPA 55's separation distances for all non-bulk flammable gases. NFPA 2 has removed the extract tags and so now maintains the non-bulk hydrogen storage system distances in table 7.2.1.1. The note pointing to NFPA 55 table 7.1.10.2 is no longer valid because NFPA 55 table 7.1.10.2 no longer applies to hydrogen. |                                                                        |

| SECTION                | Public Input #                                                                                                                                                                                                                                                                            | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| A.7.3.2.3.1.2          | 15                                                                                                                                                                                                                                                                                        | Create First Revision                                                  |
| PI TEXT                | <b>A.7.3.2.3.1.2</b><br>...<br><i>CGA PS-48, Clarification of Existing Hydrogen Setback Distances and Development of New Hydrogen Setback Distances in NFPA 55/NFPA 2, provides guidance and clarification on types of exposures as well as applications of the separation distances.</i> |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                    |                                                                        |
| PROPOSED STATEMENT     | CGA PS-48 has changed its title and scope to apply to NFPA 2 and not to NFPA 55 because hydrogen setback distances are no longer in NFPA 55. The first revision updates the title of CGA PS-48 to use the new title.                                                                      |                                                                        |

| SECTION             | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 8.3.2.3.1.5(D)      | 16                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Create First Revision                                                  |
| A.8.3.2.3.1.5(D)    | 17                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                        |
| A.8.3.2.3.1.5(D)(1) | 18                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                        |
| PI TEXT             | <b>8.3.2.3.1.5 (D)* Open Courts</b><br>Stationary containers shall be sited so that they are open to the surrounding environment except that encroachment by building walls of unlimited height shall be permitted when in accordance with the distances specified by Table 8.3.2.3.1.6(a) <del>or the material-specific tables in Chapters 9, 11, 13, and 16 of NFPA 55.</del><br><br>(1)* Where exterior building walls encroach on the system to form a court, the system shall be located at a distance not less than the height of the wall from at least two court walls.<br><br><b>A.8.3.2.3.1.5(D)(1)</b><br>The separation distances shown in Figure A.8.3.2.3.1.5(D)(1) are required to provide for ventilation in the space in order to avoid creating a confined space. <del>Chapter 8 of NFPA 55, is a generic chapter used to establish</del> |                                                                        |

| SECTION                | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|------------------------|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 8.3.2.3.1.5(D)         | 16             | Create First Revision                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| A.8.3.2.3.1.5(D)       | 17             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| A.8.3.2.3.1.5(D)(1)    | 18             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|                        |                | <p><del>minimum requirements for all cryogenics. Material-specific requirements for oxygen, hydrogen, or other gases might require greater separation distances based on the type of construction or the related exposure.</del> For example, wall number 3 shown in Figure A.8.3.2.3.1.5(D)(1) could be an exterior building wall, <del>and the gas could be hydrogen.</del> Refer to Table 8.3.2.3.1.6(a) for specific details regarding building walls, wall openings, air intakes, and similar conditions.</p> <p><b>Figure A.8.3.2.3.1.5(D)(1) Bulk Cryogenic System Located in a Courtyard.</b></p> <p>...</p> <p>(2) The required distance between the exterior walls of the building forming the court and the container shall be determined independently without regard to fire barrier walls used to allow encroachment by fire exposure hazards.</p> <p><b>A.8.3.2.3.1.5(D)</b><br/>The placement of stationary containers is limited with respect to exposure hazards. Table 8.3.2.3.1.6(A) 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 <del>and liquid oxygen</del> 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, <del>a flammable hazard, or an oxygen-enriched environment</del> <u>or a flammable hazard</u> can be created.</p> <p>...</p> |
| PROPOSED REVISION (FR) |                | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| PROPOSED STATEMENT     |                | The scope of NFPA 2 has been revised to contain all requirements for hydrogen storage, use, and handling. The scope of NFPA 55 has been revised so that it no longer contains requirements for hydrogen storage, use, and handling. These sections of NFPA 2 were originally extracted from NFPA 55's general language that applies to all cryogenic fluids and compressed gases, including oxygen, nitrogen, and other gases along with hydrogen. NFPA 2 has removed the extract tags and now maintains the requirements for hydrogen in these sections. <del>The requirements for compressed gases and cryogenic fluids other than hydrogen in this section are being removed because they do not fall into the scope of NFPA 2.</del>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

| SECTION     | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                     |
|-------------|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A.3.3.106.6 | 11             | Create First Revision                                                                                                                                                                                      |
| PI TEXT     |                | <b>A.3.3.106.6 Inert Gas.</b><br>Inert gases do not react readily with other materials under normal temperatures and pressures. For example, nitrogen combines with some of the more active metals such as |

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| SECTION                | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|------------------------|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A.3.3.106.6            | 11             | Create First Revision                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|                        |                | lithium and magnesium to form nitrides, and at high temperatures it will also combine with hydrogen, oxygen, and other elements. The gases neon, krypton, and xenon are considered rare due to their scarcity. Although these gases are commonly referred to as inert gases, the formation of compounds is possible. For example, xenon combines with fluorine, to form various fluorides and with oxygen to form oxides; the compounds formed are crystalline solids. Radon is inert under the definition provided, but because it is radioactive, it is not considered inert for the purposes of <del>NFPA-55</del> NFPA 2. |
| PROPOSED REVISION (FR) |                | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| PROPOSED STATEMENT     |                | The scope of NFPA 2 has been revised to contain all requirements for hydrogen storage, use, and handling. The scope of NFPA 55 has been revised so that it no longer contains requirements for hydrogen storage, use, and handling. The section was originally extracted into NFPA 2 from NFPA 55. NFPA 2 has removed the extract tags so that the language is resident in NFPA 2. The section now applies to NFPA 2 and not to NFPA 55 in this code (NFPA 2), and so the reference has been changed to NFPA 2.                                                                                                               |

| SECTION                | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                                                                                                                                                                          |
|------------------------|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3.3.18                 | 10             | Create First Revision                                                                                                                                                                                                                                                                                                                                           |
| PI TEXT                |                | <del>3.3.18 Bulk Oxygen System.<br/>See 3.3.237.4.</del>                                                                                                                                                                                                                                                                                                        |
| PROPOSED REVISION (FR) |                | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                          |
| PROPOSED STATEMENT     |                | The scope of NFPA 2 has been revised to contain all requirements for hydrogen storage, use, and handling. The scope of NFPA 55 has been revised so that it no longer contains requirements for hydrogen storage, use, and handling. With the removal of NFPA 55 extract tags from NFPA 2, the defined term is no longer used in the NFPA 2 body or annex notes. |

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| SECTION     | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-------------|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3.3.237.4   | 12             | Create First Revision                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| A.3.3.237.4 | 13             | Create First Revision                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| PI TEXT     |                | <del>3.3.237.4* Bulk Oxygen System:<br/>An assembly of equipment, such as oxygen storage containers, pressure regulators, pressure relief devices, vaporizers, manifolds, and interconnecting piping, that has a storage capacity of more than 20,000 scf (566 Nm<sup>3</sup>) of oxygen and that terminates at the source valve.<br/><br/>A.3.3.237.4 Bulk Oxygen System.<br/>The bulk oxygen system terminates at the point where oxygen at service pressure first enters the supply line. The oxygen containers are either stationary or movable, and the oxygen is stored as a compressed gas or cryogenic fluid.<br/><br/>Bulk oxygen systems can be used to supply gas in either its compressed gaseous or liquefied form. Systems that may be used to supply both gaseous and liquid forms are</del> |

| SECTION                  | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 3.3.237.4<br>A.3.3.237.4 | 12<br>13                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Create First Revision                                                  |
|                          | <p><del>referred to as hybrid systems. The following bulk oxygen systems are typical of those in use:</del></p> <p><del>(1) When the primary supply of the gas as stored is from a compressed gaseous source that is used in the compressed and gaseous form, the bulk oxygen system is said to be a bulk compressed oxygen gas system.</del></p> <p><del>(2) When the primary supply of the gas as stored is in a liquid form and the system is designed to transfer only liquid, the system is said to be a bulk liquefied oxygen system.</del></p> <p><del>(3) When the primary supply of the gas as stored is in a liquid form and the system is designed to transfer or store the gas in a compressed gaseous form, with or without a feature that may also allow the subsequent transfer and use of liquid, the bulk oxygen system is said to be a hybrid bulk oxygen system. For the purposes of the application of the code, a hybrid system is viewed as a bulk liquefied oxygen system.</del></p> |                                                                        |
| PROPOSED REVISION (FR)   | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                        |
| PROPOSED STATEMENT       | <p>The scope of NFPA 2 has been revised to contain all requirements for hydrogen storage, use, and handling. The scope of NFPA 55 has been revised so that it no longer contains requirements for hydrogen storage, use, and handling. With the removal of NFPA 55 extract tags from NFPA 2, the defined term is no longer used in the NFPA 2 body or annex notes.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                        |

NFPA 2 - Chapter 10 and 11 Scope Task Group Report

| DOC #                  | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                        |
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| TG #/NAME              | Chapter 10 and 11 Scope                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                        |
| TG CHAIR               | Carl H. Rivkin                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                        |
| TG MEMBERS             | Robert W. Boyd, Chris McWhinney, Spencer Quong, Kelvin Sumba, Steven Wheaton, Thomas G. Witte, Allen Adriani, and William Collins                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                        |
| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
| 10.1                   | 217                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Create First Revision                                                  |
| PI TEXT                | <p><b>Chapter 10 GH<sub>2</sub> Vehicle Fueling Facilities</b><br/> <b>10.1 Scope.</b><br/> This chapter shall apply to the design, <u>siting</u>, construction, <del>and</del>-installation, <u>and operation</u> of <u>GH<sub>2</sub> dispensing</u> systems to be utilized for <u>GH<sub>2</sub> fueling of</u> vehicles <del>fueling</del>.</p> <p><b>10.1.1 Application.</b><br/> The requirements of this chapter shall apply to fueling operations, irrespective of the system capacity, <del>of either the fueling</del><u>the hydrogen</u> source, or the vehicle being fueled.</p> <p><b>10.1.1.1</b><br/> <del>Hydrogen</del>-<u>GH<sub>2</sub></u> dispensing systems for vehicular fueling shall comply with Chapter 10.</p> <p><b>10.1.1.2</b><br/> The storage, use, and handling of <del>GH<sub>2</sub></del>-<u>hydrogen</u> in any quantity shall also comply with the requirements of Chapters 1 and 4 and the applicable requirements of Chapters 5 through <del>7</del><u>8</u>.</p> <p><b>10.1.1.3</b><br/> Hydrogen generation systems shall be designed in accordance with Chapter 13.</p> <p><b>10.1.1.4</b><br/> Where there is a conflict between a fundamental requirement and a use-specific requirement, the use-specific requirement shall apply.</p> <p><b>10.1.1.5*</b><br/> This chapter shall not apply to facilities that fill containers or trailers for the purposes of transporting hydrogen when in accordance with and regulated by 49 CFR 100–199.</p> <p><b>A.10.1.1.5</b><br/> This chapter only applies to facilities and equipment that dispense to the fuel supply container of a hydrogen motor vehicle. Examples include fueling stations that dispense to light-duty vehicles, buses, material-handling vehicles, trucks, and trains.</p> |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                        |
| PROPOSED STATEMENT     | <p>Rationale for Minor Changes to Scope Section for Chapters 10 and 11:</p> <ol style="list-style-type: none"> <li>1) Wording and format are inconsistent between Chapters 10 and 11. <ol style="list-style-type: none"> <li>a. Create common language by merging from both, but primarily from Chapter 10.</li> <li>b. Align with same format.</li> </ol> </li> <li>2) Clarify and broaden that GH<sub>2</sub> dispensing systems may also be supplied from a LH<sub>2</sub> source.</li> <li>3) Clarify that Chapter 10 is for GH<sub>2</sub> dispensing and Chapter 11 is for LH<sub>2</sub> dispensing, regardless of source.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                        |

NFPA 2 - Chapter 10 and 11 Scope Task Group Report

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 11.1                   | 216                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Create First Revision                                                  |
| PI TEXT                | <p><b>Chapter 11 LH<sub>2</sub> Fueling Facilities</b></p> <p><b>11.1 Scope.</b><br/>This chapter <del>shall apply</del><u>applies</u> to the design, siting, construction, installation, and operation of <u>dispensing systems to be utilized for LH<sub>2</sub> fueling vehicles</u><del>containers, pressure vessels, pumps, vaporization equipment, and associated equipment used for the storage or dispensing of LH<sub>2</sub> as an engine fuel for vehicles of all types.</del></p> <p><b>11.1.1 Application.</b><br/><u>The requirements of this</u> <del>This</del> chapter shall apply to <del>the storage, use, and handling of LH<sub>2</sub> fueling operations, irrespective of the system capacity of either the fueling source or the vehicle being fueled</del><u>in connection with self-propelled vehicles powered by hydrogen.</u></p> <p><b>11.1.1.1</b><br/><del>The storage, use, and handling of LH<sub>2</sub> in connection with self-propelled vehicles powered by hydrogen shall also comply with the requirements of Chapters 1 and 4 and the applicable requirements of Chapters 5 through 8.</del> <u>LH<sub>2</sub> dispensing systems for vehicular fueling shall comply with Chapter 11.</u></p> <p><b>11.1.1.2</b><br/><del>Chapters 4 and 6 through 8 contain fundamental requirements that shall apply to all hydrogen systems.</del> <u>The storage, use, and handling of hydrogen in any quantity shall also comply with the requirements of Chapter 1 and 4 and the applicable requirements of Chapters 5 through 8.</u></p> <p><del><b>11.1.1.2.1</b></del><br/><del>The use-specific requirements of this chapter for the storage, use, and handling of LH<sub>2</sub> shall apply.</del></p> <p><del><b>11.1.1.3</b></del> <b>11.1.1.2.2</b><br/>Where there is a conflict between a fundamental requirement and a use-specific requirement, the use-specific requirement shall apply.</p> <p><del><b>11.1.1.4</b></del> <b>11.1.1.4.3</b><br/>The requirements of Chapter 11 shall be applicable to LH<sub>2</sub> systems only.</p> <p><b>11.1.1.5</b><br/><u>Where LH<sub>2</sub> is converted to GH<sub>2</sub>, those portions of the system utilized for GH<sub>2</sub> shall be in accordance with Chapter 10.</u></p> |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                        |
| PROPOSED STATEMENT     | <p>Rationale for Minor Changes to Scope Section for Chapters 10 and 11:</p> <ol style="list-style-type: none"> <li>1) Wording and format are inconsistent between Chapters 10 and 11. <ol style="list-style-type: none"> <li>a. Create common language by merging from both, but primarily from Chapter 10.</li> <li>b. Align with same format.</li> </ol> </li> <li>2) Clarify and broaden that GH<sub>2</sub> dispensing systems may also be supplied from a LH<sub>2</sub> source.</li> <li>3) Clarify that Chapter 10 is for GH<sub>2</sub> dispensing and Chapter 11 is for LH<sub>2</sub> dispensing, regardless of source.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                        |

**Commented [DH1]:** From Staff: There can only be one requirement per section.

**NFPA 2**  
*Hydrogen Technologies Code*  
(F2025)

Presentations

# CHAPTER 9

# EXPLOSION PROTECTION

Rev 5

2024  
Explosion Protection  
Task Group

|                      |                    |
|----------------------|--------------------|
| Bob Boyd (chair)     | Boyd Hydrogen, LLC |
| John J. Anicello     | Chart Industries   |
| Nicholas Bartlett*   | NREL               |
| Larry M. Danner      | GE turbines        |
| Rob Early            | CGA                |
| Stephen Goyette      | Nel Hydrogen, CT   |
| Dave Farese          | Durham Consulting  |
| Marty Gresho         | FP2Fire            |
| Elizabeth Krasowski, | Ramboll            |
| Chris LaFleur        | Sandia             |
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| Jessica Robertson*   | Chemours           |
| Alexandra Schluneker | SWRI               |
| Amy Chunzhi Shen     | Air Products       |
| Achim Wechsung       | Exponent           |
| Nathan Weyandt       | SWRI               |
| Steve Wheaton        | Choshu-America     |

# Summary of the Public Input

- Removal of “old” Annex K
- “New” Annex K for using NFPA-86 with hydrogen
- Revision of “Explosion Control” definition
- New Annex material “The Table” for discussion
- Proposed Chapter 9 First Draft language
- Redirect 6.10 to Chapter 9
- New definitions for NFPA-2
- Plan to bring in some of Annex K into Chapter 9 as Public Comment (or as revised 1<sup>st</sup> draft language)

# Remove the old Annex K

**PI 174:** Replace Existing Annex K with new material from Air products. (Boyd)

**Substantiation:** As the Explosion Control task group made progress on a draft Chapter 9, TG member and former chair of NFPA-2 Martin Gresho has stated reasons to delete the current content of Annex K. Dave Farese has proposed this new material for annex K. This PC makes that change

**PI 213:** Delete Annex K (Gresho)

**Substantiation:** Annex K must be entirely deleted. Annex K was included in the 2011 (inaugural) Edition of NFPA 2 so that its content could be provided to the public. Also at that time, Chapter 9 was published as Reserved. Now 'that' Chapter 9 content has been drafted as a separate PPI and it contains content that is substantially different from that presented in Annex K. The material in Annex K may have value for future development, and will be retained because it has been published, but it now must be removed to avoid conflict with Chapter 9. Additionally, Annex K has been abused as being what NFPA 2 will contain in the future. It is an inappropriate annex.

## ~~Annex K Hydrogen Explosion Control~~

~~This annex is not a part of the enforceable requirements of this NFPA document but is included for informational purposes only. The information below is intended to provide voluntary guidance related to explosion control for hydrogen. The text is presented below in a format similar to text that is anticipated to be included in Chapter 9 (which is currently reserved) in the next edition of NFPA 2.~~

~~The guidance in Annex K pertains to explosion prevention measures as follows:~~

- ~~(1) Providing criteria to determine where explosion control measures are needed~~
- ~~(2) Providing continuous or emergency ventilation to dilute inadvertently released hydrogen in confined areas~~
- ~~(3) Inerting hydrogen contained in process equipment and piping~~
- ~~(4) Eliminating potential ignition sources associated with electrical equipment and wiring~~
- ~~(5) Avoiding highly obstructed confined and partially confined areas containing hydrogen storage vessels, process equipment, and piping~~
- ~~(6) Containing hydrogen deflagrations within equipment and vessels so as to prevent equipment or vessel rupture, and to prevent deflagration propagation to interconnected equipment~~
- ~~(7) Conducting explosion risk analyses to identify site-specific potential explosion scenarios and implement appropriate measures to reduce the likelihood of those scenarios actually occurring~~

# New Annex “K”

## K.1 Introduction

In the event of an accidental release of hydrogen inside an enclosure, a flammable gas cloud could form. Explosion of such a flammable cloud could have catastrophic consequences since confined deflagration can lead to much higher overpressures than would be the case for an equivalent explosion in the open atmosphere. Specific measures are usually required to reduce risk to a tolerable level. Forced or natural ventilation is commonly used to reduce flammable gas concentrations inside enclosures, and deflagration vents are commonly used to relieve deflagration over-pressure and mitigate potential equipment damage and risk to people close to the enclosure.

Various engineering models are available in the literature, including NFPA 68. After several significant developments and re-issues of NFPA 68 in recent years, NFPA 68 (2023)<sup>[2]</sup> is now proven to better address fast-burning fuels such as hydrogen. However, NFPA 68 (2023) recommends considering the worst-case stoichiometric mixture. This usually leads to over-conservative results and has limited applicability for hydrogen and hydrogen mixtures which has high reactivity.

Since NFPA 68 (2018) is based on fundamental combustion parameters, it can easily be modified to other hydrogen concentrations, more representative of expected conditions, resulting in less conservative conclusions. NFPA 68 (2018) modified in this way has been validated against published data across a range of hydrogen concentrations, from tests performed between 2016 and 2018 in Europe, under the project named HySEA<sup>[3,4]</sup>.

# Revise Explosion Control Definition

## Public Input No. 107-NFPA 2-2023 [ Section No. 3.3.51.2 ]

3.3.51.2\* Explosion Control.

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

### Statement of Problem and Substantiation for Public Input

When we read the word "either" it seems you can do either (1) try to prevent an explosion or (2) manage the explosion the best you can. We think one must always try to prevent an explosion and if the risk assessment shows a deflagration is a likely possibility, then add deflagration venting. The word ***either*** is confusing and the definition reads better without the word either.

| Related Input                                           | Relationship                                     |
|---------------------------------------------------------|--------------------------------------------------|
| Public Input No. 169-NFPA 2-2023 [Section No. 3.3.81]   | move and use modified definition, add annex note |
| Public Input No. 170-NFPA 2-2023 [Section No. 3.3.51.2] | point to 3.3.81                                  |

# PI 106 and 215

## A.3.3.51.2 Explosion Control.

Explosion control is provided to prevent formation of flammable mixtures, prevent ignition, protect against deflagration, and prevent detonation conditions from developing when there is the potential to exceed 1 percent hydrogen concentration in enclosures.

NFPA 69 provides guidance on the use of suppression, ventilation systems, and the limiting of oxidants as a means to prevent the occurrence of an explosion.

NFPA 68 provides guidance on the use of deflagration venting systems in buildings and other enclosures. The primary purpose of a venting system is to relieve the overpressure produced in an explosion to limit the potential damage to the building where the explosion occurs. Although some structural damage can be anticipated, the use of relief venting is expected to prevent massive building failure and collapse. In cases where detonation is probable, venting is often used in conjunction with barricade construction where the pressure-resistant portions of the building have been constructed to resist the pressures anticipated should an explosive event occur. Design of barricade systems is highly specialized and the subject of military standards applicable to the subject. NFPA 69 provides guidance on the use of suppression, ventilation systems, and the limiting of oxidants as a means to prevent the occurrence of an explosion. When relief vents are to be used as a means to provide explosion relief, the fundamental requirements of the adopted building code for structural elements, including snow, wind, and seismic events, should be considered. In some instances, the requirements for wind resistance can impose more rigorous requirements on the relief vents than required by the engineering analysis used to determine the relief pressure. In such cases, users must demonstrate that the relief vents will not become airborne or release in such a manner as to create secondary hazards within or external to the building in which they are installed. Specific designs might require approval by the AHJ.

**Rationale:** the TG wanted to move the reference to NFPA-69 out of the middle of the paragraph about NFPA 68 and put that reference first. The Explosion Protection TG also wanted to add the first sentence to speak to the need for prevention of deflagration conditions and add into the existing NFPA 69 language

# Move “Explosion Control” to 3.3.81 and revise annex note

**Public Input No. 169-NFPA 2-2023 [ Section No. 3.3.81 ]**

**Public Input No. 106-NFPA 2-2023 [ Section No. A.3.3.51.2 ]**

3.3.81 Explosion Control.

See 3.3.51.2

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

## A.3.3.81

Explosion control is provided to prevent formation of flammable mixtures, prevent ignition, protect against deflagration, and prevent detonation conditions from developing when there is the potential to exceed 1 percent hydrogen concentration in enclosures.

NFPA 69 provides guidance on the use of suppression, ventilation systems, and the limiting of oxidants as a means to prevent the occurrence of an explosion.

NFPA 68 provides guidance on the use of deflagration venting systems in buildings and other enclosures. The primary purpose of a venting system is to relieve overpressure produced in an explosion to limit the potential damage to the building where the explosion occurs. Although some structural damage can be anticipated, the use of relief venting is expected to prevent massive building failure and collapse. In cases where detonation is probable, venting is often used in conjunction with barricade construction where the pressure-resistant portions of the building have been constructed to resist the pressures anticipated should an explosive event occur.

When relief vents are to be used as a means to provide deflagration relief, the fundamental requirements of the adopted building code for structural elements, including snow, wind, and seismic events, should be considered. In some instances, the requirements for wind resistance can impose more rigorous requirements on the relief vents than required by the engineering analysis used to determine the relief pressure. Users must demonstrate that the relief vents will not become airborne or release in such a manner as to create secondary hazards within or external to the building in which they are installed. Specific designs might require approval by the AHJ.

# Simplified table after Explosion Protection TG meeting of 13 March 2024

| Flammable and Explosive mixtures of Hydrogen and Air inside an enclosure |       |                                               |         |         |                           |              |           |                                             |                |              |         |         |            |         |         |              |         |           |           |  |  |
|--------------------------------------------------------------------------|-------|-----------------------------------------------|---------|---------|---------------------------|--------------|-----------|---------------------------------------------|----------------|--------------|---------|---------|------------|---------|---------|--------------|---------|-----------|-----------|--|--|
|                                                                          |       |                                               |         |         |                           |              |           |                                             |                |              |         |         |            |         |         |              |         |           |           |  |  |
|                                                                          |       |                                               |         |         |                           |              |           | Range of H2 in Air for deflagration venting |                |              |         |         |            |         |         |              |         |           |           |  |  |
|                                                                          |       |                                               |         |         | Emergency Shutdown System |              |           | Explosive Range of Hydrogen in Air          |                |              |         |         |            |         |         |              |         |           |           |  |  |
|                                                                          |       |                                               |         |         | Alarm Action              | Alarm Action | Shut Down |                                             |                |              |         |         |            |         |         |              |         |           |           |  |  |
|                                                                          |       | Portable Personal Monitors<br>(0 to 1000 ppm) |         |         | FLAMMABLE GAS DETECTION   |              |           | Flammable                                   |                | Deflagration |         |         | Detonation |         |         | Deflagration |         | Flammable |           |  |  |
|                                                                          |       |                                               |         |         | 25% LFL                   | 50% LFL      | "LFL"     | still lazy                                  | turbulent Jets |              |         |         |            |         |         |              |         |           |           |  |  |
| hydrogen                                                                 | %     | 0.001%                                        | 0.01%   | 0.10%   | 1%                        | 2%           | 4%        | 5%                                          | 10%            | 10.5%        | 12%     | 17%     | 18.2%      | 29.53%  | 58.9%   | 60%          | 70%     | 71%       | 100%      |  |  |
| hydrogen                                                                 | ppm   | 10                                            | 100     | 1000    | 10,000                    | 20,000       | 40,000    | 50,000                                      | 100,000        | 105,000      | 120,000 | 170,000 | 182,000    | 295,300 | 589,000 | 600,000      | 700,000 | 710,000   | 1,000,000 |  |  |
| air                                                                      | %     | 99.999%                                       | 99.99%  | 99.9%   | 99%                       | 98%          | 96%       | 95%                                         | 90%            | 89.5%        | 88%     | 83%     | 82%        | 70%     | 41%     | 40%          | 30%     | 29%       | 0%        |  |  |
| oxygen                                                                   | %     | 21%                                           | 21%     | 21%     | 21%                       | 21%          | 20%       | 20%                                         | 19%            | 18.8%        | 18%     | 17%     | 17%        | 15%     | 9%      | 8%           | 6%      | 6%        | 0%        |  |  |
| oxygen                                                                   | ppm   | 209,498                                       | 209,479 | 209,291 | 207,405                   | 205,310      | 201,120   | 199,025                                     | 188,550        | 187,503      | 184,360 | 173,885 | 171,371    | 147,635 | 86,105  | 83,800       | 62,850  | 60,755    | -         |  |  |
| H2/O2                                                                    |       | 0.0                                           | 0.0     | 0.005   | 0.05                      | 0.1          | 0.2       | 0.3                                         | 0.5            | 0.6          | 0.7     | 1.0     | 1.1        | 2.0     | 6.8     | 7.2          | 11.1    | 11.7      |           |  |  |
| hydrogen                                                                 | g/m3  | 0.0008                                        | 0.008   | 0.084   | 0.84                      | 1.67         | 3.35      | 4.19                                        | 8.4            | 8.8          | 10.0    | 14.2    | 15.2       | 24.7    | 49.3    | 50.2         | 58.6    | 59.4      | 83.7      |  |  |
| TNT equiv                                                                | grams | 0.02                                          | 0.24    | 2.40    | 24                        | 48           | 96        | 120                                         | 240            | 252          | 288     | 408     | 436        | 708     | 1412    | 1439         | 1679    | 1703      | 2398      |  |  |

28.65 grams TNT/ gram H<sub>2</sub>

| source of information |                                                                       | lower  | upper |
|-----------------------|-----------------------------------------------------------------------|--------|-------|
| AP                    | Explosion limits : H2 in air @ 1 atm                                  | 12 %   | 70%   |
| KITS                  |                                                                       | 10.5 % |       |
| AP                    | Detonable limits: H2 in air @ 1 atm                                   | 18.2 % | 70%   |
| AP                    | Flammable and Detonation limits from AP document 900-13-082-US (2014) |        |       |
| KITS                  | Thomas Jordan KITS. 9/14/2023                                         |        |       |

# Minimal table proposal after call with Heath 14 March 2024

| Flammable and Explosive mixtures of Hydrogen and Air inside an enclosure           |       |                                            |        |       |                           |              |           |             |                |                                    |      |      |            |      |      |              |      |
|------------------------------------------------------------------------------------|-------|--------------------------------------------|--------|-------|---------------------------|--------------|-----------|-------------|----------------|------------------------------------|------|------|------------|------|------|--------------|------|
|                                                                                    |       |                                            |        |       | Emergency Shutdown System |              |           |             |                |                                    |      |      |            |      |      |              |      |
|                                                                                    |       |                                            |        |       | Alarm Action              | Alarm Action | Shut Down | Flammable   |                | Explosive Range of Hydrogen in Air |      |      |            |      |      |              |      |
|                                                                                    |       | Portable Personal Monitors (0 to 1000 ppm) |        |       | FLAMMABLE GAS DETECTION   |              |           | still mixes | turbulent Jets | Deflagration                       |      |      | Detonation |      |      | Deflagration |      |
|                                                                                    |       |                                            |        |       | 25% LFL                   | 50% LFL      | "LFL"     |             |                |                                    |      |      |            |      |      |              |      |
| hydrogen                                                                           | %     | 0.001%                                     | 0.01%  | 0.10% | 1%                        | 2%           | 4%        | 5%          | 10%            | 11%                                | 12%  | 17%  | 18%        | 30%  | 59%  | 60%          | 70%  |
| hydrogen                                                                           | ppm   | 10                                         | 100    | 1000  |                           |              |           |             |                |                                    |      |      |            |      |      |              |      |
| air                                                                                | %     | 99.999%                                    | 99.99% | 99.9% | 99%                       | 98%          | 96%       | 95%         | 90%            | 89.5%                              | 88%  | 83%  | 82%        | 70%  | 41%  | 40%          | 30%  |
| oxygen                                                                             | %     | 21%                                        | 21%    | 21%   | 21%                       | 21%          | 20%       | 20%         | 19%            | 18.8%                              | 18%  | 17%  | 17%        | 15%  | 9%   | 8%           | 6%   |
| H2/O2                                                                              |       | 0.0                                        | 0.0    | 0.005 | 0.05                      | 0.1          | 0.2       | 0.3         | 0.5            | 0.6                                | 0.7  | 1.0  | 1.1        | 2.0  | 6.8  | 7.2          | 11.1 |
| Upper table for annex note. The lower table rows are only for TG and TC discussion |       |                                            |        |       |                           |              |           |             |                |                                    |      |      |            |      |      |              |      |
| hydrogen                                                                           | g/m3  | 0.0008                                     | 0.008  | 0.084 | 0.84                      | 1.67         | 3.35      | 4.19        | 8.4            | 8.8                                | 10.0 | 14.2 | 15.2       | 24.7 | 49.3 | 50.2         | 58.6 |
| TNT equiv                                                                          | grams | 0.02                                       | 0.24   | 2.40  | 24                        | 48           | 96        | 120         | 240            | 252                                | 288  | 408  | 436        | 708  | 1412 | 1439         | 1679 |



## Public Input No. 175-NFPA 2-2023 [ Chapter 9 ]

### Chapter 9 ~~Explosion Protection (Reserved)~~Control

#### **9.1\* General**

Explosion control shall be provided for buildings and hydrogen equipment enclosures where the amount of GH2 or LH2 exceeds the maximum allowable quantities per control area or where required by the hazard analysis in accordance with 9.2

##### A.9.1

Explosion control is provided to prevent formation of flammable mixtures, prevent ignition, protect against deflagration, and prevent detonation conditions from developing when there is the potential to exceed 1 percent hydrogen concentration in enclosures.

NFPA 69 provides guidance on the use of suppression, ventilation systems, and the limiting of oxidants as a means to prevent the occurrence of an explosion.

# New definitions for NFPA-2

| Definitions                                                                                                                                                                                                     |     |                                                                                     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-------------------------------------------------------------------------------------|
| Public Input No.                                                                                                                                                                                                | 171 | Substantiation                                                                      |
| <b>3.3.XX Deflagration.</b><br>Propagation of a combustion zone at a velocity that is less than the speed of sound in the unreacted medium. [68, 2023]                                                          |     | The term appears in the new proposed language in Chapter 9 and needs to be defined. |
| Public Input No.                                                                                                                                                                                                | 172 | Substantiation                                                                      |
| <b>3.3.XX Detonation.</b><br>Propagation of a combustion zone at a velocity that is greater than the speed of sound in the unreacted medium. [68, 2023]                                                         |     | The term appears in the new proposed language in Chapter 9 and needs to be defined. |
| Public Input No.                                                                                                                                                                                                | 173 | Substantiation                                                                      |
| <b>3.3.XX* Enclosure.</b><br>A confined or partially confined volume. [68, 2023]<br><b>A.3.3.XX Enclosure.</b><br>Examples of enclosures include a room, building, vessel, silo, bin, pipe, or duct. [68, 2023] |     | The term appears in the new proposed language in Chapter 9 and needs to be defined. |

# Redirect 6.10 to Chapter 9

## Public Input No. 157-NFPA 2-2023 [ Section No. 6.10 ]

### 6.10\* Explosion Control.

#### 6.10.1

Explosion control shall be provided where the quantity of GH<sub>2</sub> or LH<sub>2</sub> in storage or use exceeds the quantity thresholds requiring special provisions as listed in Table 6.4.1.1.1 or where otherwise required.

#### 6.10.2

Where explosion control is required, it shall be provided in accordance with Chapter 9 ~~by one or both of the following methods :~~

- ~~(1) Explosion prevention in accordance with 6.10.3~~
- ~~(2) Deflagration venting in accordance with 6.10.4~~

#### ~~6.10.3\* Explosion Prevention.~~

~~Where provided, explosion prevention shall be in accordance with one or more of the methods specified in NFPA 69.~~

#### ~~6.10.4 Deflagration Venting.~~

~~Where provided, explosion protection by the use of deflagration venting shall be in accordance with NFPA 68.~~

# Redirect references to 6.10 to Chapter 9

| PI # | Section        |
|------|----------------|
| 108  | 7.1.23.15.1    |
| 109  | 7.3.2.2.2.3    |
| 110  | 7.3.2.2.3.3    |
| 111  | 7.3.2.5        |
| 112  | 8.3.2.2.2.1(B) |
| 113  | 8.3.2.2.3.2    |
| 114  | 10.5.3.4.1.4   |

# After 1<sup>st</sup> draft... submit PCs to enhance Chapter 9

- Add definition for explosion

**3.3.10 Explosion.** The bursting or rupturing of an enclosure or a container due to the development of internal pressure from a deflagration.

Nathan: Slide 13: Definition of explosion. There may be too many words that make the definition too narrow. “from a deflagration” is what I’m honing in on. It could be an explosion if a detonation occurred as well. In fact, if no event occurred, but you pressurized something with too much hydrogen... or nitrogen for that matter, I would think that is still an explosion. Finally, maybe going too far but maybe not, it would probably also be an explosion if the internal pressure did not develop, but the container weakened... from rust, physical damage, or whatever?

- Reformat chapter 9 to put all explosion prevention requirements (NFPA 69) up front, followed by hazard assessment, and then end with explosion control requirements (NFPA-68)
- Add some K1 content (see the following page)

# Language from annex K that could go into Chapter 9

- **K.1.1 Applicability.** The storage, use, and handling of GH2 in any quantity should also comply with the requirements of Chapter 1 through 4 and the applicable requirements of Chapters 5 through 8.
- **K.2.2.1.1.1** The hazard analysis should identify and document the applicable explosion hazard scenarios.
- **K.2.2.2 Deflagration Prevention by Hydrogen Gas Concentration Reduction.**
- **K.2.2.2.1** Deflagration prevention by gas concentration reduction can be considered where a mixture of a combustible material and an oxidant is confined to an enclosure and where the concentration of the hydrogen can be maintained below the lower flammable limit (LFL) of hydrogen (4.0 volume per- cent at room temperature and pressure).
- Note: See NFPA 69, Annex B, for a discussion of the control of flammable gas mixtures. See also NFPA 69, Annex D, for information on calculating the time required for concentration reduction by ventilation.

These are just a few examples of Annex K language that could be included in Chapter 9

# NFPA 2 1<sup>st</sup> draft

PI-180

Section 6.1.1.4

#### 6.1.1.4 Quantities Less Than or Equal to the MAQ

- Confusing convoluted charging language.
- 2 step process proposed.
- Step 1 – Get TC agreement on which CH 6 sections apply below MAQ.
- Step 2 – (PC at 2<sup>nd</sup> draft) Create a separate stand alone section for below MAQ making the existing 6.1.1.4 largely unnecessary.

# Approach

- For amounts of HAZMAT < MAQ 6.1.1.4 lists the Building Related Controls that apply. – confusing. Often missed. Not correct?
- For **GREATER THAN** MAQ everything applies. No changes for > MAQ.
- Let's agree on what applies below MAQ. Go to WORD TABLE

CH 6 Sections.

| Section                         | Currently applies <MAQ | Should apply <MAQ | PI-180 changes to 6.1.1.4                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|---------------------------------|------------------------|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 6.1 Charging language           | YES                    | YES               | NO CHANGE                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 6.2 Design and Construction     | NO                     | YES               | <b>Added to 6.1.1.4.</b> This invokes the building code globally which is redundant (it always applies) but needs to apply below MAQ as well as above.                                                                                                                                                                                                                                                                                                                               |
| 6.3 Control areas               | NO                     | YES               | <b>Added to 6.1.1.4.</b> The control area concept is only useful below MAQ.                                                                                                                                                                                                                                                                                                                                                                                                          |
| 6.4 Occupancy protection levels | NO                     | YES               | <b>Added to 6.1.1.4.</b> Applies above MAQ also. Among the sections of 6.3 that need to apply below MAQ but would be missed if not included in the 6.2.4 list:<br>6.3.1.3 Aggregate Quantities – provides instruction on how to add them up in use and storage.<br>6.3.1.4 Incompatible. This needs to apply equally above and below MAQ.<br>6.3.1.5. Multiple Hazards – provides instruction on how to deal with multiple hazard categories.                                        |
| 6.5 Piping                      | NO                     | YES               | <b>Added to 6.1.1.4.</b> This section contains basic requirements for hydrogen piping that ensure the robustness and integrity the code counts on are included. This needs to apply to piping systems connected to below MAQ quantities as well as above.                                                                                                                                                                                                                            |
| 6.6 Gas Rooms                   | NO                     | YES               | <b>Added to 6.1.1.4.</b> Gas rooms are used to allow hydrogen in excess of 250 cubic feet (per the limitation of 6.4.1.5.1.1) and up to but not exceeding MAQ in sensitive occupancies (other than Storage, Industrial). Additional protections are required. At greater than MAQ the area changes occupancy classification to high hazard. (Group H-2 per IBC or Protection Level 1 per NFPA 1). Gas rooms are a useful option for below MAQ and must be made applicable below MAQ. |
| 6.7 Weather Protection          | NO                     | YES               | <b>Added to 6.1.1.4</b> - This is often used to make sure an outside storage area both above or below MAQ does actually qualify as outdoors (not indoors) even though a roof may be                                                                                                                                                                                                                                                                                                  |

| Section                          | Currently applies <MAQ | Should apply <MAQ | PI-180 changes to 6.1.1.4                                                                                                                                                                                                                                                                                                                                                                                                                  |
|----------------------------------|------------------------|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                  |                        |                   | installed. This must apply below MAQ as well as above                                                                                                                                                                                                                                                                                                                                                                                      |
| 6.8 Electrical                   | YES                    | YES               | <b>Retained in 6.1.1.4. NO CHANGE.</b>                                                                                                                                                                                                                                                                                                                                                                                                     |
| 6.9 Employee Alarm System        | YES                    | NO                | <b>Deleted from 6.1.1.4.</b> This was removed because Employee Alarm Systems are only needed above MAQ. They are intended to provide a means of notifying employees of a need to exit or stay out of a HAZMAT room. Currently, this conflicts with the IFC (ref. 2013 IFC 5004.9) which has the same requirement, but it only applies above MAQ. They are not warranted below MAQ. This change makes them only required above MAQ not both |
| 6.10 Explosion control           | NO                     | NO                | NO CHANGE. Only applies above MAQ. Agrees with IFC.                                                                                                                                                                                                                                                                                                                                                                                        |
| 6.11 Fire Protection Systems     | NO                     | NO                | NO CHANGE. Only applies above MAQ. Agrees with IFC.                                                                                                                                                                                                                                                                                                                                                                                        |
| 6.12 Fire Alarm System.          | NO                     | NO                | NO CHANGE. Only applies above MAQ. Agrees with IFC.                                                                                                                                                                                                                                                                                                                                                                                        |
| 6.13 GH2 Detection Systems       | YES                    | YES               | NO CHANGE. <b>Retained in 6.1.1.4.</b>                                                                                                                                                                                                                                                                                                                                                                                                     |
| 6.13 Hazard Identification Signs | YES                    | YES               | NO CHANGE. <b>Retained in 6.1.1.4.</b>                                                                                                                                                                                                                                                                                                                                                                                                     |
| 6.14 Lighting                    | NO                     | NO                | NO CHANGE. Silly but not fatal? Needed at all? Delete?                                                                                                                                                                                                                                                                                                                                                                                     |
| 6.15 Spill Control.              | NO                     | NO                | NO CHANGE. Only needed >MAQ. Agrees with IFC.                                                                                                                                                                                                                                                                                                                                                                                              |
| 6.16 Shelving                    | NO                     | NO                | NO CHANGE. Only needed >MAQ. Agrees with IFC.                                                                                                                                                                                                                                                                                                                                                                                              |
| 6.17 Vent System termination     | YES                    | YES               | NO CHANGE. <b>Retained in 6.1.1.4.</b> Applies both above and below MAQ.                                                                                                                                                                                                                                                                                                                                                                   |
| 6.18 Ventilation                 | YES                    | NO                | <b>Deleted from 6.1.1.4.</b> Not needed below MAQ. Should apply only above MAQ. Consistent with IFC. This needs a threshold and MAQ is the right one. Note: Other PIs change the title to “Exhaust ventilation” which is more clear.                                                                                                                                                                                                       |
| 6.19 Gas Cabinets                | NO                     | YES               | <b>Added to 6.1.1.4.</b> For flammable gas and other gases, gas cabinets can                                                                                                                                                                                                                                                                                                                                                               |

| Section                             | Currently applies <MAQ | Should apply <MAQ | PI-180 changes to 6.1.1.4                                                                                                                             |
|-------------------------------------|------------------------|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                     |                        |                   | be useful to increase the MAQ threshold and remain below it                                                                                           |
| 6.20 Exhausted enclosures           | NO                     | YES               | <b>Added to 6.1.1.4.</b> Similar to gas cabinets, exhausted enclosures can be used to increase the MAQ but only if they are applicable below the MAQ. |
| 6.21 Source valve                   | NO                     | NO                | NO CHANGE. Only applies above MAQ. Only applies to bulk systems which are always above MAQ.                                                           |
| 6.22 Cleaning, Purging<br>Repairing | NO                     | YES               | <b>Added to 6.1.1.4.</b>                                                                                                                              |

NFPA 2 – ESS/ESD Topic

|             |               |
|-------------|---------------|
| DOC #       | 2             |
| Topic       | ESS/ESD Topic |
| Provided By | Bob Boyd      |

| SECTION                                                                                    | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|--------------------------------------------------------------------------------------------|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3.3.69<br>3.3.70<br>New Def.                                                               | 58             | <a href="#">Create First Revision</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| PI TEXT                                                                                    |                | <p><del>3.3.69 Emergency Shutdown Device (ESD).<br/>See 3.3.63.1. A device that activates the emergency shutdown system (ESS).</del></p> <p>3.3.70 Emergency Shutoff Valve (ESV).<br/><del>See 3.3.252.1. A designated valve designed to shut off the flow of fluid in the event of an emergency.</del></p> <p><del>3.3.XX Emergency Shutdown System (ESS)*<br/>The system that responds to ESD activation and closes emergency shutdown valves (ESVs), issues alarms and other actions according to the site safety plan.</del></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| PROPOSED REVISION (FR)                                                                     |                | <p><b>3.3.69 Emergency Shutdown Device (ESD).</b><br/><del>See 3.3.63.1. A device that activates the emergency shutdown system (ESS).</del></p> <p><b>A.3.3.69. Emergency Shutdown Device (ESD).</b><br/>Emergency shutdown devices (ESDs) could <del>may</del> be any of the following devices that will trip the emergency shutdown system (ESS) to shut down the system into a safe mode:<br/> (1) A manually operated red pushbutton switch with a yellow background in compliance with NFPA-79.<br/> (2) A low pressure switch measuring hydrogen compressor suction pressure.<br/> (3) A flame (UV/IR), heat or hydrogen detector.<br/> (4) Or any other safety related input device that has a switch for electrical conductivity of signal or other means of connection to the ESS</p> <p><b>3.3.XX Emergency Shutdown System (ESS)*</b><br/>The system that responds to ESD activation and closes emergency shutdown valves (ESVs), issues alarms and other actions according to the equipment risk assessments <del>site safety plan.</del></p> <p><del>A.3.3.x. A.3.3.XX Emergency Shutdown System (ESS).<br/>The emergency shutdown system responds to an activation of an ESD(s) and shuts down the system safely.</del></p> |
| Includes new text from:<br>PI 57<br>PI 59<br><del>PI 79</del><br><del>PI 80</del><br>PI 87 |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| PROPOSED STATEMENT                                                                         |                | <p><del>In the review of PC submitted for the last code cycle in 2021, a few of us noted inconsistencies with the use of ESD and ESS. This is one of a series of public comments will provide consistency in the definitions and use of the terms ESS an ESD throughout the document.</del></p> <p><del>ESV was removed from this proposed First Revision and will be addressed in PC 61</del></p> <p>This <del>revision and the subsequent PCs</del> harmonizes the use of these terms with what is defined in CSA-HGV-4.1 <i>Hydrogen Dispensers</i>, and CSA-HGV-4.9 <i>Hydrogen Fueling Stations</i></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

**Commented [DH1]:** From Staff: This PI is redundant to several other PIs identified in this report. This PI cannot be accepted if the other PIs are also accepted.

**Commented [RB2R1]:** I added annex material from other PCs and will address the ESV in the second proposed FR

**Commented [DH3]:** From Staff: This PI is redundant to several other PIs identified in this report. This PI cannot be accepted if the other PIs are also accepted.

**Commented [RB4R3]:** I added annex material from other PCs and will address the ESV in the second proposed FR

NFPA 2 – ESS/ESD Topic

| SECTION                                                                                                                                                                                                                                    | Public Input # | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|------------------------------------------------------------------------|
| 3.3.69<br>3.3.70<br>New Def.                                                                                                                                                                                                               | 58             | <a href="#">Create First Revision</a>                                  |
| <del>Hydrogen vehicle fueling is the largest new hydrogen application and it is good have definitions for safety systems that are harmonized with North American and International product safety standards (CSA HGV and ISO-TC-197.</del> |                |                                                                        |

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 3.3.69<br>A.3.3.69     | <del>57</del><br>64<br>81<br>87                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Resolve Public Input                                                   |
| PI TEXT                | <p><b>3.3.69 Emergency Shutdown Device (ESD).</b><br/> <a href="#">See 3.3.63.1: A device that activates the emergency shutdown system (ESS).</a></p> <p><b><u>A.3.3.69. Emergency Shutdown Device (ESD).</u></b><br/> <a href="#">Emergency shutdown devices (ESDs) may be any of the following devices that will trip the emergency shutdown system (ESS) to shut down the system into a safe mode:</a></p> <ul style="list-style-type: none"> <li><a href="#">(1) A manually operated red pushbutton switch with a yellow background in compliance with NFPA-79.</a></li> <li><a href="#">(2) A low pressure switch measuring hydrogen compressor suction pressure.</a></li> <li><a href="#">(3) An UV/IR or hydrogen detector.</a></li> <li><a href="#">(4) Or any other safety related input device that has a switch for electrical conductivity of signal or other means of connection to the ESS.</a></li> </ul> <p><a href="#">Most hydrogen fueling station modules will include a separate ESS to stop the process of the module (production, compression, dispensing) in the event of an ESS activation. Each hydrogen fueling station site will typically have all operating modules connected to a site-wide emergency shutdown system.</a></p> |                                                                        |
| PROPOSED REVISION (FR) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                        |
| PROPOSED STATEMENT     | This annex note guides the user to an understanding of how the ESS is connected to numerous ESDs that can initiate a shutdown of a hazardous process. This annex note has been incorporated into PC #58 (FR xx)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                        |

Commented [A15]: This moves ESD out from Device

| SECTION        | Public Input #                                                                                                                                                                                                                                                                                              | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| New Definition | 59<br>82                                                                                                                                                                                                                                                                                                    | Resolve Public Input                                                   |
| PI TEXT        | <p><b><u>3.3.XX Emergency Shutdown System (ESS)*</u></b><br/> <a href="#">The system that responds to ESD activation and closes emergency shutdown valves (ESVs), issues alarms and other actions according to the site safety plan.</a></p> <p><b><u>A.3.3.XX Emergency Shutdown System (ESS).</u></b></p> |                                                                        |

NFPA 2 – ESS/ESD Topic

| SECTION                   | Public Input #                                                                                                                         | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| New<br>Definition         | 59<br>82                                                                                                                               | Resolve Public Input                                                   |
|                           | <u>The emergency shutdown system (ESS) responds to an activation of an ESD and shutdown the system safely.</u>                         |                                                                        |
| PROPOSED<br>REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.] |                                                                        |
| PROPOSED<br>STATEMENT     | This PC has been incorporated into PI 58 (FR xx)                                                                                       |                                                                        |

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 3.3.252                | 61                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Create First Revision                                                  |
| PI TEXT                | <p><b>3.3.252 Valve.</b><br/> <b>3.3.252.1 Emergency Shutoff Valve (ESV).</b><br/> A designated valve designed to shut off the flow of gases or liquids.<br/> <b>3.3.252.1.1 Automatic Emergency Shutoff Valve:</b><br/> <del>A designated fail-safe automatic closing valve designed to shut off the flow of gases or liquids that held open by the emergency shutdown system (ESS) and is closed when the ESS is initiated-activated by a control system where the control system is activated by either manual or automatic means. (See 3.3.69 and 3.3.71)</del></p> <p><b>3.3.252.2 Shutoff Valve.</b><br/> <b>3.3.252.2.1* Safety Shutoff Valve:</b><br/> <del>A normally-closed valve installed in the piping that closes automatically to shut off the fuel, atmosphere gas, or oxygen in the event of abnormal conditions or during shutdown. [66, 2023]</del><br/> <b>3.3.252.2* Source Valve:</b><br/> A shutoff valve on the piping system serving a bulk gas supply system where the gas supply, at service pressure, first enters the supply line.</p> |                                                                        |
| PROPOSED REVISION (FR) | <p><b>3.3.252.1 Emergency Shutoff Valve (ESV).</b><br/> See 3.3.70<br/> <b>3.3.70 Emergency Shutoff Valve (ESV).</b><br/> A designated fail-safe automatic closing valve designed to shut off the flow of gases or liquids that is closed when the ESS is activated by either manual or automatic means.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                        |
| PROPOSED STATEMENT     | <p>This points the reader to the Emergency Shutoff Valve definition and moves (new) the definition (PC 61, FR xx) out from “under”. Valve This PC also removes the <b>3.3.251.2 Safety Shutoff Valve</b> definition and incorporates the fail-safe aspects into the ESV definition. This revision increases clarity of the definitions and harmonizes with CSA-ANSI HGV04.x and ISO-TC-197 terms used for H2 fueling station product safety standards</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                        |

| SECTION                | Public Input #                                                                                                                                                                | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 3.3.252                | 75                                                                                                                                                                            | Resolve Public Input                                                   |
| PI TEXT                | <p><b>3.3.252 Valve.</b><br/> <b>3.3.252.1 Emergency Shutoff Valve.</b><br/> <del>A designated valve designed to shut off the flow of gases or liquids.</del> See 3.3.70.</p> |                                                                        |
| PROPOSED REVISION (FR) |                                                                                                                                                                               |                                                                        |
| PROPOSED STATEMENT     | This has been incorporated into PI 61 (FR XX)                                                                                                                                 |                                                                        |

| SECTION | Public Input #                                                                                                                                                                                                                                                                                         | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 3.3.70  | 73                                                                                                                                                                                                                                                                                                     | Resolve Public Input                                                   |
| PI TEXT | <p><b>3.3.70 Emergency Shutoff Valve.</b><br/> Designated fail-safe automatic closing valve designed to shut off the flow of gases or liquids that is held open by the emergency shutdown system (ESS) and is closed when the ESS is activated by either manual or automatic means. See 3.3.252.1.</p> |                                                                        |

NFPA 2 – ESS/ESD Topic

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 3.3.70                 | 73                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Resolve Public Input                                                   |
| PROPOSED               | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                        |
| PROPOSED STATEMENT     | This has been incorporated into PI 61 (FR XX)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                        |
| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
| 8.3.1.2.9              | 63                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Create First Revision                                                  |
| PI TEXT                | <p><b>8.3.1.2.9 Emergency Shutdown System.</b></p> <p><b>8.3.1.2.9.1</b><br/>Emergency isolation shall comply with 7.1.25.1, 8.3.1.2.4.2, and 8.3.1.2.9.</p> <p><b>8.3.1.2.9.2</b><br/>An emergency shutdown <del>device</del> (ESD)-<del>system</del> shall be provided at the bulk source to stop the flow of liquid and gas into the use line when actuated.</p> <p><b>8.3.1.2.9.3</b><br/>The <del>ESD-emergency shutdown</del> system shall be operated by a remotely located, manually activated shutdown <del>control-located- device (switch or push button)</del> located not less than 15 ft (4.5 m) from the source of supply.</p> <p><b>8.3.1.2.9.4</b><br/>Reactivation of the <del>ESD-system</del>ESS after <del>an</del> ESD event shall require that the <del>ESD-system</del> ESS be manually reset.</p> <p><b>8.3.1.2.9.5</b><br/>The <del>manually activated</del> ESD(s)-<del>system</del> shall be identified by means of a sign.</p> |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                        |
| PROPOSED STATEMENT     | This is a good example of how the language in NFPA-2 can be enhanced by clearly defining ESD, and ESS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                        |

**Commented [DH6]:** From Staff: This needs to be moved to an annex or deleted to align with the MOS.

**Commented [DH7]:** This PI table was duplicated in the TGR. See other table for PI-63 for recommended action.

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                      | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| New Definition         | 74                                                                                                                                                                                                                                                                                                                                                  | Create First Revision                                                  |
| PI TEXT                | <p><b>3.3.XY E-Stop.</b><br/>A manually operated, red push button switch which will initiate an emergency system shutdown.</p>                                                                                                                                                                                                                      |                                                                        |
| PROPOSED REVISION (FR) | <p><b>3.3.XY E-Stop.</b><br/>A manually operated, red push button <del>ESD</del> switch which will initiate an emergency system shutdown.</p>                                                                                                                                                                                                       |                                                                        |
| PROPOSED STATEMENT     | The E-Stop “button” is a key element in every emergency shutdown system and is often specified in the fire code regarding specific placement of and E-Stop button at the fueling station (island or area) and this definition helps to clarify the interaction of safety system components and refers to the E-Stop as an Emergency Shutdown Device |                                                                        |

NFPA 2 – ESS/ESD Topic

| SECTION                | Public Input #                                                                                                                                                                                                               | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 3.3.63.1               | 84                                                                                                                                                                                                                           | Create First Revision                                                  |
| PI TEXT                | <b>3.3.63.1 Emergency Shutdown Device (ESD) [Vehicle Fueling].</b><br><del>A device that brings all operations to a fail-safe condition within the fueling facility from either local or remote locations. See 3.3.69.</del> |                                                                        |
| PROPOSED REVISION (FR) |                                                                                                                                                                                                                              |                                                                        |
| PROPOSED STATEMENT     | This moves the definition to 3.3.69 out from “under” DEVICE.                                                                                                                                                                 |                                                                        |

| SECTION                | Public Input #                                                                                                                                                                                                              | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 3.3.63.1               | 60                                                                                                                                                                                                                          | Resolve Public Input                                                   |
| PI TEXT                | <del><b>3.3.63.1 Emergency Shutdown Device (ESD) [Vehicle Fueling].</b></del><br><del>A device that brings all operations to a fail-safe condition within the fueling facility from either local or remote locations.</del> |                                                                        |
| PROPOSED REVISION (FR) |                                                                                                                                                                                                                             |                                                                        |
| PROPOSED STATEMENT     | The intent was captured in PI 84.                                                                                                                                                                                           |                                                                        |

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| SECTION                | Public Input #                                                                                                                            | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 3.3.70                 | 83                                                                                                                                        | Resolve Public Input                                                   |
| PI TEXT                | <b>3.3.70 Emergency Shutoff Valve.</b><br><del>A designated valve designed to shut off the flow of liquids or gases. See 3.3.252.1.</del> |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]    |                                                                        |
| PROPOSED STATEMENT     | This change was incorporated into PI 58 , FR xx                                                                                           |                                                                        |

NFPA 2 – ESS/ESD Topic

|             |               |
|-------------|---------------|
| DOC #       | 2             |
| Topic       | ESS/ESD Topic |
| Provided By | Bob Boyd      |

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                         | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 6.18.2.1.3             | 92                                                                                                                                                                                                                                                                                                     | <a href="#">Create First Revision</a>                                  |
| PI TEXT                | <b>6.18.2.1.3 Manual Shutoff Switch.</b><br>The switch shall be the <del>breakglass or equivalent type and</del> <u>accessible, non-resettable and</u><br>shall be labeled as follows:<br>WARNING: VENTILATION SYSTEM EMERGENCY SHUTOFF                                                                |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                 |                                                                        |
| PROPOSED STATEMENT     | <u>The main purpose of clause 6.18.2.3.1 is to provide means to manually shut off the ventilation switch either for service or in case of emergency. the requirement that a break glass device be used instead of a normal ESD or service switch is unnecessary and provides no additional safety.</u> |                                                                        |

| SECTION                | Public Input #                                                                                                                                                                                                                                        | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 8.3.1.2.8.3            | 62<br>88                                                                                                                                                                                                                                              | <a href="#">Create First Revision</a>                                  |
| PI TEXT                | <b>8.3.1.2.8.3 Emergency Shutdown System Operation.</b><br>When an emergency shutdown (ESD) is required, activation of the <del>ESD-system</del> <u>emergency shutdown system (ESS)</u> shall shut down operation of all pumps and compressors.       |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                |                                                                        |
| PROPOSED STATEMENT     | The confusing use of the term "ESD system" can be clarified by defining ESS and ESD clearly. Emergency response and safety is paramount, and it is good practice to have all of these definitions together in 3.3.69 ESD , 3.3.70 ESS and 3.3.71 ESV. |                                                                        |

| SECTION   | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 8.3.1.2.9 | 63                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <a href="#">Create First Revision</a>                                  |
| PI TEXT   | <b>8.3.1.2.9 Emergency Shutdown System.</b><br><b>8.3.1.2.9.1</b><br>Emergency isolation shall comply with 7.1.25.1, 8.3.1.2.4.2, and 8.3.1.2.9.<br><br><b>8.3.1.2.9.2</b><br>An emergency shutdown <u>device</u> (ESD) <del>-system</del> shall be provided at the bulk source to stop the flow of liquid and gas into the use line when actuated.<br><br><b>8.3.1.2.9.3</b><br>The <del>ESD-emergency shutdown</del> system shall be operated by a remotely located, manually activated shutdown <del>control-located- device</del> <u>(switch or push button)</u> <del>located</del> not less than 15 ft (4.5 m) from the source of supply.<br><br><b>8.3.1.2.9.4</b><br>Reactivation of the <del>ESD-system</del> <u>ESS</u> after <u>an</u> ESD <u>event</u> shall require that the <del>ESD-system</del> <u>ESS</u> be manually reset.<br><br><b>8.3.1.2.9.5</b><br>The <u>manually activated</u> ESD(s) <del>-system</del> shall be identified by means of a sign. |                                                                        |

**Commented [DH8]:** From Staff: This needs to be moved to an annex or deleted to align with the MOS.

NFPA 2 – ESS/ESD Topic

| SECTION                | Public Input #                                                                                                                                                                                                                                                                               | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 8.3.1.2.9              | 63                                                                                                                                                                                                                                                                                           | <a href="#">Create First Revision</a>                                  |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                       |                                                                        |
| PROPOSED STATEMENT     | The confusing use of the terms ESD and ESD system (Emergency Shutdown System ESS) can be clarified by defining ESS and ESD clearly. Emergency response and safety is paramount, and it is good practice to have all of these definitions together in 3.3.69 ESD , 3.3.70 ESS and 3.3.71 ESV. |                                                                        |

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 8.3.1.2.9              | 85                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <a href="#">Resolve Public Input</a>                                   |
| PI TEXT                | <p><b>8.3.1.2.9 Emergency Shutdown System.</b></p> <p><b>8.3.1.2.9.1</b><br/>Emergency isolation shall comply with 7.1.25.1, 8.3.1.2.4.2, and 8.3.1.2.9.</p> <p><b>8.3.1.2.9.2</b><br/>An emergency shutdown <del>device</del> (ESD)-<del>system</del> shall be provided at the bulk source to stop the flow of liquid and gas into the use line when actuated.</p> <p><b>8.3.1.2.9.3</b><br/>The <del>ESD</del>-<del>emergency shutdown</del> system shall be <del>operated-initiated</del> by a remotely located, manually activated shutdown <del>control-device</del> (ESD) located not less than 15 ft (4.5 m) from the source of supply.</p> <p><b>8.3.1.2.9.4</b><br/>Reactivation of the <del>ESD-system</del>ESS after <del>an</del> ESD <del>activation</del> shall require that the <del>ESD system- ESS</del> be manually reset.</p> <p><b>8.3.1.2.9.5</b><br/>The ESD (<del>emergency stop button</del>) <del>system</del> shall be <del>red in color and</del> identified by means of a sign.</p> |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                        |
| PROPOSED STATEMENT     | This is a duplicate of PC 63, see FR xx                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                        |

| SECTION                | Public Input #                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | PROPOSED MOTION<br>(e.g., First Revision, Resolve, or Committee Input) |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| 11.3.1.8               | 86                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <a href="#">Create First Revision</a>                                  |
| PI TEXT                | <p><b>11.3.1.8 Emergency Shutdown System.</b></p> <p>An emergency shutdown system (<del>ESD</del>ESS) shall be provided that includes a shut-off valve, <del>and ESD</del> which shall be provided within 10 ft (3.1 m) of the dispenser, for stopping liquid supply and shutting down transfer equipment. <del>An-The ESD</del> actuator for the <del>ESS</del>valve, <del>shall be</del> distinctly marked for easy recognition with a permanently affixed, legible sign<del>7. The ESS</del> shall be provided with <del>a shutdown-control-point</del><del>an ESD</del> located near the dispenser and another <del>shutdown-control-point</del>ESD located at a safe, remote location.</p> |                                                                        |
| PROPOSED REVISION (FR) | [If making a motion that has different language than the PI, enter the current code language here and make edits using track changes.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                        |
| PROPOSED STATEMENT     | In the review of NFPA-2 we found inconsistency with the use of ESD and ESS. This is one of a series of public comment that will provide consistency in the definitions and use of the terms ESS and ESD throughout the document.                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                        |

**Commented [DH9]:** From Staff: There are multiple mandatory statements in this subsection that violates the NFPA MOS.



Exceptional service in the national interest

# Gaseous Hydrogen Outdoor Bulk Storage Setback Distance Revision Options

For HYD Technical Committee

Brian D. Ehrhart and Ethan S. Hecht

NFPA 2 First Draft Meeting

April 8-11, 2024

SAND2024-04008PE

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# Current gaseous hydrogen bulk storage outdoor setback distance tables

- 3 sub-tables:
  - a) List of exposure groups with values for typical pipe size and 4 pressure ranges
  - b) Distances for exposure Groups 1-3 with variable pressure and 2 lower pressure ranges
  - c) Distances for exposure Groups 1-3 with variable pressure and 2 higher pressure ranges
- Distances are consequence-based from model results from 2009 Sandia report

Table 7.3.2.3.1.2(B)(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 <sub>mm</sub>                                       | d = 52.5 <sub>mm</sub> |    | d = 18.97 <sub>mm</sub> |    | d = 7.31 <sub>mm</sub> |    | d = 7.16 <sub>mm</sub>  |    |
| 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 |

Table 7.3.2.3.1.2(B)(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<br>>103.4 to ≤1724 kPa |    |                      |    |            |    | >250 to ≤3000 psig<br>>1724 to ≤20,684 kPa |    |                      |    |             |    |
|-----------------------------|--------|-----------------------------------------|----|----------------------|----|------------|----|--------------------------------------------|----|----------------------|----|-------------|----|
|                             |        | Exposures <sup>†</sup>                  |    |                      |    |            |    | Exposures <sup>†</sup>                     |    |                      |    |             |    |
| Internal Pipe Diameter (ID) |        | Group 1                                 |    | Group 2              |    | Group 3    |    | Group 1                                    |    | Group 2              |    | Group 3     |    |
| ID (in.)                    | d (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  | 0.2                  | 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 |

Table 7.3.2.3.1.2(B)(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<br>>20,684 to ≤51,711 kPa |    |                    |    |                    |    | >7500 to ≤15,000 psig<br>>51,711 to ≤103,421 kPa |    |                    |    |                     |    |
|-----------------------------|--------|-----------------------------------------------|----|--------------------|----|--------------------|----|--------------------------------------------------|----|--------------------|----|---------------------|----|
|                             |        | Exposures <sup>†</sup>                        |    |                    |    |                    |    | Exposures <sup>†</sup>                           |    |                    |    |                     |    |
| 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  | 1.5                | 5  | 2                  | 7  | 2                                                | 7  | 4                  | 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 |
| 0.6                         | 15.2   | 12.7                                          | 42 | 8.4                | 28 | 7                  | 22 | 17                                               | 55 | 11                 | 38 | 9                   | 29 |



## Issues to Discuss

- Unreproducible values for high-pressure ranges in current tables
  - Table values appear too large (conservative) compared to model results
- Basis for setback distances inconsistent between liquid and gaseous hydrogen
  - Not just physical release behavior
  - Exposure groups, harm criteria selection, safety factor, basis for leak size, inclusion of overpressure calculations
- Pressure ranges result in unnecessarily large setbacks for some pressures
  - E.g., 300 psig system subject to 3000 psig setback distances (pressure range:  $>250$  to  $\leq 3000$  psig)

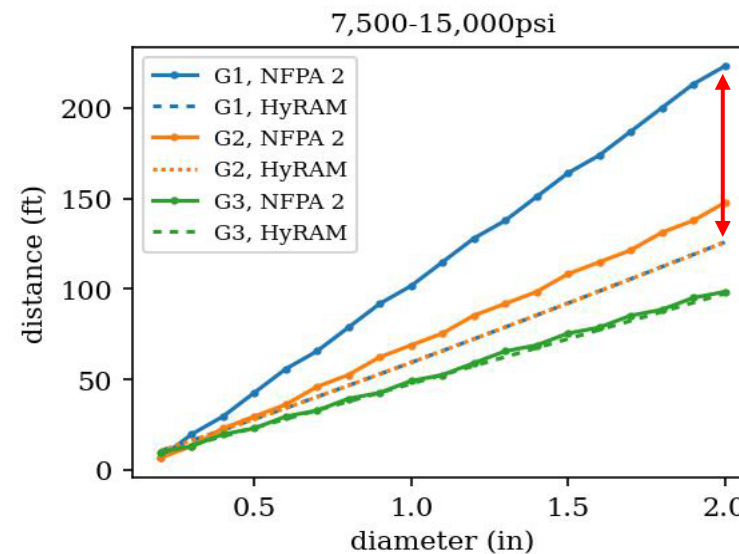
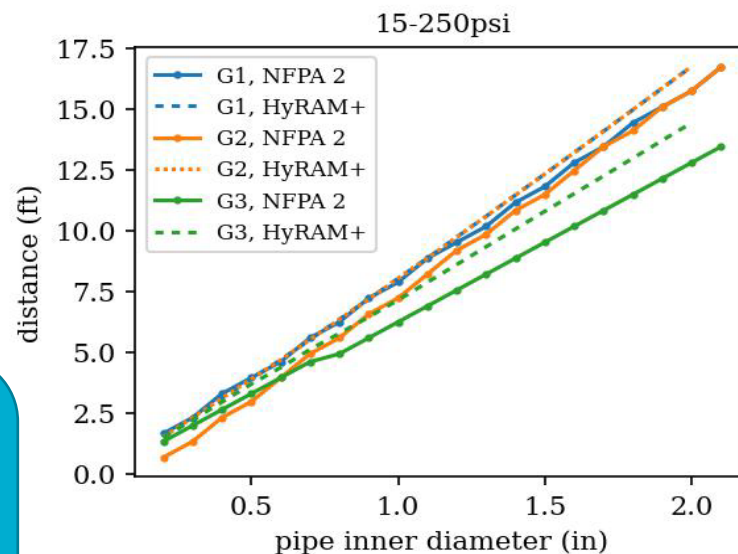


Unreproducible  
Values in  
Current Tables

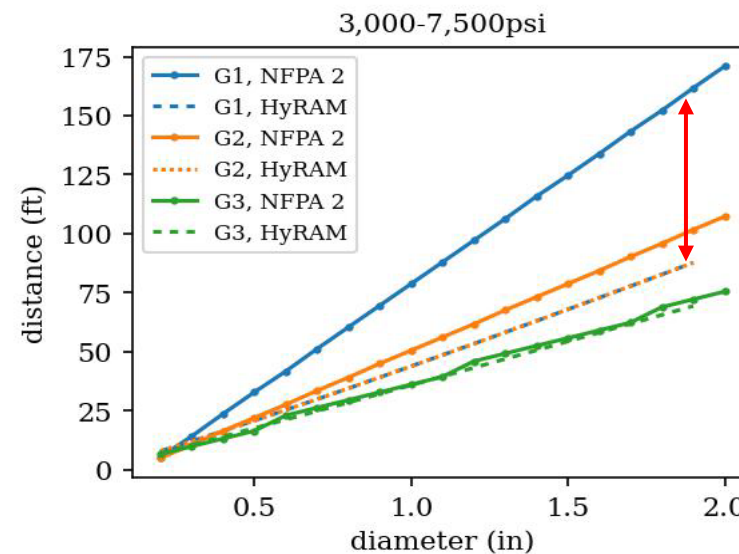
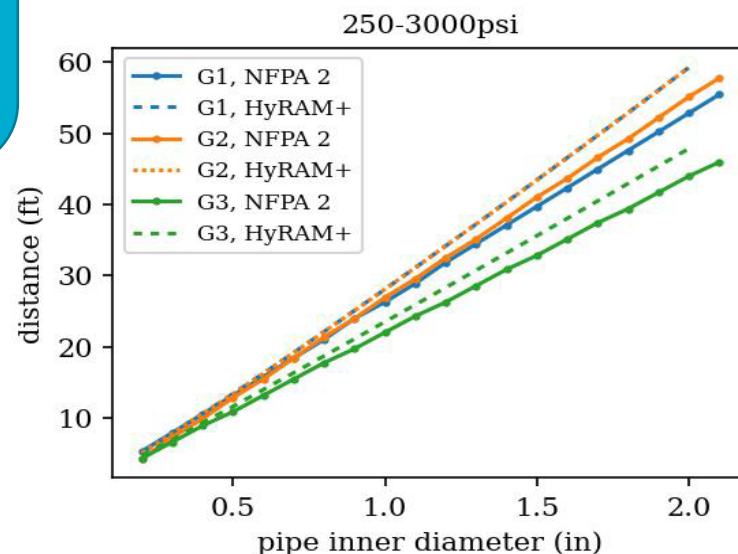


# Unable to reproduce current NFPA 2 GH<sub>2</sub> setback distances values for higher pressure ranges

NFPA 2 table values align closely with reproduced values from HyRAM+ for lower pressure ranges



NFPA 2 table values significantly larger than reproduced values from HyRAM+ for higher pressure ranges





## Why are these values incorrect?

- Table values align well with SAND2009-0874 report in 2016 edition
- Multiple changes in 2020 edition of table in NFPA 55/2
  - Leak size: 3% → 1%
  - Mole fraction: 4% → 8%
  - Group 1 heat flux: 1.6 → 4.7 kW/m<sup>2</sup>
  - Safety factor: 1 (none) → 1.5 (50%)
- Table values align well with SAND2009-0874 report for lower pressure ranges in 2020 and 2023 editions
  - Do not align well for higher pressure ranges

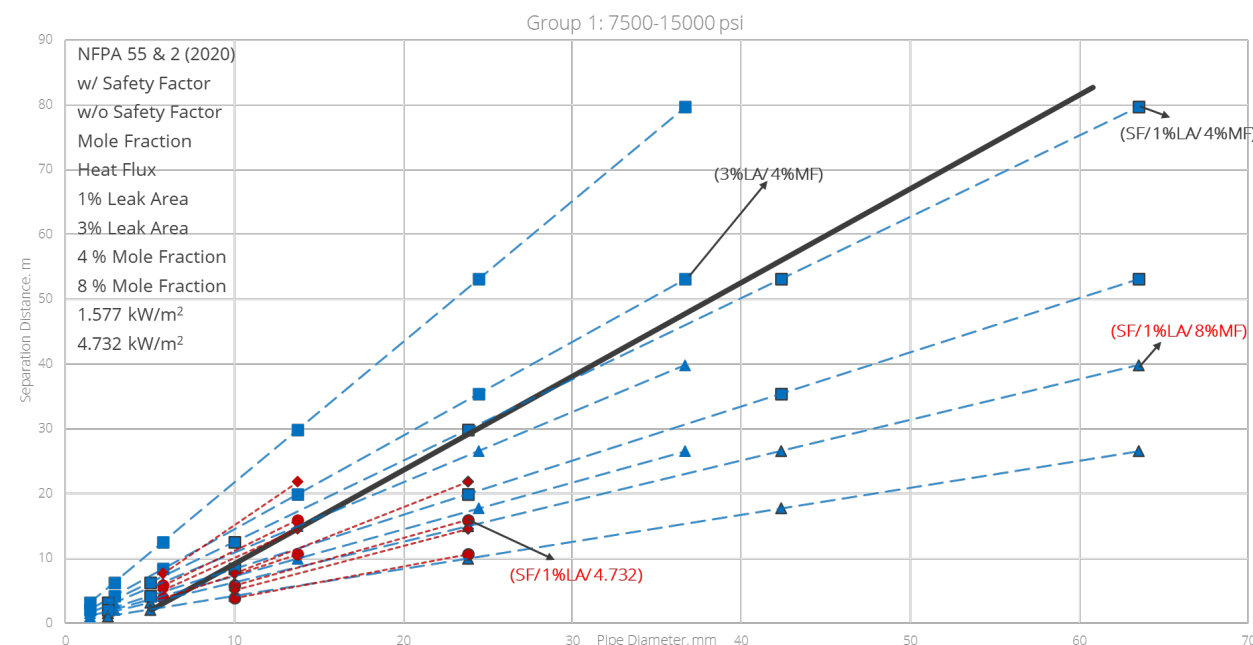


Table values appear to align with report values in which some criteria changed but not all



## Proposed solutions: correct or re-calculate values

- Revise table values
  - Keep current criteria and basis, correct values based on tables in SAND2009-0874
  - Keep current criteria and basis, correct values based on HyRAM+ calculations
  - Would be modified version of PI 96-NFPA 2-2023

But since we're already updating...

- Calculate values based on revised criteria and groups consistent with LH2 calculations [PI: 96-NFPA 2-2023]
- And/or re-organize tables with additional pressure fidelity [PI: 115-NFPA 2-2023]

Details on next slides...



Differences  
Between  $\text{GH}_2$   
and  $\text{LH}_2$  Basis



# Exposure Groups

## Gaseous Hydrogen Exposure Groups

### Group 1

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

### Group 2

- Exposed persons other than those servicing the system
- Parked cars

### Group 3

- 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 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

## Liquid Hydrogen Exposure Groups

### • Group 1

1. Lot lines
2. Air intakes
3. Operable openings in buildings
4. Ignition sources such as open flames/welding

### • Group 2

5. Exposed persons other than those servicing the system
6. Parked cars
7. Buildings of combustible construction
8. Hazardous materials storage systems above ground or fill/vent openings for below ground storage systems
9. 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

### • Group 3

10. Buildings of non-combustible non-fire-rated construction
11. Flammable gas storage systems above or below ground
12. Heavy timber, coal, or other slow-burning combustible solids
13. Unopenable openings in buildings and structures
14. Encroachment by overhead utilities (horizontal distance from the vertical plane below the nearest overhead electrical wire of building service)
15. Piping containing other hazardous materials
16. Flammable gas metering and regulating stations such as natural gas or propane



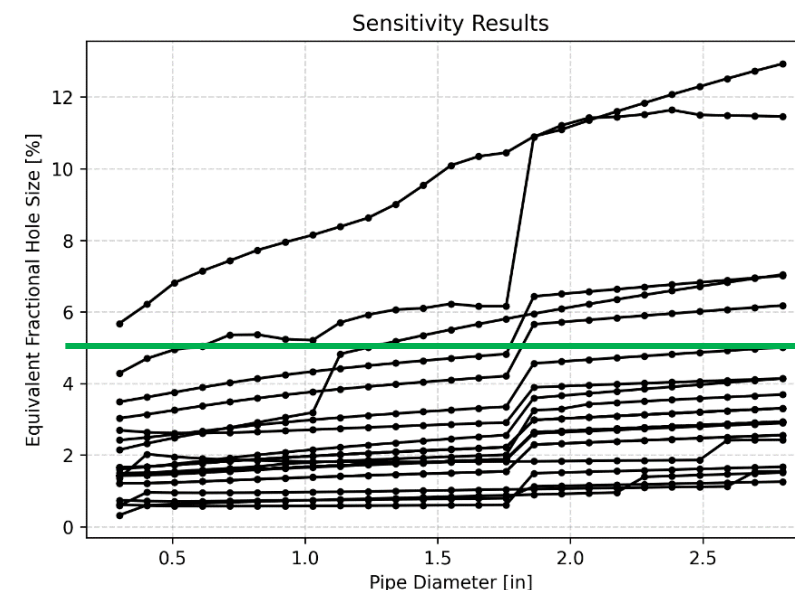
# Leak size basis in NFPA 2 2023 Edition

## Gaseous Hydrogen Setbacks

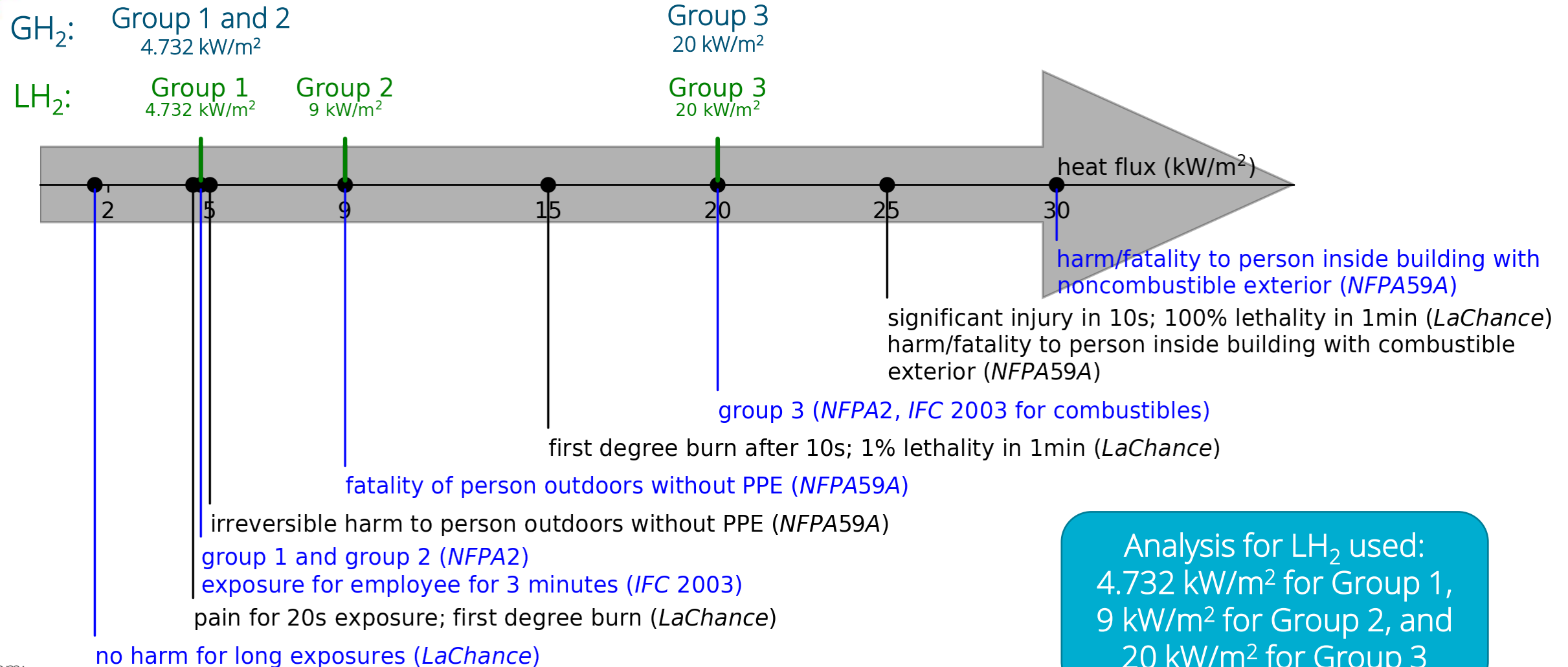
- Originally based on storage quantity (pre-NFPA 2)
- **3% of pipe flow area** in 2011 Edition
  - Analysis in SAND2009-0874 identified leak sizes of 1-10% based on leak frequency and risk calculation
  - Conservative choice
- **Changed to 1%** in 2020 Edition
  - Reducing conservatism in original choice but still within acceptable range
  - Included new safety factor of 1.5 (50%) to increase conservatism

## Liquid Hydrogen Setbacks

- Originally based on storage quantity
- **Changed to 5% of pipe flow area** in 2023 Edition
  - Conservative choice based on risk-informed sensitivity analysis



# Heat flux harm criteria in NFPA 2 2023 Edition

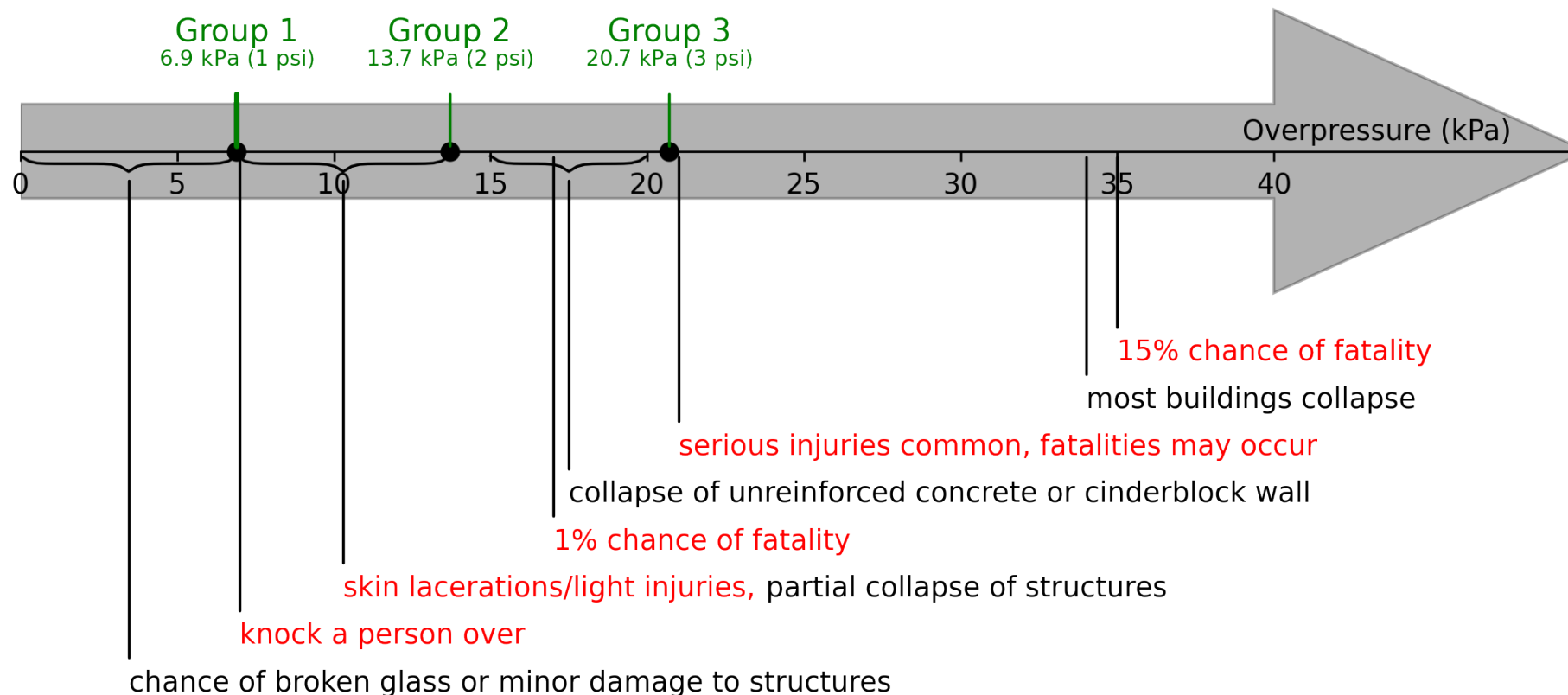


Analysis for LH<sub>2</sub> used:  
4.732 kW/m<sup>2</sup> for Group 1,  
9 kW/m<sup>2</sup> for Group 2, and  
20 kW/m<sup>2</sup> for Group 3



12

## Criteria for peak overpressure



Overpressure currently not considered for  $\text{GH}_2$  setbacks in NFPA 2 2023 Edition

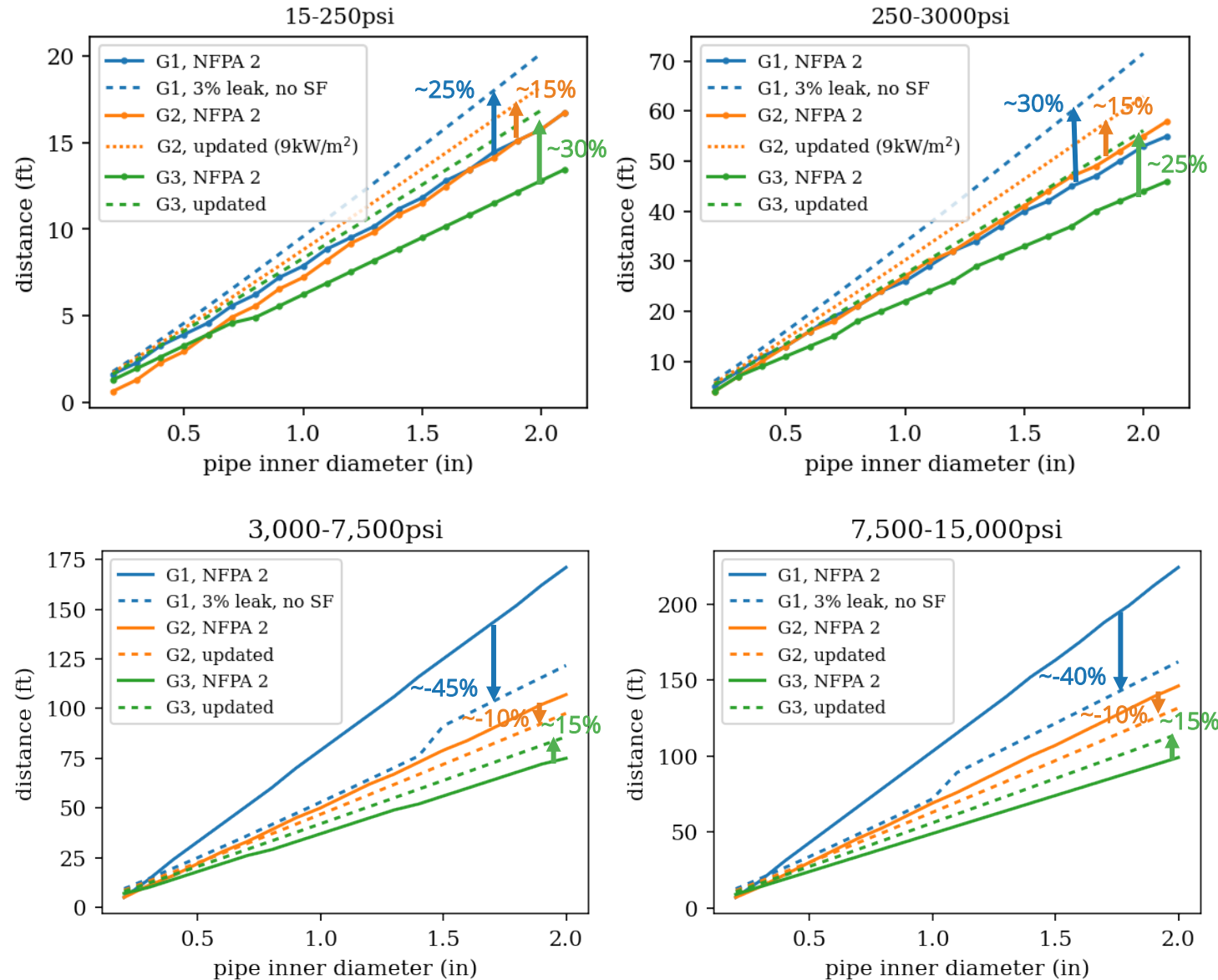
Analysis for  $\text{LH}_2$  used:  
 1 psi (7 kPa) for Group 1 exposures,  
 2 psi (14 kPa) for Group 2 exposures,  
 3 psi (21 kPa) for Group 3 exposures

# Summary of differences for public inputs

| Current (NFPA 2 2023)                                         | Public input                                       |
|---------------------------------------------------------------|----------------------------------------------------|
| 1% by area leak size                                          | 3% by area leak size                               |
| Safety factor of 1.5                                          | Safety factor of 1 (no safety factor)              |
| G1 heat flux criteria: 4.7 kW/m <sup>2</sup>                  | G1 heat flux criteria: 4.7 kW/m <sup>2</sup>       |
| G1 mole fraction criteria: 8%                                 | G1 mole fraction criteria: 8%                      |
| G1 no overpressure criteria                                   | G1 overpressure criteria: 1 psi                    |
| G2 heat flux criteria: 4.7 kW/m <sup>2</sup>                  | G2 heat flux criteria: 9 kW/m <sup>2</sup>         |
| G2 no overpressure criteria                                   | G2 overpressure criteria: 2 psi                    |
| G3 heat flux criteria: 20 kW/m <sup>2</sup>                   | G3 heat flux criteria: 20 kW/m <sup>2</sup>        |
| G3 no overpressure criteria                                   | G3 overpressure criteria: 3 psi                    |
| 20 pipe diameters, 4 pressure bins                            | 20 pipe diameters, 12 pressure bins                |
| Calculations via spreadsheet using unknown versions of models | Calculations in Python using version 5.0 of HyRAM+ |

&lt;-PI: 115-NFPA 2-2023

# How do updated calculations compare?



- 250 psi and 3000 psi – new exposure distances are longer for each group
- 7500 and 15000 psi – new exposure distances are longer for group 3, but shorter for groups 1 and 2



# Pressure Ranges

# Pressure ranges result in unnecessarily large setbacks for pressures in low end of range

- Basis for consequence-based setback distance calculated based on maximum pressure in each range
  - Pressure ranges can span order of magnitude
- Example: Group 1 exposures, pipe ID of 1"
  - 200 psig system → 8 ft
    - Based on calculation for 250 psig
  - 300 psig system → 26 ft
    - Based on calculation for 3000 psig (10x pressure)

| Pressure Range        | Basis for setbacks |
|-----------------------|--------------------|
| >15 to ≤250 psig      | 250 psig           |
| >250 to ≤3000 psig    | 3000 psig          |
| >3000 to ≤7500 psig   | 7500 psig          |
| >7500 to ≤15,000 psig | 15,000 psig        |

Table 7.3.2.3.1.2(B)(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<br>>103.4 to ≤1724 kPa |    |                      |    |            |    | >250 to ≤3000 psig<br>>1724 to ≤20,684 kPa |    |                      |    |             |    |
|-----------------------------|--------|-----------------------------------------|----|----------------------|----|------------|----|--------------------------------------------|----|----------------------|----|-------------|----|
|                             |        | Exposures <sup>a†</sup>                 |    |                      |    |            |    | Exposures <sup>a†</sup>                    |    |                      |    |             |    |
| Internal Pipe Diameter (ID) |        | Group 1                                 |    | Group 2              |    | Group 3    |    | Group 1                                    |    | Group 2              |    | Group 3     |    |
| ID (in.)                    | d (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  | 0.2                  | 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 |

## Proposed solution: reformat tables to make both pipe ID and pressure variable

- 3 sub-tables:

- a) List of exposure groups with values for typical pipe size and 4 pressure ranges
- b) Distances for exposure Groups 1-3 with variable pipe size and 2 lower pressure ranges
- c) Distances for exposure Groups 1-3 with variable pipe size and 2 higher pressure ranges

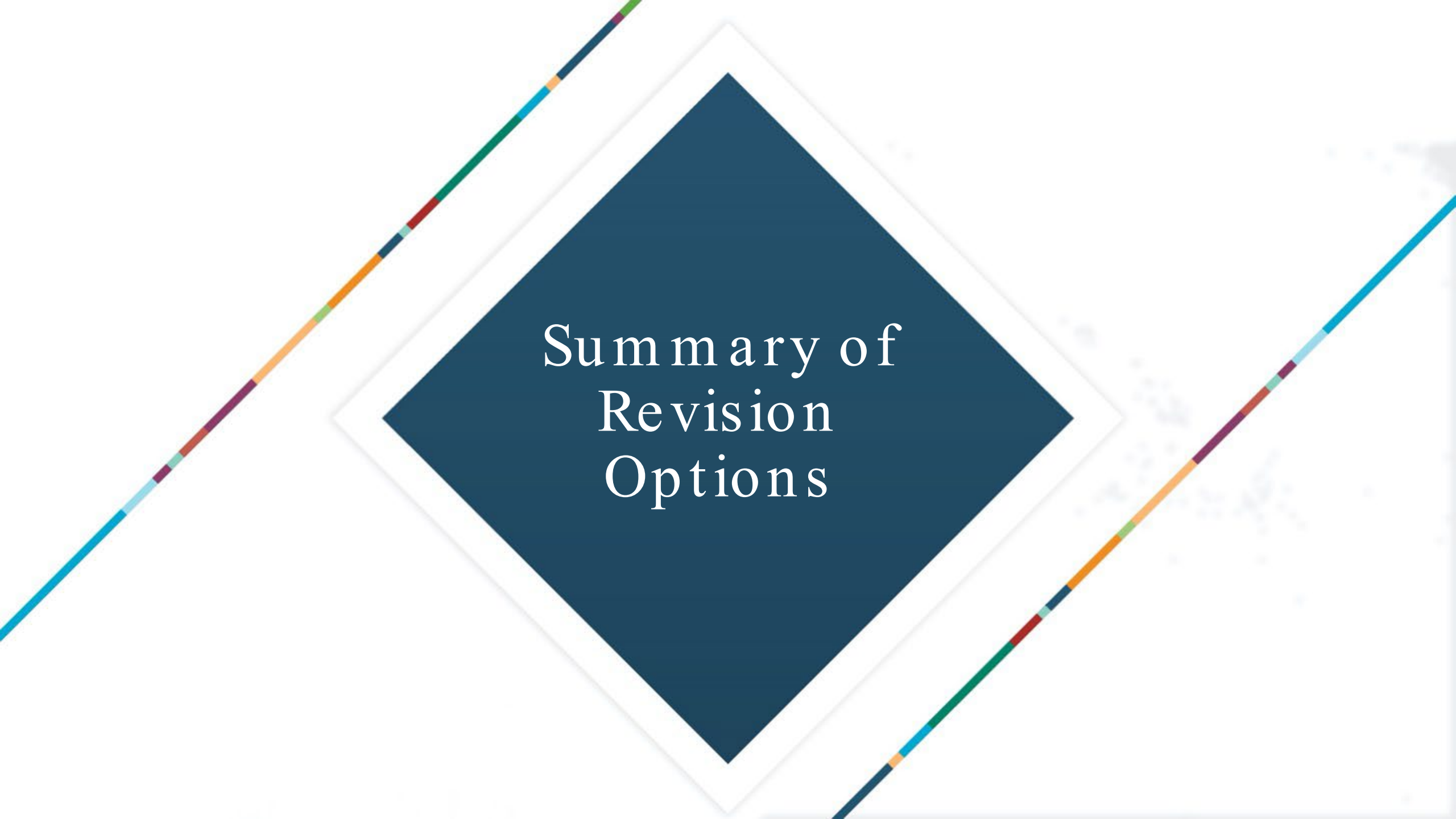
|         | Pressure Range 1 |         |         | Pressure Range 2 |         |         |
|---------|------------------|---------|---------|------------------|---------|---------|
| Pipe ID | Group 1          | Group 2 | Group 3 | Group 1          | Group 2 | Group 3 |
| XXX     | XXX              | XXX     | XXX     | XXX              | XXX     | XXX     |
| XXX     | XXX              | XXX     | XXX     | XXX              | XXX     | XXX     |
| XXX     | XXX              | XXX     | XXX     | XXX              | XXX     | XXX     |
| XXX     | XXX              | XXX     | XXX     | XXX              | XXX     | XXX     |



- 4 sub-tables:

- a) List of exposure groups
- b) Distances for exposure Group 1 with variable pipe size and variable pressure
- c) Distances for exposure Group 2 with variable pipe size and variable pressure
- d) Distances for exposure Group 3 with variable pipe size and variable pressure

|         | Group 1  |     |     |     |     |     |
|---------|----------|-----|-----|-----|-----|-----|
|         | Pressure |     |     |     |     |     |
| Pipe ID | XXX      | XXX | XXX | XXX | XXX | XXX |
| XXX     | XXX      | XXX | XXX | XXX | XXX | XXX |
| XXX     | XXX      | XXX | XXX | XXX | XXX | XXX |
| XXX     | XXX      | XXX | XXX | XXX | XXX | XXX |
| XXX     | XXX      | XXX | XXX | XXX | XXX | XXX |



# Summary of Revision Options



## Options for updating – some can be combined

1. Keep same basis
  - a) update values in higher pressure ranges using tables from SAND2009-0874
  - b) recalculate all distances using HyRAM+ (will be very minor differences for lowest pressure bins )
2. Update setback distance values with more consistency to LH2 calculation method
  - a) Exposure groups: move some Group 3 exposures to Group 2
  - b) Leak size:
    - i. Keep at 1% w/ safety factor
    - ii. Use 3% value w/o safety factor [current PI-96-NFPA 2-2023 calculations], using NFPA 2/55 2011/2016 justification
    - iii. Change to 5% w/o safety factor (to match LH2)
    - iv. Use risk informed analysis to determine new leak size
  - c) Overpressure: add harm criteria and include in setback distance calculation
3. Reorganize tables with additional pressure resolution (with or without changing the basis)

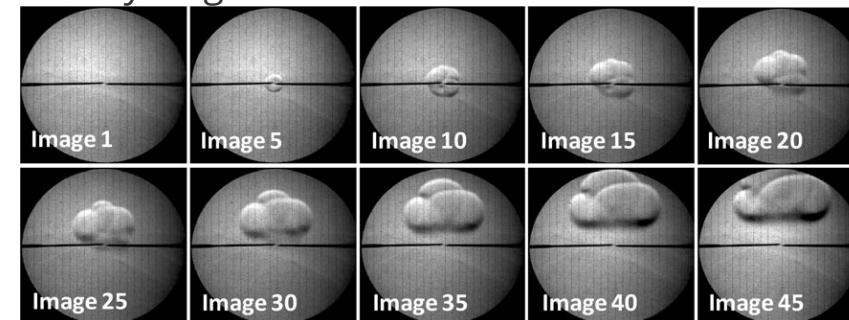


Discussion of  
unignited  
concentration

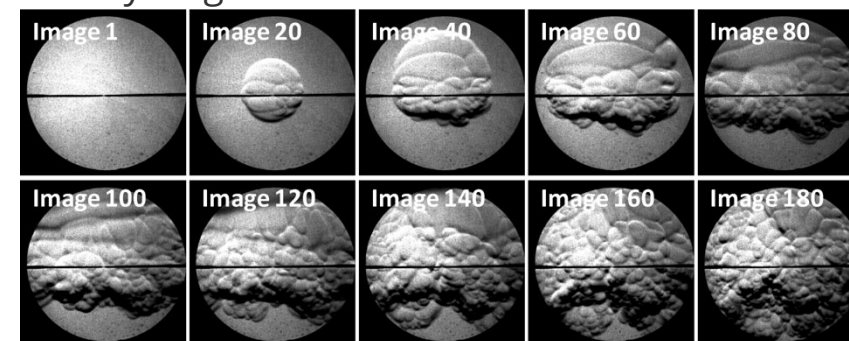
# Why use 8% as the hazardous concentration limit for hydrogen (in group 1 exposure distance calculations)

- 4% by volume/mole is the lower flammability limit for hydrogen/air mixtures
  - Requires mixing and quiescence
  - Practically never occurs
- Flame propagation between 4%-8% only upwards
  - Even in well-mixed scenario only some of the mixture will burn unless ignited at the very bottom of the mixture
  - Sustained jet flame will not form, only ignition kernel (if even that)
- 8% is an appropriate “practical hazardous limit”

7% hydrogen



9% hydrogen



Images from: H. Cheikhvat, N. Chaumeix, A. Bentaib & C.-E. Paillard (2012) Flammability Limits of Hydrogen-Air Mixtures, Nuclear Technology, 178:1, 5-16, DOI: [10.13182/NT12-A13543](https://doi.org/10.13182/NT12-A13543)

jet mean  
hydrogen mole  
fraction at  
each ignition  
point

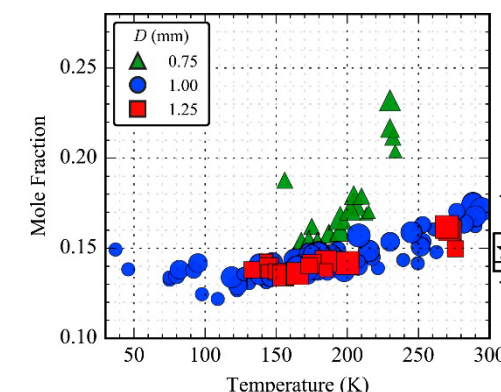


Image from: P.P. Panda and E.S. Hecht (2017) Ignition and flame characteristics of cryogenic hydrogen releases, Int. J. Hydrogen Energ., 42:1, 775-785, DOI: [10.1016/j.ijhydene.2016.09.054](https://doi.org/10.1016/j.ijhydene.2016.09.054)

This work is supported by the U.S. DOE Office of Energy Efficiency and Renewable Energy (EERE) Hydrogen and Fuel Cell Technologies Office (HFTO) Safety Codes and Standards (SCS) sub-program under the direction of Laura Hill

# Thank you! Questions?

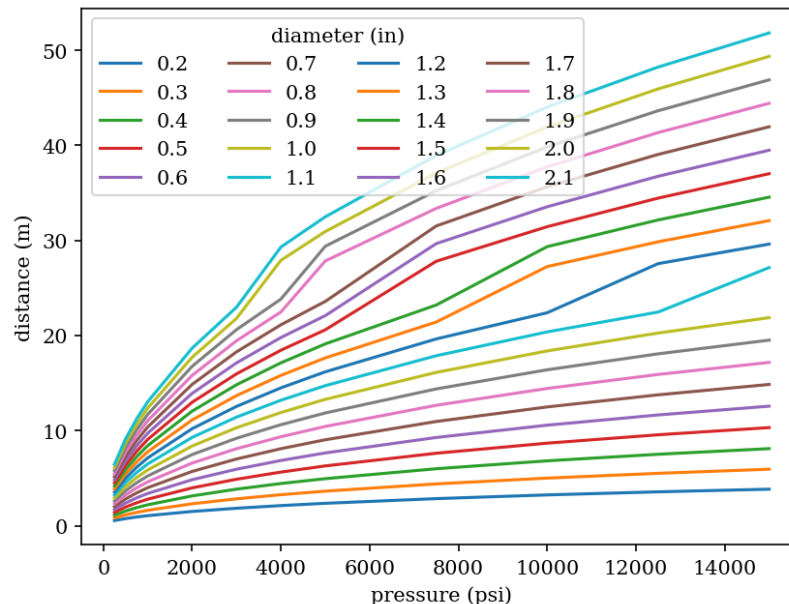
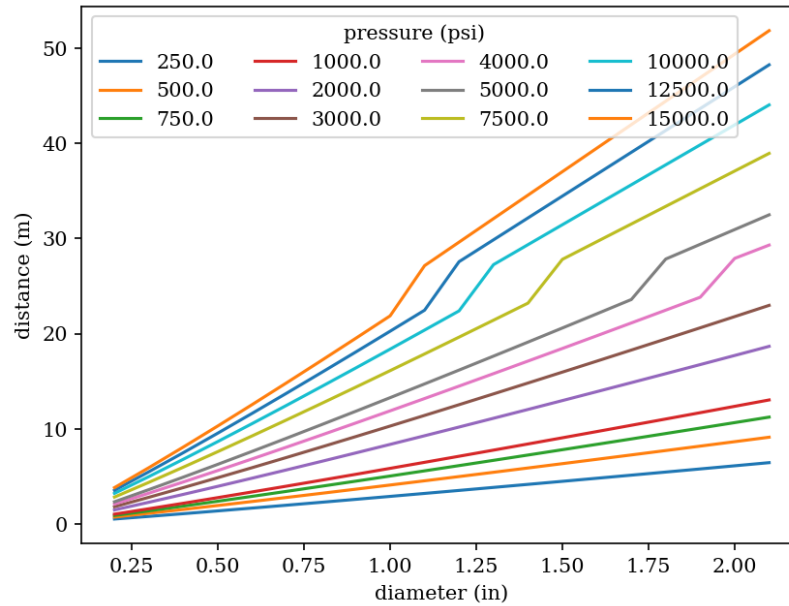
Contact:

[bdehrha@sandia.gov](mailto:bdehrha@sandia.gov)

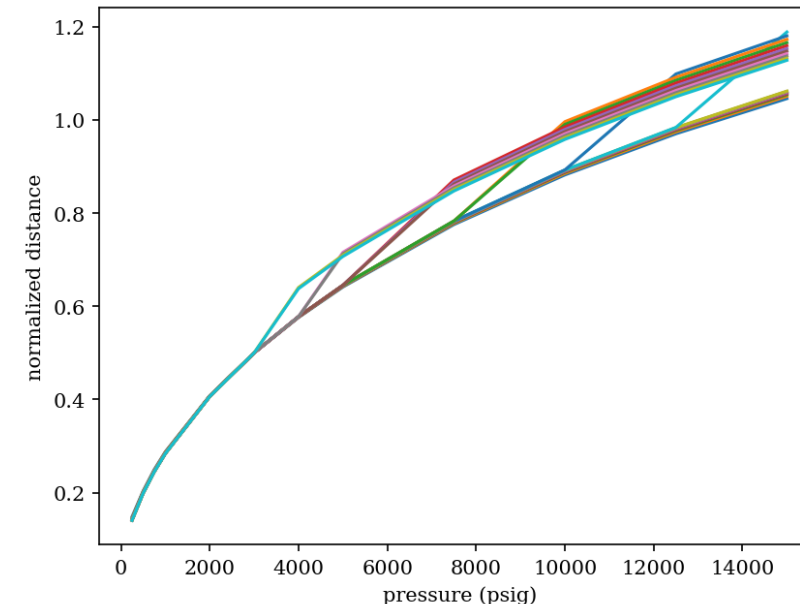
[ehocht@sandia.gov](mailto:ehocht@sandia.gov)



# How do the new group 1 distances scale with pressure and diameter?

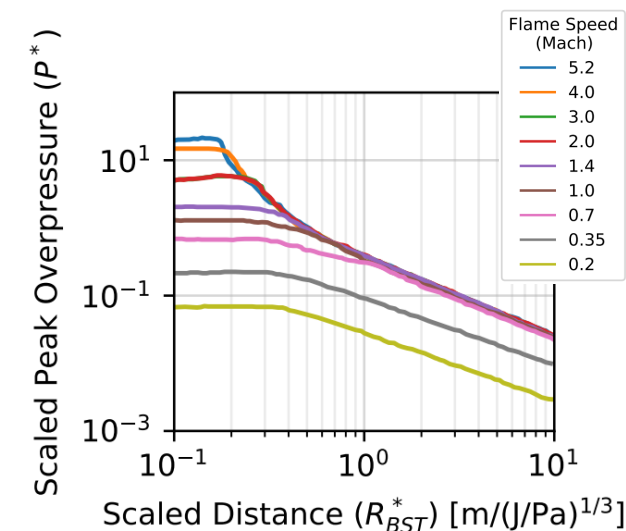
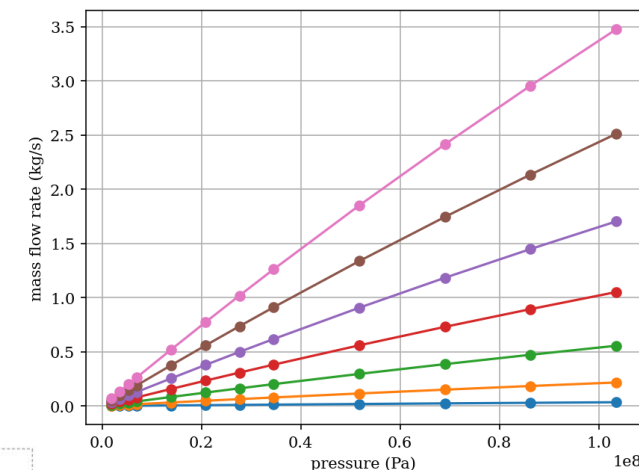
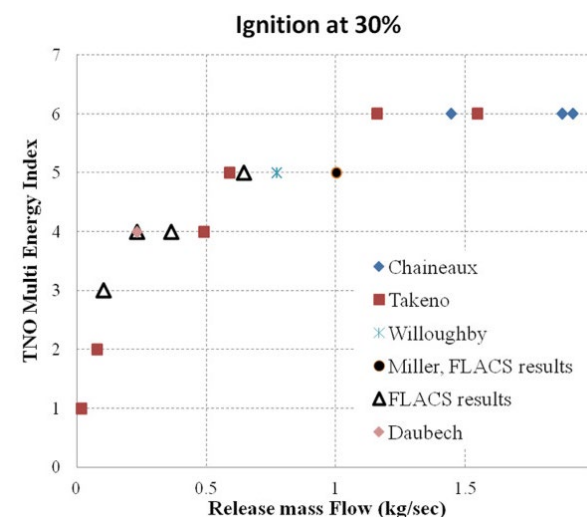
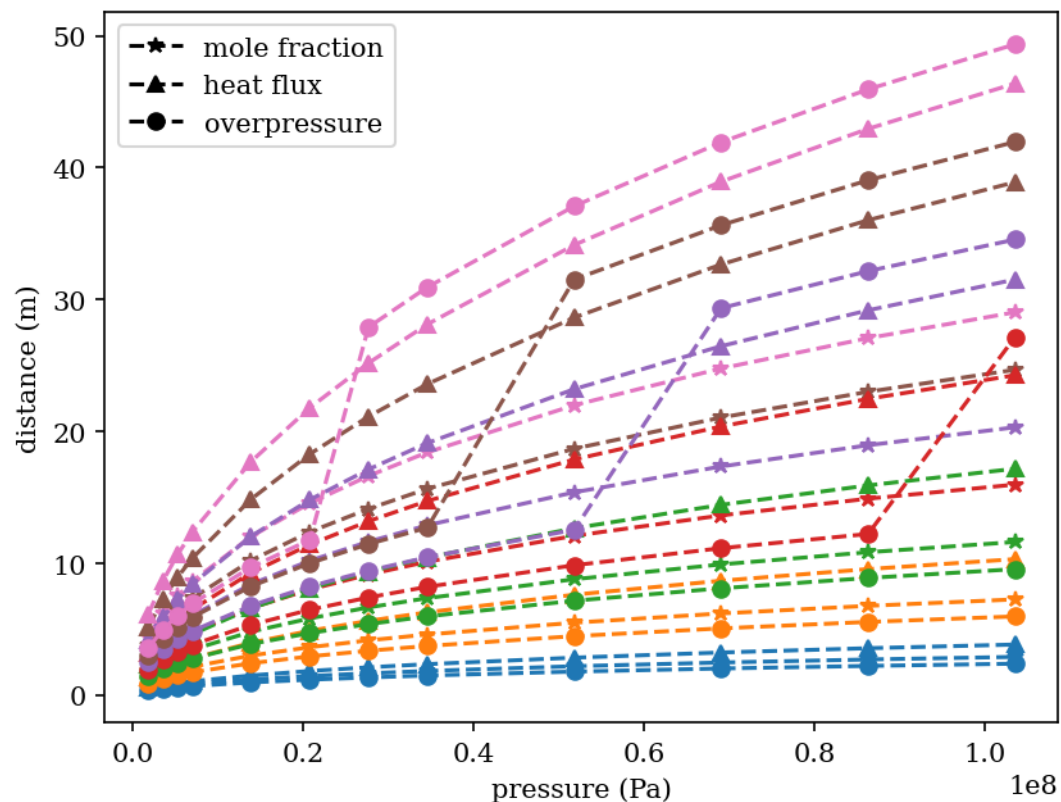


- Nearly linear with diameter
- Nearly power law decay with pressure
- Curves collapse but have a shift at large diameters and high pressures



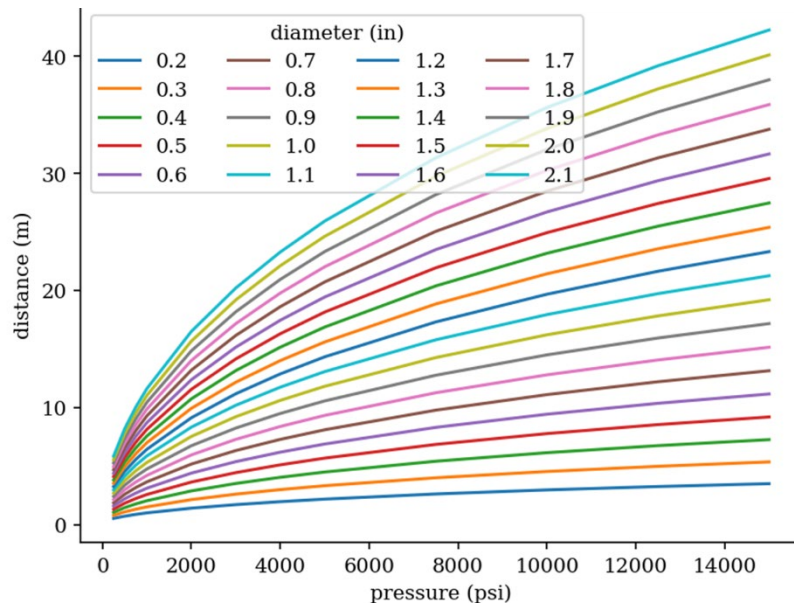
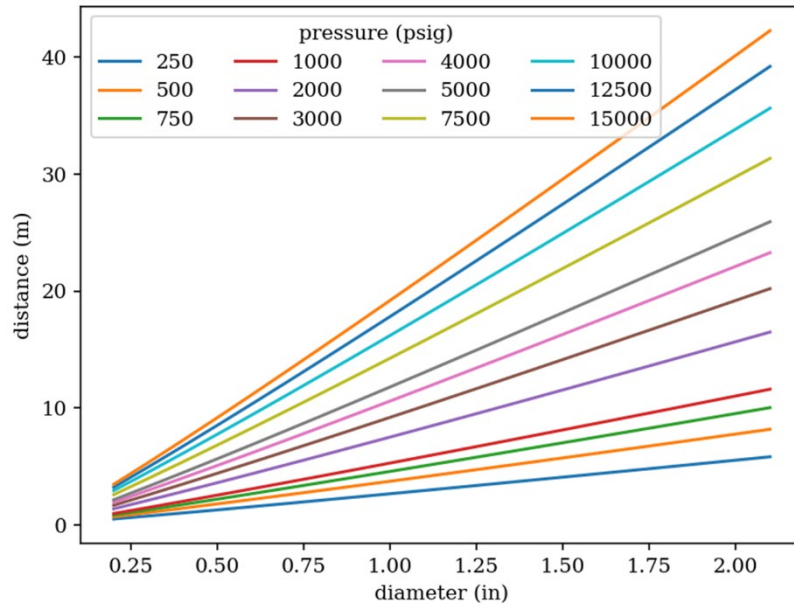


# What causes the shift for Group 1 exposures?

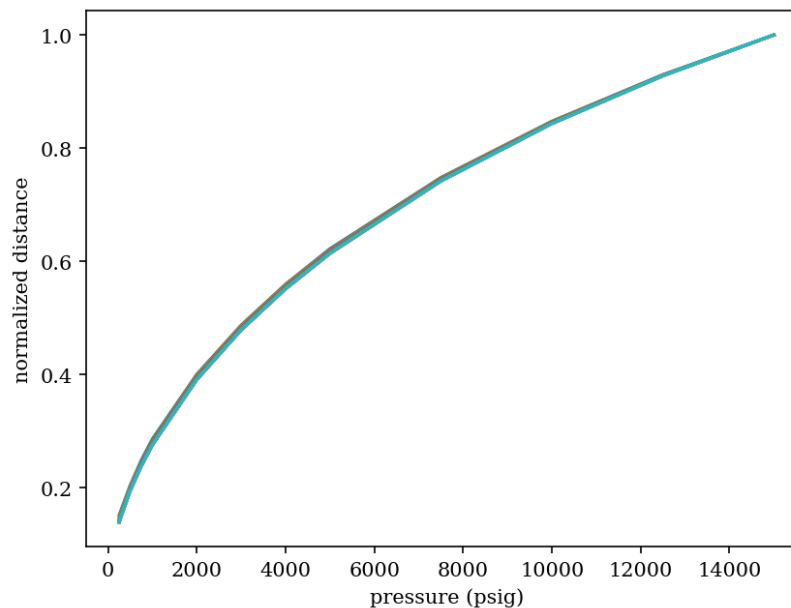


- Overpressure method uses different curves based on flowrate
- When flowrate is above 1 kg/sec, overpressure method switches curves
- Overpressure becomes limiting criteria instead of heat flux

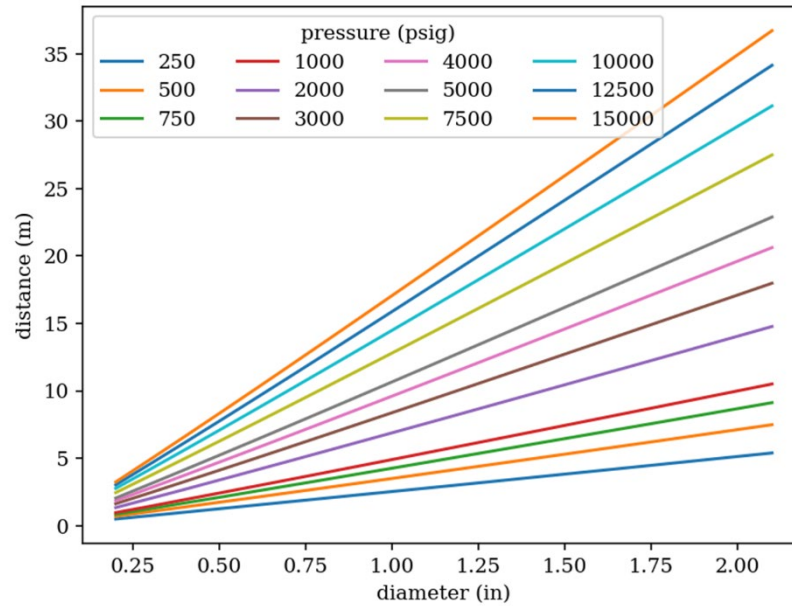
# How do the new group 2 distances scale with pressure and diameter?



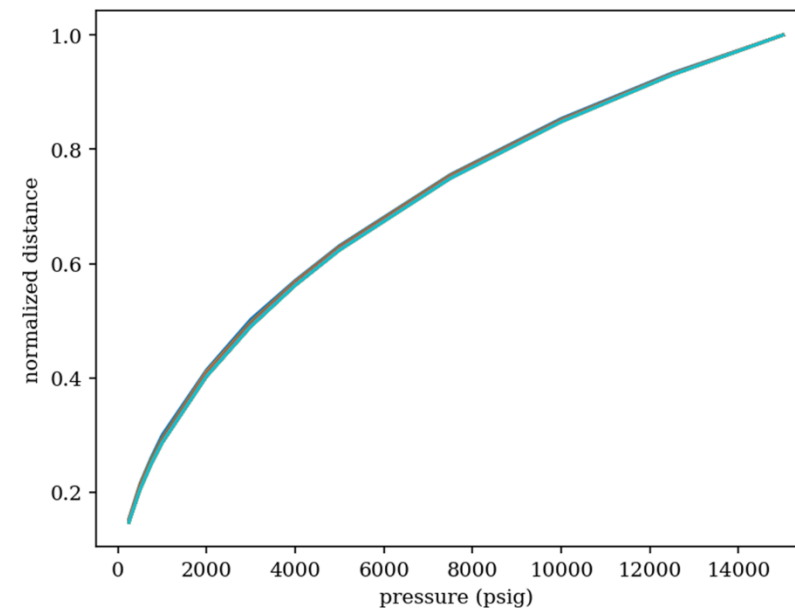
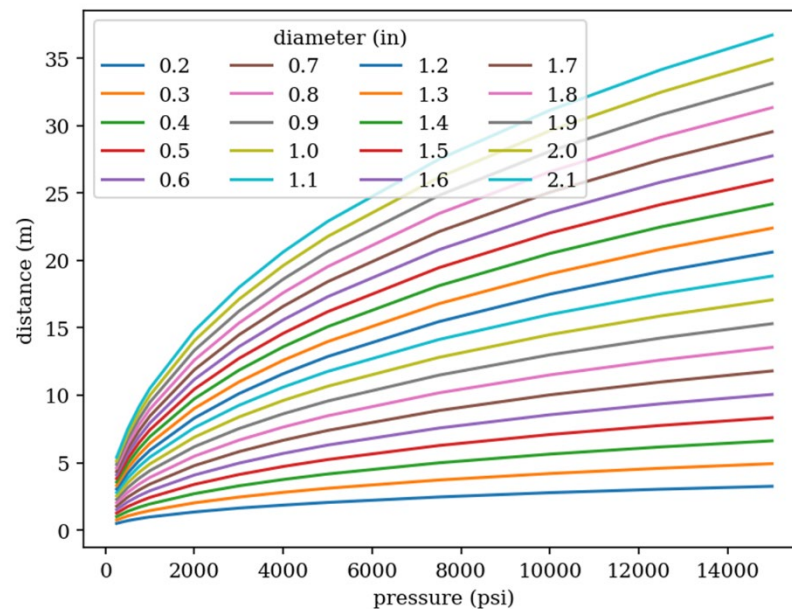
- Linear with diameter
- Power law decay with pressure
- All curves collapse when normalized



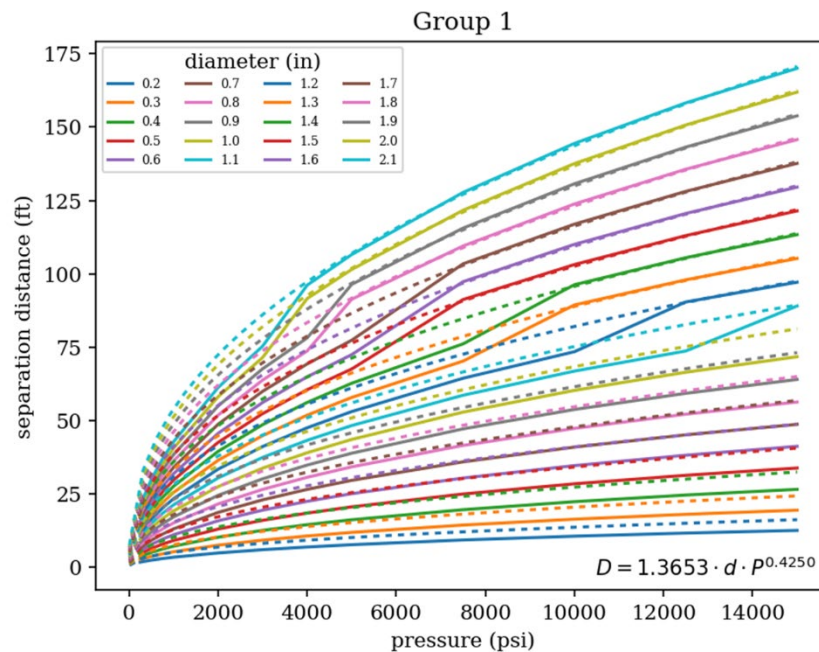
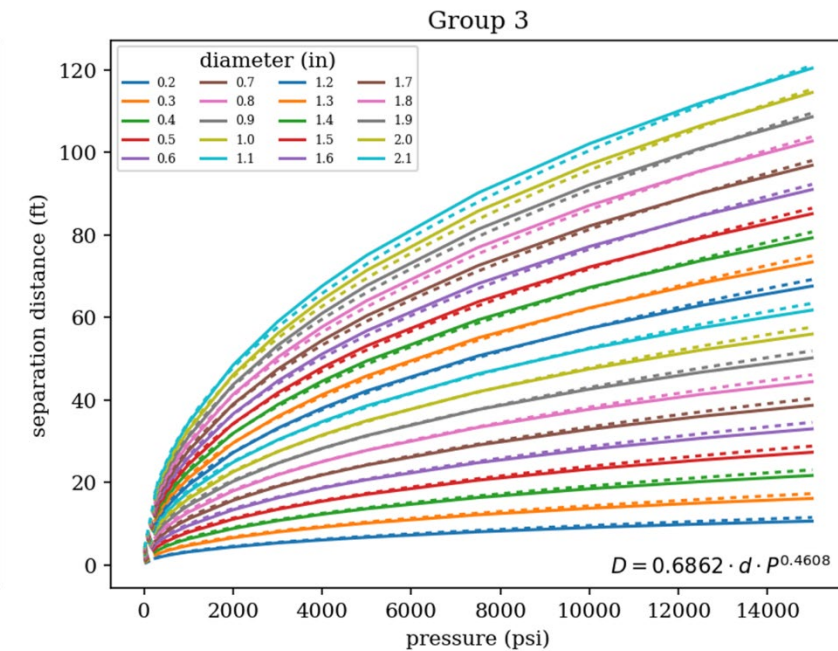
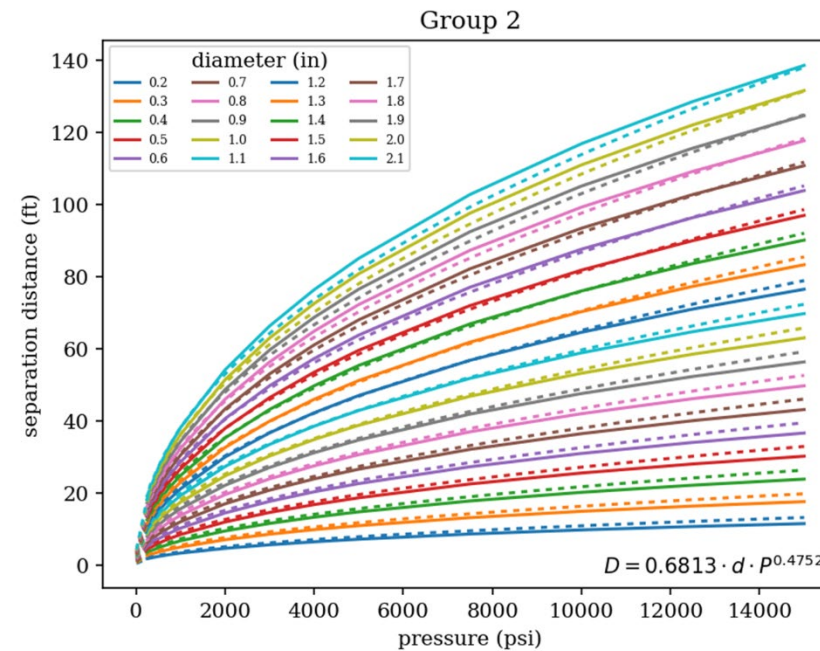
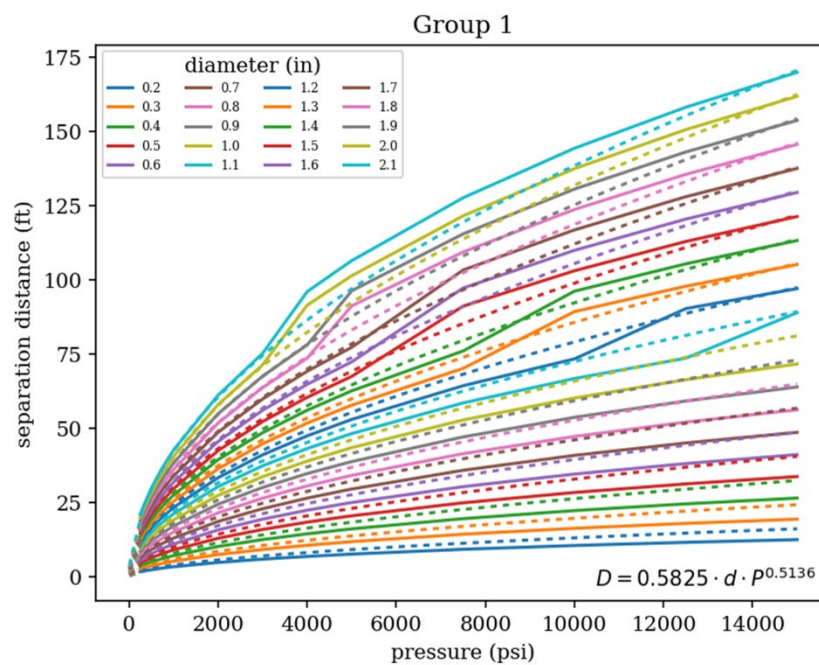
## How about group 3?



- Linear with diameter
- Power law decay with pressure
- Curves perfectly collapse when normalized



# How well can we do with an equation?



- 2-parameter equation does a pretty reasonable job
- Group 1 is a bit less good due to the shift from heat-flux to overpressure criteria
  - Option to fit just the overpressure part of the curves to be conservative for all cases

## **6.8 \* Electrical Equipment.**

Electrical wiring and equipment shall be in accordance with Section 6.8, NFPA 70, and NFPA 79, as applicable.

### **6.8.1 Standby Power.**

#### **6.8.1.1**

Where the following systems are required by this code for the storage or use of GH2 or LH2 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.

### **6.8.2 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.

#### **6.8.2.1**

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



## NFPA 2: Hydrogen Technologies Code, 2023 Edition - Chapter 3 Definitions

### **3.3.228 Special Provisions.**

Controls required when the maximum allowable quantity in the control area is exceeded.

# Edits Highlighted

## **6.8 \* Electrical Equipment.**

Electrical wiring and equipment shall be in accordance with Section 6.8, NFPA 70, and NFPA 79, as applicable

### Clause 6.8.1 – Standby Power

#### Clause 6.8.1.1 – As is

Where the following systems are required by this code for the storage or use of GH2 or LH2 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

#### Revision to Clause 6.8.1.1 –

Where the following systems are required by this code for the storage or use of GH2 or LH2, **and** 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

# Edits Highlighted

## 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.

## 6.8.2 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.

### 6.8.2.1

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

## 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.

## 6.8.2 Emergency Power.

When emergency power is required, the system shall meet the requirements for a Level ~~2~~ **1** system in accordance with NFPA 110 or NFPA 111.

### 6.8.2.1

When standby power is required, the system shall meet the requirements for a Level ~~2~~ **1** system in accordance with NFPA 111.

# NFPA 110: Standard for Emergency and Standby Power Systems, 2022 Edition – Chapter 4 Classification of Emergency Power Supply Systems (EPSSs)

## 4.4 \* Level.

This standard recognizes two levels for equipment installation, performance, and maintenance requirements.

**4.4.1 \*** Level 1 systems shall be installed where failure of the equipment to perform could result in loss of human life or serious injuries.

**4.4.2 \*** Level 2 systems shall be installed where failure of the EPSS to perform is less critical to human life and safety.

**4.4.3 \*** All equipment shall be permanently installed.

**4.4.4 \*** Level 1 and Level 2 systems shall ensure that all loads served by the EPSS are supplied with alternate power that meets all the following criteria:

- (1) Of a quality within the operating limits of the load
- (2) For a duration specified for the class as defined in Table 4.1(a)
- (3) Within the time specified for the type as defined in Table 4.1(b)

# NFPA 111: Standard on Stored Electrical Energy Emergency and Standby Power Systems, 2022 Edition – Chapter 4 Classification of Stored-Energy Emergency Power Supply Systems (SEPSS)

## **4.5 \* Level.**

The level of equipment installation, performance, and maintenance shall be as specified in 4.5.1 through 4.5.5.

### **4.5.1 \***

Level 1 systems shall be installed where failure of the equipment to perform could result in loss of human life or serious injuries.

### **4.5.2 \***

Level 2 systems shall be installed where failure of the EPSS to perform is less critical to human life and safety.

### **4.5.3**

All equipment shall be permanently installed.

### **4.5.4 \***

Level 1 and Level 2 SEPSS shall supply alternate power of a quality that ensures reliable operation of the load, within the time determined by the type and for a duration determined by the class.

### **4.5.5 \***

Other equipment and applications, including optional standby systems, not defined in Levels 1 and 2 are beyond the scope of this document.



# CSA B107 Update for NPFA 2

Hydrogen Equipment Enclosures (HEE) /  
Enclosed Hydrogen Equipment (EHE)

-S. Goyette  
2024-04-02



# Agenda / Table of Contents

- 7.1.23 HEE background
- CSA B107 overview
- Intent
- Time line
- Public Inputs (PIs)
  
- Annex
  - Why CSA?

# NFPA 2 Section 7.1.23, HEEs

- Concern about manufacturers / integrators installing & combining various pieces of hydrogen equipment in shipping containers to create a new product without the appropriate safety measures
- Reads like a high-level summary of a product safety standard
- Somewhat out of character for NFPA 2:
  - Primarily a fire safety code
  - Mostly focused on installation

# CSA B107, Enclosed Hydrogen Equipment - Safety

- Product safety standard for Enclosed Hydrogen Equipment (EHE = HEE)
- Includes same topics for requirements as 7.1.23, ex.:
  - Ventilation
  - H<sub>2</sub> detection
  - Ignition sources
  - Safety system (ESS, etc.)
- Has more detailed requirements while...
  - Focused on performance (what must be achieved) vs. prescription
- Requires risk assessments & area classification
- Can be used to certify (“List”) products – including serial manufacturing

# CSA B107 – Intent?

- Support / complement NFPA 2 by providing:
  - Standard for safe design of HEEs
  - an alternative that 7.1.23 can point to re: design
    - similar to Chapter 12 pointing to ANSI/CSA FC 1 for fuel cells &
    - chapter 13 pointing to ANSI/CSA B22734 for electrolyzers
  - requirements in a form manufacturers are accustomed to
  - standard that products can be certified (“Listed”) to
- Clarify requirements
- Allow NFPA 2 to focus on safe installation
- NOT to supersede NFPA 2

# CSA B107 – Time line / Access for review

| Milestone                                             | Revised Target Date   |
|-------------------------------------------------------|-----------------------|
| Kick-off meeting                                      | Sept. 2022            |
| Content Development (bi-weekly meetings)              | Oct. 2022 – Oct. 2023 |
| Public Review / CSA Editing                           | Nov. - Dec 2023       |
| Disposition of Public Review & CSA Editorial comments | Jan. - May 2024       |
| Public Review # 2                                     | Jun.- Jul. 2024       |
| Disposition of Public Review # 2                      | Aug. 2024             |
| CSA Editing                                           | Sept. 2024            |
| Ballot to Fuel Cell Technical Committee               | Sept - Oct. 2024      |
| Ballot comment disposition                            | Oct. 2024             |
| Editing / Publication                                 | Nov. 2024             |

Mark Duda of CSA is working with Heath to provide easy access to the whole NFPA 2 committee for the next public review period.

# NFPA 2 PIs

- PI 66: 7.1.23.1 Adds option for HEE to be listed or approved to CSA B107.
- PI 67: 7.1.23.1.1 Adds HEEs that are listed or approved to B107 to list of exemptions.
- Appreciate that timing is not ideal & may have to wait for next edition of NFPA 2.

number one by nature

# ANNEX - Why CSA?

- Despite “Canadian” being the first word CSA is an SDO for the United States
  - ANSI accredited
- CSA acquired the AGA 30ish years ago
- CSA writes & publishes the standards for all gas appliances for the U.S. (& Canada)
- CSA wrote the first hydrogen product safety standard, FC 1
- CSA has written most of the hydrogen related product safety standards for the U.S. (& Canada):
  - FC 1, Fuel cells
  - FC 5, Reformers
  - FC 6, Cell stack modules
  - HGV 2, Hydrogen vehicle fuel containers
  - HGV 3.1, Hydrogen fuel system components
  - HGV 4.1 – 4.10 re: Hydrogen dispensers, fueling stations, fittings, etc.

[https://www.csagroup.org/wp-content/uploads/CSA-HydrogenVehiclesFuelCells-Infographic\\_Accessible.pdf](https://www.csagroup.org/wp-content/uploads/CSA-HydrogenVehiclesFuelCells-Infographic_Accessible.pdf)

## Hydrogen as a Combustion Fuel Task Group

### Chapter 14 Combustion Applications

#### 14.1 Scope.

This chapter shall apply to equipment that uses hydrogen ~~or a hydrogen enriched as a~~ fuel source for combustion ~~fuel to provide heat used for the processing of materials and related equipment~~ [applications in accordance with Section 14.3](#).

#### 14.1.1\* Applicability

The requirements of this chapter shall apply to the use of GH<sub>2</sub> [or a hydrogen enriched fuel](#) as part of a manufacturing process using thermal spraying or as a fuel in heating applications.

##### A.14.1.1

~~Examples of the use of hydrogen used for the purposes of this chapter is as a fuel involving flame, include, but would not be limited to, combustion of the gas in a torch used in welding or heating operations where the gas is used to provide a flame and accompanied by a reducing atmosphere. The melting of quartz or glass frequently involves the use of hydrogen combustion operations gas for commercial and industrial applications.~~

[Several European countries are pre-mixing hydrogen up to 20 percent concentration in the distribution pipelines. Although this is outside the scope of this code, it is worth noting for awareness.](#)

[There is a movement to start mixing hydrogen into the fuel supply for industrial internal combustion engines and gas turbines. In Europe this will be provided by way of the pipeline premixed fuel and the vision is for additional hydrogen to be added from a local source, up to 100 percent hydrogen, as hydrogen availability increases. For gas turbines this path was formalized in January 2020 by the European Turbine Network \(ETN Global\) Hydrogen Working Group in their report "The Path Towards a Zero-Carbon Gas Turbine" which is available at <https://etn.global/news-and-events/news/hydrogen-gas-turbines-report/>. With this direction in mind, a task group was formed to develop initial guidance for the use of hydrogen enriched fuels in the 2024 edition of NFPA 37.](#)

[The provisions for premixed hydrogen in pipelines will also affect all other gas consumers such as NFPA 85, NFPA 86, and NFPA 87.](#)

##### 14.1.1.1

This chapter also shall apply to new installations and to alterations or extensions to existing equipment [that introduces hydrogen gas or a hydrogen enriched fuel to the installation](#).

##### 14.1.1.2

The storage, use, and handling of GH<sub>2</sub> in any quantity shall also comply with the requirements of Chapters 1 and 4 and the applicable requirements of Chapters 5 through 8.

##### 14.1.1.2.1

[Where an LH<sub>2</sub> source is used to supply the combustion process, the storage and vaporization to GH<sub>2</sub> shall be in accordance with Chapter 8.](#)

##### ~~14.1.1.3~~

~~The requirements of Chapters 4 and 6 through 8 shall be applicable to all hydrogen systems.~~

##### 14.1.1.4

Use-specific requirements for hydrogen or hydrogen ~~mixtures-enriched fuels~~ [used as a fuel for thermal spray equipment and for heating the applications in 14.3](#) shall apply.

##### 14.1.1.5

Where there is a conflict between a fundamental requirement and a use-specific requirement, the use-specific requirement shall be applicable.

#### 14.2 General. (Reserved)

#### 14.3 Use.

**Commented [LD1]:** Rewrote the charging statement that was part of the original chapter to be appropriate for the additional chapter and annex material

**Commented [HD2]:** No need to update the proceeding section numbers. This will be done automatically is the revisions are adopted.

## Hydrogen as a Combustion Fuel Task Group

### 14.3.W General.

#### ~~14.3.1 Thermal Spraying Equipment.~~

##### ~~14.3.1.1 General.~~

~~Thermal spraying equipment shall meet the requirements of 14.3.1.~~

#### ~~14.3.1.2\* Indoor Installations of Thermal Spraying Equipment.~~

##### ~~A.14.3.1.2~~

~~Thermal spraying is typically conducted with robotic equipment in isolated chambers or otherwise protected areas to isolate persons from hazards such as noise, intense ultraviolet light, process gases, and vapors. The equipment includes multiple flexible piping or hoses, which pass through the chamber walls to deliver the gas from a control source to the process device or gun. The flexible portions of the fuel delivery system represent potential leak sources.~~

~~NFPA 497 provides guidance on the classification of areas.~~

##### ~~14.3.1.2.1\*~~

~~Thermal spray equipment shall be installed, inspected, and maintained in accordance with the manufacturer's instructions to minimize the potential for leaks of the gas delivery system.~~

##### ~~A.14.3.1.2.1~~

~~System preventive maintenance typically includes regular leak checks and the replacement of hoses in accordance with the manufacturer's recommendations. An increase in the frequency might be warranted based on maintenance experience.~~

#### 14.3.1.2.2\* Electrical Equipment [Move to 14.3.W.1]

The area ~~containing the~~in which the thermal spray equipment is installed ~~identified in 14.3.X, 14.3.Y, and 14.3.Z using hydrogen gas or hydrogen enriched fuel~~ shall be classified ~~as Class I, Gas Group B or Group IIC/IIB+H2~~ in accordance with Article 500 or Article 505 of *NFPA 70*.

##### ~~A.14.3.1.2.2~~ [Move to A.14.3.W.1]

~~NFPA 497 provides guidance on the classification of areas which includes the appropriate Division and Zone designation of the area.~~

#### 14.3.1.2.2.1 [Move to 14.3.W.1.1]

Electrical ~~wiring and~~equipment shall ~~comply be in accordance with the requirements Article 500, Article 501, and Article 504 of NFPA 70 for the electrical classification of the area in which it is installed.~~

#### 14.3.1.2.3 Ventilation. [Move to 14.3.W.2]

##### 14.3.1.2.3.1 [Move to 14.3.W.2.1]

The ~~enclosed~~ area containing the ~~thermal spray~~equipment ~~identified in 14.3.2 and 14.3.3 below using hydrogen gas or a hydrogen enriched fuel~~ shall be ~~ventilated provided with exhaust ventilation in accordance with Section 6.18~~ to prevent flammable gas buildup from potential system leaks.

##### ~~14.3.1.2.3.2~~

~~Mechanical exhaust ventilation systems required by Section 6.18 or for operation of the equipment shall be interlocked with the thermal spraying equipment to prevent the flow of gases without the ventilation system operating.~~

#### 14.3.W.2.2\*

The specifics of the exhaust ventilation system shall be determined by a risk assessment considering all of the following:

- (1) the volume of the space containing the equipment
- (2) the thermal rejection rate of the equipment in the space
- (3) the potential leak rate of the equipment fuel train piping within the space
- (4) the buoyancy properties of the leaked gas

##### A.14.3.W.2.2

The risk assessment team should include knowledgeable and experienced members for the industrial equipment being protected as well as building and facility design specialists.

A team member with specific knowledge of ventilation systems should also be included.

Commented [HD3]: Moved to 14.3.X.

## Hydrogen as a Combustion Fuel Task Group

### 14.3.1.2.4\* [Move to 14.3.W.2.3]

The ceiling of rooms in which ~~thermal-spray~~ equipment using hydrogen gas or a hydrogen enriched fuel is installed shall be constructed in a manner to prevent the accumulation of hydrogen gas.

#### A.14.3.1.2.4 [Move to A.14.3.W.2.3]

Features such as solid beams that form a tight fit with the roof deck and create a pocket where the gas could collect should be avoided. The ceiling should be smooth with an upward slope to intakes for the exhaust ventilation system intakes should be located at high points in the ceiling to prevent the trapping of hydrogen ~~in the thermal-spraying area~~.

### 14.3.1.2.5 Gas Venting. [Move to 14.3.W.3]

Venting systems discharging hydrogen to the atmosphere shall be piped ~~to a designated point~~ outside the building in accordance with Section 6.17.

### 14.3.1.2.6 Gas Detection System. [Move to 14.3.W.4]

#### 14.3.1.2.6.1\* [Move to 14.3.W.4.1]

A hydrogen gas detection system in accordance with 6.13 shall be installed ~~in for~~ the room or enclosed area where ~~thermal-spray~~ the equipment identified in 14.3.2 and 14.3.3 below using utilizing hydrogen gas or a hydrogen enriched fuel is installed.

#### A.14.3.1.2.6.1 [Move to 14.3.W.4.2\*]

The gas detection location(s) ~~should be located in the spray area, at the gas controller, and at the gas supply when the source of supply is located indoors.~~ shall be determined by a risk assessment considering the effectiveness of the following detection location options:

- (1) detector manufacturer requirements
- (2) in the immediate area of open combustion applications.
- (3) in the immediate area of potential equipment leak sources
- (4) in a location where leaked gas is expected to accumulate
- (5) integrated with the exhaust ventilation system

#### A.14.3.W.4.2

See A.14.3.W.2.2. A team member with specific knowledge of design specialist knowledgeable in gas detection systems should also be included.

### 14.3.W.4.3\*

The gas detection risk assessment shall also define the alarm and action concentration values for the installation.

#### A.14.3.W.4.3

The maximum gas concentration value for action should be no higher than 25 percent of the lower flammability limit.

### 14.3.W.4.3.1

The alarm concentration shall result in a controlled shutdown of the process using the hydrogen gas or hydrogen enriched fuel.

### 14.3.W.4.3.2

The action concentration shall result in closure of the safety shutoff valves.

### 14.3.W.5\* Fire Alarm and Protection System

The fire alarm and protection systems for the equipment identified shall be determined by a performance-based risk assessment in accordance with Chapter 5 that considers all of the following:

- (1) The Chapter 4 and Chapter 14
- (2) The applicable equipment specific requirements in NFPA 37, NFPA 85, NFPA 86 or NFPA 87
- (3) Sections 6.9, 6.11, and 6.12

#### A.14.3.W.5

See A.14.3.W.2.2. For the alarm system, an NFPA 72 knowledgeable team member specialist should also be included.

### 14.3.W.5.1 Emergency Alarm System.

**Commented [HD4]:** The following has been restructured to align with the NFPA Manual of Style.

## Hydrogen as a Combustion Fuel Task Group

An emergency alarm system in accordance with Section 6.9 shall be provided where the equipment identified in 14.3.X and 14.3.Y using hydrogen gas or a hydrogen enriched fuel is installed.

### **14.3.W.5.1.1**

The emergency alarm system shall be connected to and controlled by the fire alarm control panel for the building or area.

### **14.3.W.5.1.2**

The emergency alarm system shall be addressed in both the initial and recurring employee trainings that cover both operation of and expected response to the emergency alarm system.

### **14.3.W.5.1.3**

The emergency alarm system shall automatically trigger an isolation of the hydrogen gas or hydrogen enriched fuel to the equipment in the facility.

### **14.3.W.5.1.4**

The emergency alarm system shall provide an alarm signal to the fire alarm control panel.

### **14.3.W.5.1.5**

The emergency alarm initiation devices shall have manual pull stations located at each combustion equipment enclosure.

### **14.3.W.5.1.6**

The emergency alarm initiation device manual pull stations shall be a different color than the fire alarm manual pull stations and be identified with a sign stating HYDROGEN EMERGENCY ALARM.

### **14.3.W.5.1.7**

The emergency alarm initiation devices shall include automatic area flame detection in accordance with 14.3.W.5.2.1 to provide coverage of egress paths adjacent to all sides of the hydrogen combustion equipment enclosures.

### **14.3.W.5.1.8**

The emergency alarm system notification system shall be specific to the area covered by the activated initiation device, and be separate and unique from the building or area fire alarm notification system.

### **14.3.W.5.2\* Area Flame Detection.**

Flame detection shall be provided where the equipment identified in 14.3.X and 14.3.Y below using hydrogen gas or a hydrogen enriched fuel is installed.

#### **A.14.3.W.5.2**

If ignited, external leakage of hydrogen or hydrogen enriched fuels from the equipment fuel train piping and gas control system supplying the equipment can result in an invisible flame that is difficult to feel the heat from prior to direct exposure and risk of personnel injury should a worker inadvertently walk into the flame.

This is a unique hazard associated with hydrogen and is herein differentiated from the general fire detection and suppression requirements of Chapter 4, Section 14.3.W.5, and the guidance included in the various referenced technology standards that should be considered for the facility fire protection system design.

### **14.3.W.5.2.1**

The flame detection system shall be connected to the fire alarm system in accordance with Section 6.12.

### **14.3.W.5.2.2\***

The area flame detection system coverage and functions shall be determined by a Chapter 5 compliant risk assessment that considers all of the following:

- (1) The physical layout of the facility and facility exits
- (2) The arrangement of the individual equipment installations within the facility
- (3) The appropriate exit path for personnel at given equipment installation versus the location of the fire

#### **A.14.3.W.5.2.2**

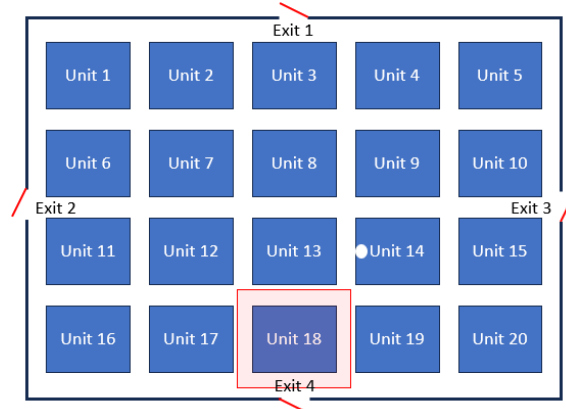
## Hydrogen as a Combustion Fuel Task Group

See A.14.3.W.2.2. A team member with specific knowledge of flame detection systems should also be included. The type, number, and location of the flame detection devices should be determined by the risk assessment based on the following considerations:

- (1) Detector effectiveness for the gas composition in use
- (2) The optical view capability of the detectors
- (3) Restrictions to the device views due to building features or equipment between the detector and potential fire locations
- (4) Shielding from sunlight (direct or reflected) that can result in false detection
- (5) Selection of detector type

The historical detection technology for hydrogen flames is ultraviolet (UV) or ultraviolet/infrared (UV/IR). These systems are susceptible to false detection due to sun light, either direct or reflected, and other sources such as welding and activities that create sparks. In recent years a Multi-Spectrum IR (MIR) technology has been developed that reduces the potential for false alarms. Additionally, detectors that are specific to the fuel being burned (e.g., natural gas, propane, hydrogen) are available and some detectors are capable of selectively detecting fires from various fuels or mixtures with hydrogen. See Figure A.14.3.W.5.2.2 for an example of a multiple furnace installation arrangement.

**Figure A.14.3.W.5.2.2 Example of a Multiple Furnace Installation Arrangement for 20 Units Within A Building**



In the example depicted in Figure A.14.3.W.5.2.2, there is an operator at the operator station on the left side of Unit 14 when a hydrogen fire is detected at Unit 18. The appropriate exit path to avoid the fire, within this example, would be to Exit 3 rather than Exit 4.

### 14.3.W.5.2.3

The risk assessment shall define the combination of visual and aural warning devices required to guide personnel to an exit while avoiding the invisible fire hazard.

### 14.3.W.5.3\* Fire Protection System.

A fire protection system compliant to 6.11 and 6.12 shall be defined by a risk assessment and provided where the equipment identified in 14.3.X and 14.3.Y, using hydrogen gas or a hydrogen enriched fuel, is installed.

### A.14.3.W.5.3

See A.14.3.W.2.2. A team member with specific knowledge of design specialist knowledgeable in fire suppression systems should also be included.

### 14.3.W.5.3.1

**Commented [HD5]:** The following has been restructured to align with the NFPA Manual of Style.

## Hydrogen as a Combustion Fuel Task Group

The fire protection system shall be connected to and controlled by the fire alarm control panel for the building or area.

### **14.3.W.5.3.7**

The fire protection system shall be addressed in both the initial and recurring employee trainings that cover both operation of and expected response to the emergency alarm system.

### **14.3.W.5.3.8**

The fire protection system shall automatically trigger an isolation of the hydrogen gas or hydrogen enriched fuel to the equipment in the facility.

### **14.3.W.5.3.2**

The fire protection system initiation devices shall have manual pull stations within the building or area.

### **14.3.W.5.3.3**

The fire protection initiation device manual pull stations shall be a different color than the hydrogen emergency alarm pull stations and be identified with a sign stating FIRE EMERGENCY ALARM.

### **14.3.W.5.3.4**

The fire protection initiation device manual pull stations shall include automatic fire detection devices as identified by the risk assessment.

### **14.3.W.5.3.5**

The upon detection of a fire, the fire protection system shall activate the alarm devices within the building or area and activate the fire protection system(s) identified by the risk assessment.

### **14.3.W.5.3.6**

The fire protection system(s) shall be activated upon detection of a hydrogen flame in 2 or more flame detection areas.

### **14.3.W.6\* Emergency Shutoff.**

The following requirements shall apply to the low pressure applications identified in 14.3.X and 14.3.Y below that are supplied with a gas pressure of 345 kPa (50 psig) or less.

#### **A.14.3.W.6**

Given the flammability characteristics of hydrogen (e.g., upper and lower flammability limits, laminar flame velocity) versus natural gas, propane, or other combustion gases with respect to the gas supply pressure, the 345 kPa (50 psig) low pressure limit defined in NFPA 54, 1.1.1.1(C) is used for the equipment identified in this chapter.

Where the fuel supply is greater than 345 kPa (50 psig) the specific requirements for combustion engines and gas turbines defined in NFPA 37, as modified in 14.3.Z, are applicable.

### **14.3.W.6.1**

Two safety shutoff valves shall be provided as part of the equipment fuel train piping downstream of the equipment isolation valve used to supply hydrogen or hydrogen enriched fuel to the equipment.

#### **14.3.W.6.1.1**

Where there is a separate gas supply to a combustion system pilot flame device, two safety shutoff valves shall be included for the pilot gas supply.

#### **14.3.W.6.2\***

The two safety shutoff valves shall require a manual reset after the cause of the activation has been resolved.

#### **A.14.3.W.6.2**

The reset can be either a physical reset of the valve actuation or clearing of the fault in the control system that returns the valve to the normal operation state.

#### **14.3.W.6.2.1\* Pressures Up To And Including 103 Kpa (15 Psig).**

A listed safety shutoff valve that meets the requirements of ANSI Z21.21, *Automatic Valves for Gas Appliances*, or UL 429, *Electrically Operated Valves*, shall be used, or have a Class VI leakage rating in accordance with ANSI FC 70-2, *Control Valve Seat Leakage*, as declared by valve manufacturer.

**Commented [HD6]:** Should this be the “fire protection system”?

**Commented [HD7]:** Need to be specific here. Should this say 14.3.W.6.1 and 14.3.W.6.2?

**Commented [HD8]:** I believe this needs clarity.

**Commented [HD9]:** This has been revised to align with the NFPA manual of style.

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### A.14.3.W.6.2.1

The valve manufacturer should consider independent testing laboratory verification and certification of the valve leakage using a 10 percent minimum helium – nitrogen blend.

### 14.3.W.6.2.2 Pressures Greater Than 103 Kpa (15 Psig).

For pressures greater than 103Kpa (15Psig), safety shutoff valves shall be in accordance with one of the following:

(A) Safety shutoff valves shall be listed for use with hydrogen gas or be certified by the valve manufacturer for use with hydrogen gas or hydrogen enriched gas, and be in accordance with ANSI Z21.21, *Automatic Valves for Gas Appliances*, or UL 429, *Electrically Operated Valves*.

(B)\* Where a safety shut off valve in accordance with 14.3.W.6.2.2(A) is not available for the application, a valve certified by the manufacturer for use with hydrogen gas or hydrogen enriched gas, or one that is specified by the equipment manufacturer for the particular fuel, and that has a Class VI leakage rating per ANSI FC 70-2, *Control Valve Seat Leakage*, as declared by valve manufacturer shall be used.

### A.14.3.W.6.2.2(B)

The valve manufacturer should consider independent testing laboratory verification and certification of the valve seat leakage using a 10 percent minimum helium – nitrogen blend.

### 14.3.W.6.3\*

At least one safety shutoff valve shall be located external to the equipment chamber, separate detached structure, or building.

### A.14.3.W.6.3

A separate detached structure is one that has does not have separate rooms and only the hydrogen consuming equipment is located within the enclosure or building.

### 14.3.W.6.3.1

Where the equipment isolation valve for the equipment fuel gas train is located external to the separate detached structure or building, it shall be permitted to use one of the safety shutoff valves required by 14.3.W.6.1 external to the detached structure or building.

### 14.3.W.6.3.2

The safety shutoff valve external to the equipment chamber, separate detached structure or building shall be dedicated to and actuated by the downstream equipment process controls and be separate from the upstream shutoff valves required by 7.1.24 and 7.1.25.

### 14.3.W.6.3.3

Where the safety shutoff valve includes both an automatic and a manual shutoff capability, is accessible, and located outside, it shall be permitted to be used for the upstream manual isolation required by 7.1.24 and 7.1.25, or the local building code, if the valve location of 7.1.24 and 7.1.25, or the local building code is compatible with the location required by this section.

### 14.3.W.6.4\*

Valve seat leakage testing of safety shutoff valves and valve proving systems shall be performed in accordance with the manufacturer's instructions. [86:7.4.10]

### A.14.3.W.6.4

See NFPA 86 Annex section A.7.4.10 for additional guidance.

### 14.3.W.7 Pre-Mixed Air-Fuel Gas Mixtures.

#### 14.3.W.7.1\*

Where a pre-mixed air-fuel gas, hydrogen or hydrogen enriched fuel, mixture is provided to the equipment identified in 14.3.X and 14.3.Y, a flame arrestor shall be provided in piping systems that distribute the mixture.

### A.14.3.W.7.1

Two basic configurations for the flame arrestor are recognized. One is to provide a separate flame arrestor at each burner, the other is to provide a flame arrestor at each group of burners.

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**Commented [HD12]:** I am not sure what this means.

**Commented [HD13]:** Should this be defined in Chapter 3?

**Commented [HD14]:** This is unenforceable language.

**Commented [HD15]:** This needs to be specific. Does "this section" mean 14.3.W.6?

**Commented [HD16]:** It is not recommended that NFPA 86 be cross-referenced in this way. The annex section of NFPA 86 can be revised, moved, or deleted in future edition of NFPA 86 and this cross-reference would not be updated accordingly.

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The single a flame arrester for a group of burners is more practical if a system consists of many closely spaced burners. Pre-mixed air-fuel gas mixtures are typically less than 6.9 kPa (1 psig).

### **14.3.W.7.2\***

The flame arrester shall be installed at the equipment burner inlet(s) in accordance with the manufacturer's installation guidelines.

#### **A.14.3.1.7.2**

See NFPA 67 for flame arrester installation guidance.

### **14.3.W.7.3**

A separate, manually operated, gas valve shall be provided at the inlet to the air gas mixer for shutting off the flow of fuel to the mixer after a flashback has occurred.

### **14.3.W.7.4**

The valve(s) required by 14.3.W.6.3 shall not be reopened after a flashback has occurred until the flame arrester has cooled sufficiently to prevent reignition of the flammable mixture and has been properly reset.

### **14.3.W.7.5\***

A safety blowout shall be installed in accordance with the manufacturer's instructions near the outlet of the mixing equipment that produces the flammable air-fuel gas mixture at a pressure greater than 0.5 kPa (2 in. w.c.).

#### **A.14.3.W.7.5**

It is recommended to include a safety blowout regardless of the mixture pressure. Acceptable safety blowouts should incorporate all the following components and design features:

- (1) Flame arrester
- (2) Blowout disk
- (3) Provision for automatically shutting off the supply of air-gas mixture to the burners in the event of a flashback passing through an automatic fire check

### **14.3.X Open Combustion Applications.**

#### **14.3.1 Thermal Spraying Equipment. [Move to 14.3.X.1]**

##### **14.3.1.1 General. [Move to 14.3.X.1.1]**

Thermal spraying equipment shall meet the requirements of 14.3.1.

##### **14.3.1.2\* Indoor Installations of Thermal Spraying Equipment. [Move to 14.3.X.1.2]**

###### **A.14.3.1.2 [Move to A.14.3.X.1.2]**

Thermal spraying is typically conducted with robotic equipment in isolated chambers or otherwise protected areas to isolate persons from hazards such as noise, intense ultraviolet light, process gases, and vapors. The equipment includes multiple flexible piping or hoses, which pass through the chamber walls to deliver the gas from a control source to the process device or gun. The flexible portions of the fuel delivery system represent potential leak sources.

NFPA 497 provides guidance on the classification of areas.

##### **14.3.1.2.1\* [Move to 14.3.X.1.2.1\*]**

Thermal spray equipment shall be installed, inspected, and maintained in accordance with the manufacturer's instructions to minimize the potential for leaks of the gas delivery system.

###### **A.14.3.1.2.1 [Move to a.14.3.X.1.2.1]**

System preventive maintenance typically includes regular leak checks and the replacement of hoses in accordance with the manufacturer's recommendations. An increase in the frequency might be warranted based on maintenance experience.

##### **14.3.1.2.6.2 Gas Detection System. [Move to 14.3.X.1.3]**

Activation of the gas detection system required by 14.3.W.4 at the alarm concentration determined by the risk assessment in accordance with 14.3.W.4.2 shall result in the following:

- (1) The thermal spray system shall be prevented from starting ~~if hydrogen is detected at a concentration exceeding 25 percent of the lower flammable limit (LFL).~~

Commented [HD17]: Moved from 14.3.1.

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- (2) The thermal spray system shall be shut down ~~upon detection of hydrogen during operation at a concentration exceeding 25 percent of the LFL.~~

### 14.3.1.2.7 Emergency Shutoff. [Move to 14.3.X.1.4]

#### 14.3.1.2.7.1 [Move to 14.3.X.1.4.1]

~~Automatic emergency~~The two safety shutoff valves specified in 14.3.W.6 shall ~~be provided on the piping used to supply hydrogen gas to the thermal spraying equipment.~~

#### ~~14.3.1.2.7.2~~

~~Activation of the valves shall~~ shut off the flow of hydrogen gas or hydrogen enriched fuel in the event of the following:

- (1) Loss of exhaust ventilation systems required by ~~14.3.1.2.3.2~~ 14.3.W.2
- (2) Detection of hydrogen at a concentration exceeding the action concentration determined by the risk assessment in accordance with 14.3.W.4 ~~25 percent of the LFL~~

(XX) A fire alarm system

- (3) Activation of emergency stop functions specified by the equipment manufacturer ~~provided with the manufacturer's equipment~~

### 14.3.1.3 Outdoor Installations of Thermal Spray Equipment. (Reserved) [Move to 14.3.X.2]

## 14.3.Y Atmospheric Combustion Applications.

### 14.3.Y.1 Boilers and Combustion Systems.

#### 14.3.Y.1.1 General.

Boilers and combustion system installations using hydrogen gas or a hydrogen enriched fuel for heating shall comply with NFPA 85 and 14.3.Y.1.

#### 14.3.Y.1.2\* Indoor Installations of Boilers and Combustion Systems.

##### A.14.3.Y.1.2

The categories of equipment identified in NFPA 85 that can use a gaseous fuel, to include hydrogen or a hydrogen enriched fuel, are:

- (1) Single burner boilers
- (2) Multiple burner boilers
- (3) Warm-up burners and lances for fluidized bed boilers
- (4) Duct burners included in a heat recovery steam generator
- (5) An auxiliary boiler associated with a stoker

This guidance can also be applied to the equipment covered by ASME/CSD-1, Controls and Safety Devices for Automatically Fired Boilers.

#### 14.3.Y.1.2.1\*

Boilers and heat recovery steam generator (HRSG) duct burner systems shall be installed, inspected, and maintained in accordance with the manufacturer's instructions to minimize the potential for leaks of the gas delivery system.

##### A.14.3.Y.1.2.1

Additional guidance for leak checks is provided at 14.3.W.6.4. Also see A.14.3.X.1.2.1.

#### 14.3.Y.1.2.2 Gas Detection System for the Room or Enclosed Area.

Activation of the gas detection system required by 14.3.W.4 at the alarm concentration determined by the risk assessment in accordance with 14.3.W.4.2 shall result in all of the following:

- (1) Boiler and HRSG duct burner systems shall be prevented from starting.
- (2) If running, boiler and HRSG duct burner systems shall be shut down.

#### 14.3.Y.1.2.3 Emergency Shutoff.

The two safety shutoff valves specified in 14.3.W.6 shall shut off the flow of hydrogen gas or hydrogen enriched fuel in the event of the following:

- (1) Loss of exhaust ventilation systems required by 14.3.W.2

**Commented [HD18]:** To Editorial: Sub-section 14.3.1.2.3.2 is being incorporated into 14.3.1.2.3.1, which is moving to 14.3.W.1.1.

**Commented [HD19]:** This is not typical code language. Should this be changed to "concentration limit"

## Hydrogen as a Combustion Fuel Task Group

- (2) [Detection of hydrogen at a concentration exceeding the action concentration determined by the risk assessment in accordance with 14.3.W.4.](#)
- (3) [A fire alarm signal](#)
- (4) [Activation of emergency stop functions specified by the equipment manufacturer](#)

### **14.3.Y.1.3 Outdoor Installations of Boilers and Combustion Systems. (Reserved)**

### **14.3.Y.2 Ovens and Furnaces.**

#### **14.3.Y.2.1 General.**

[Ovens and furnace installations using hydrogen gas or a hydrogen enriched fuel shall comply with NFPA 86 and meet the requirements of 14.3.3.2.](#)

#### **14.3.Y.2.2 Indoor Installations of Ovens and Furnaces.**

##### **14.3.Y.2.2.1**

[Ovens and Furnaces using hydrogen gas or a hydrogen enriched fuel shall be installed, inspected, and maintained in accordance with the manufacturer's instructions to minimize the potential for leaks of the gas delivery system. \(See A.14.3.X.1.2.1\)](#)

##### **14.3.Y.2.2.2 Gas Detection System for the Room or Enclosed Area.**

[Activation of the gas detection system required by 14.3.W.4 at the alarm concentration determined by the risk assessment in accordance with 14.3.W.4.2 shall result in the following:](#)

- (1) [Ovens and Furnaces shall be prevented from starting.](#)
- (2) [Ovens and Furnaces shall be shut down.](#)

##### **14.3.Y.2.2.3\* Emergency Shutoff.**

[The two safety shutoff valves specified in 14.3.W.6 shall shut off the flow of hydrogen gas or hydrogen enriched fuel in the event of the following:](#)

- (1) [Loss of exhaust ventilation systems required by 14.3.W.2](#)
- (2) [Detection of hydrogen at a concentration exceeding the action concentration determined by the risk assessment in accordance with 14.3.W.4.](#)
- (3) [A fire alarm signal](#)
- (4) [Activation of emergency stop functions specified by the equipment manufacturer.](#)

##### **A.14.Y.3.2.2.3**

[NFPA 86 permits a single safety shutoff valve for radiant tube-fired burner systems based on an explosion resistance validation of the assembly. The explosion pressure from a hydrogen or hydrogen enriched fuel can be significantly greater than the explosion pressure for other fuels, and a validation of a single valve configuration must consider the fuel being used for the installation. Additionally, due to the inherent leakage characteristic of hydrogen and hydrogen enriched fuels, a second safety shutoff valve should be considered for radiant tube-fired burner systems.](#)

### **14.3.Y.2.3 Outdoor Installations of Ovens and Furnaces. (Reserved)**

### **14.3.Y.3 Fluid Heater Systems**

#### **14.3.Y.3.1 General.**

[Fluid Heater system installations using hydrogen or a hydrogen enriched fuel as a heating fuel shall comply with NFPA 87 and meet the requirements of 14.3.Y.3.](#)

#### **14.3.Y.3.2 Indoor Installations of Fluid Heater Systems.**

##### **14.3.Y.3.2.1\***

[Fluid heater systems shall be installed, inspected, and maintained in accordance with NFPA 87 and the manufacturer's instructions to minimize the potential for leaks of the gas delivery system.](#)

##### **A.14.3.Y.3.2.1**

[NFPA 87, Chapter 7 provides specific requirements on system maintenance. Also see A.14.3.X.1.2.1.](#)

##### **14.3.3.3.2.2 Gas Detection System for the Room or Enclosed Area.**

[Activation of the gas detection system required by 14.3.W.4 at the alarm concentration determined by the risk assessment in accordance with 14.3.W.4.2 shall result in the following:](#)

## Hydrogen as a Combustion Fuel Task Group

- (1) The heating system burners and pilots shall be prevented from starting.
- (2) The heating system burners and pilots shall be shut down.

### **14.3.3.3.2.3 Emergency Shutoff.**

The two safety shutoff valves specified in 14.3.W.6 shall shut off the flow of hydrogen gas or hydrogen enriched fuel in the event of all the following:

- (1) Loss of exhaust ventilation systems required by 14.3.W.2
- (2) Detection of hydrogen at a concentration exceeding the action concentration determined by the risk assessment in accordance with 14.3.W.4.
- (3) A fire alarm signal
- (4) Activation of emergency stop functions specified by the equipment manufacturer.

### **14.3.Y.3.3 Outdoor Installations of Fluid Heater Systems. (Reserved)**

#### **14.3.4\* High Pressure Combustion Applications.**

These are combustion applications that use hydrogen or hydrogen enriched fuel at greater than 345 kPa (50 psig). The following applications shall be considered in this category:

- (1) Combustion engines with a gaseous fuel injection system at greater than 345 kPa (50 psig).
- (2) Gas turbines

#### **A.14.3.4**

- (A) Reciprocating engines have demonstrated operation at 100 percent hydrogen
- (B) Today's gas turbines are fully capable of operating on 20 percent hydrogen
- (C) Gas turbines have demonstrated reliable operation at hydrogen concentrations of 50 percent and greater using "Syn gas", Refinery Gas and Coke Oven Gas; these uses have been limited primarily to industrial settings that, in general, fall into the "petrochemical plant" category.
- (D) The gas turbine industry has committed to achieving the ability to run on 100 percent hydrogen by 2030 with expanded applications to include power generation facilities.

#### **14.3.Z.1\* General.**

The installation and operation of combustion engines and gas turbines shall be in accordance with NFPA 37 and 14.3.Z.1.

#### **A.14.3.Z.1**

NFPA 37 provides detailed information and requirements related to ventilation of system enclosures, gas detection and emergency action, and fire detection and suppression.

#### **14.3.Z.2 Gas Supply.**

The supply of a hydrogen enriched fuel shall take the form of pipeline supplied hydrogen enriched fuel or the form of locally mixed fuel.

##### **14.3.Z.2.1 Hydrogen Mixing.**

Where the hydrogen enriched fuel mixing is provided locally, the mixing function shall comply with the manufacturer's requirements related to:

- (1) Maximum hydrogen content in the mixture
- (2) Shutdown sequence for abnormal or emergency operating conditions

##### **14.3.Z.2.2\* Emergency Shutoff.**

In addition to the two automatic safety shutoff valve (ASSV) and associated vent valve arrangement required by NFPA 37 for a combustion engine or gas turbine, the hydrogen or hydrogen enriched fuel supply shall comply with all of the following:

- (1) The ASSVs shall be in accordance with 14.3.W.6.2.2
- (2) A vent valve shall be located between the two ASSVs
- (3) One of the two ASSVs required by NFPA 37 for an engine other than a Gas turbine shall be located external to the engine package and any associated building
- (4) Automatic vent valves shall be provided between all shutoff valves starting downstream of the second ASSV
- (5) The gas train shall be provided with an inert purge function to remove the residual hydrogen or hydrogen enriched fuel downstream of the second ASSV

**Commented [HD20]:** This is not a requirement and does not follow the NFPA Manual of Style. Both 14.3.Z and A.14.3.Z will need substantial revision prior to adoption.

**Commented [HD21]:** This is not proper code language. Should this just be changed to say "shall comply with the manufacturer's instructions"?

**Commented [HD22]:** This seems like a separate requirement.

## Hydrogen as a Combustion Fuel Task Group

(6) The vent(s) for the hydrogen or hydrogen enriched fuel shall be in accordance with 7.1.16.

### A.14.3.Z.2.2

The automatic safety shutoff valves (ASSV) required by NFPA 37 are defined as a valve that, upon shutdown conditions, will automatically stop the flow of gas to the engine or turbine. This is consistent with the safety shutoff valve functionality defined in NFPA 2.

**Commented [HD23]:** Are these listed items meant to apply to the ASSV mentioned in the lead in statement, or to the fuel supply? Clarity to this requirement and the listed items is needed.

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#### **3.3.7.1 Control Area.**

A building or portion of a building or outdoor area within which hazardous materials are allowed to be stored, dispensed, used, or handled in quantities not exceeding the MAQ. [400, 20222024]

#### **3.3.119 Health Hazard Material.**

A chemical or substance classified as a toxic, highly toxic, or corrosive material in accordance with definitions set forth in this code. [400, 20222024]

#### **3.3.149.1\* Hazardous Material.**

A chemical or substance that is classified as a physical hazard material or a health hazard material, whether the chemical or substance is in usable or waste condition. (See also 3.3.119, *Health Hazard Material*, and 3.3.188, *Physical Hazard Material*.) [400, 20222024]

#### **3.3.188 Physical Hazard Material.**

A chemical or substance classified as an explosive, flammable cryogen, flammable gas, flammable solid, ~~ignitable~~ignitable (flammable or combustible) liquid, organic peroxide, oxidizer, oxidizing cryogen, pyrophoric, unstable (reactive), or water-reactive material. [400, 20222024]

#### **3.3.216\* Safety Data Sheet (SDS).**

The document that describes composition of a material, hazardous properties and hazard mitigation, and disposal information. [400, 20222024]

#### **A.3.3.216 Safety Data Sheet (SDS).**

SDSs in the United States are prepared in accordance with the Occupational Safety and Health Administration (OSHA) hazard communication standard (29 CFR 1910.1200, "Hazard Communication"). Chemicals transported internationally might include additional requirements. (See Annex B of NFPA 400 for additional information regarding SDSs.) [400, 20222024]

#### **4.7.1**

Where required by the AHJ, no facility storing hazardous materials listed in 1.1.1 of NFPA 400 shall close or abandon an entire storage facility without notifying the AHJ at least 30 days prior to the scheduled closing. [400:1.9.1]

#### **4.7.2**

The AHJ shall be permitted to reduce the 30-day period specified in 4.7.1 ~~where~~when there are special circumstances requiring such reduction. [400:1.9.2]

#### **4.7.3 Facilities Out of Service.**

##### **4.7.3.1 Facilities Temporarily Out of Service.**

Facilities that are temporarily out of service shall continue to maintain a permit and be monitored and inspected. [400:1.9.3.1]

##### **4.7.3.2 Facilities Permanently Out of Service.**

Facilities for which a permit is not kept current or that are not monitored and inspected on a regular basis shall be deemed to be permanently out of service and shall be closed in accordance with 4.7.4.1 through 4.7.4.2. [400:1.9.3.2]

#### **4.7.4 Closure Plan.**

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#### 4.7.4.1

Where required by the AHJ, the permit holder or applicant shall submit a closure plan to the fire department to terminate storage, dispensing, handling, or use of {GH<sub>2</sub> or LH<sub>2</sub>} at least 30 days prior to facility closure.

~~[400:1.9.4.1]~~

#### 4.7.4.2

The plan shall demonstrate that {GH<sub>2</sub> or LH<sub>2</sub>} that was stored, dispensed, handled, or used in the facility has been transported, disposed of, or reused in a manner that eliminates the need for further maintenance and any threat to public health and safety. ~~[400:1.9.4.2]~~

#### 4.9.2\* Hazardous Materials Inventory Statement.

When required by the AHJ, a hazardous materials inventory statement (HMIS) ~~[addressing the GH<sub>2</sub> or LH<sub>2</sub> present]~~ shall be completed and submitted to the AHJ. ~~[400:1.12.1]~~

#### 4.9.3 Safety Data Sheets.

Safety Data Sheets (SDS) shall be available on the premises for {GH<sub>2</sub> or LH<sub>2</sub>} regulated by this code.

##### 4.9.3.1

When approved by the AHJ, the SDSs shall be permitted to be retrievable by electronic access. ~~[400:6.1.2]~~

#### 4.10.2 Control and Mitigation of Unauthorized Releases.

Provisions shall be made for controlling and mitigating unauthorized releases. [400:6.1.3.2]

#### 4.10.3\* Records of Unauthorized Releases.

Accurate records of the unauthorized release~~releases~~ of {GH<sub>2</sub> or LH<sub>2</sub>} shall be kept by the permittee. ~~[400:6.1.3.3]~~

#### 4.10.4 Notification of Unauthorized Releases.

The fire department shall be notified immediately or in accordance with approved emergency procedures when an unauthorized release becomes reportable under state, federal, or local regulations. [400:6.1.3.4]

#### 4.10.5 Container Failure.

When an unauthorized release due to primary container failure is discovered, the involved primary container shall be repaired or removed from service. [400:6.1.3.5]

#### 4.10.6 Responsibility for Cleanup of Unauthorized Releases.

##### 4.10.6.1

The person, firm, or corporation responsible for an unauthorized release shall institute and complete all actions necessary to remedy the effects of such unauthorized release, whether sudden or gradual, at no cost to the AHJ. [400:6.1.3.7.1]

##### 4.10.6.2

When deemed necessary by the AHJ, cleanup of an unauthorized release shall be permitted to be initiated by the fire department or by an authorized individual or firm, and costs associated with such cleanup shall be borne by the owner, operator, or other person responsible for the unauthorized release. [400:6.1.3.7.2]

#### 4.11\* Personnel Training.

Persons in areas where {GH<sub>2</sub> or LH<sub>2</sub>} are stored, dispensed, handled, or used shall be trained in the hazards of the materials employed and actions required by the emergency plan. The level of training to be conducted shall be

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consistent with the responsibilities of the persons to be trained in accordance with 4.11.1 through 4.11.4.4.

~~[400:6.1.4]~~

#### **4.11.1 Awareness.**

The training provided for persons designated in Section 4.11 shall include awareness training in accordance with 4.11.1.1 through 4.11.1.3. ~~[400:6.1.4.1]~~

##### **4.11.1.1 Completion.**

Initial training shall be completed prior to beginning work in the work area. ~~[400:6.1.4.1.1]~~

##### **4.11.1.2 Hazard Communications.**

Training shall be provided prior to beginning work in the work area to enable personnel to recognize and identify ~~[GH<sub>2</sub> or LH<sub>2</sub>]~~ stored, dispensed, handled, or used on site and where to find hazard safety information pertaining to the hazards of the materials employed. ~~[400:6.1.4.1.2]~~

##### **4.11.1.3 Emergency Plan.**

Training shall be provided prior to beginning work in the work area to enable personnel to implement the emergency plan. ~~[400:6.1.4.1.3]~~

#### **4.11.2 Operations Personnel.**

Persons engaged in storing, using, or handling ~~[GH<sub>2</sub> or LH<sub>2</sub>]~~ shall be designated as operations personnel and shall be trained in accordance with 4.11.1 and 4.11.2.2 through 4.11.2.7. ~~[400:6.1.4.2]~~

##### **4.11.2.2 Physical and Health Hazard Properties.**

Operations personnel shall be trained in the chemical nature of the materials, including their physical hazards and the symptoms of acute or chronic exposure as provided by the safety data sheet (SDS) furnished by the manufacturer or other authoritative sources. ~~[400:6.1.4.2.1]~~

##### **4.11.2.3 Dispensing, Using, and Processing.**

Operations personnel shall be trained in the ~~specific~~ use of specific safeguards applicable to the dispensing, processing, or use of the materials and the equipment employed. ~~[400:6.1.4.2.2]~~

##### **4.11.2.4 Storage.**

Operations personnel shall be trained in the application of storage arrangements and site-specific limitations on storage for the materials employed. ~~[400:6.1.4.2.3]~~

##### **4.11.2.5 Transport (Handling).**

Operations personnel involved in materials handling shall be trained in the requirements for on-site transport of the materials employed. ~~[400:6.1.4.2.4]~~

##### **4.11.2.6 Actions in an Emergency.**

Operations personnel shall be trained in the necessary actions to take in the event of an emergency, including the operation and activation of emergency controls prior to evacuation. ~~[400:6.1.4.2.5]~~

##### **4.11.2.7 Changes.**

Training shall be provided whenever a new hazardous material is introduced into the work area that presents a new physical or health hazard, or when new information is obtained pertaining to physical or health hazards of an existing hazardous material that has not been included in previous training, and when there are changes in any of the following:

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- (1) Equipment
- (2) Operations
- (3) Hazardous Materials

[400:6.1.4.2.6]

**4.11.3 Emergency Response Liaison. [400:6.1.4.3]**

**4.11.3.1**

Responsible persons shall be designated and trained to be emergency response (ER) liaison personnel.

[400:6.1.4.3.1]

**4.11.3.2**

Emergency response liaison personnel shall do the following:

- (1) Aid emergency responders in pre-planning responses to emergencies
- (2) Identify locations where ~~GH<sub>2</sub>~~ or ~~LH<sub>2</sub>~~ are located
- (3) Have access to safety data sheets
- (4) Be knowledgeable in the site emergency response procedures

~~[400:6.1.4.3.2]~~

**4.11.4\* Emergency Responders.**

Emergency responders shall be trained to be competent in the actions to be taken in an emergency event.

[400:6.1.4.4]

**4.11.4.1\* Emergency Response Team Leader.**

Persons acting as ER team leaders shall be trained under the Incident Command System concept or equivalent.

[400:6.1.4.4.1]

**4.11.4.2\* Response to Incipient Events.**

Responses to incidental releases of ~~GH<sub>2</sub>~~ or ~~LH<sub>2</sub>~~ where the material can be absorbed, neutralized, or otherwise controlled at the time of release by employees in the immediate release area, or by maintenance personnel, shall not be considered emergency responses as defined ~~with~~ within the scope of this code. ~~[400:6.1.4.4.2]~~

**4.11.4.3\* On-Site Emergency Response Team.**

When an on-site emergency response team is provided, emergency responders shall be trained in accordance with the requirements of the specific site emergency plan or as required by federal, state, or local governmental agencies. [400:6.1.4.4.3]

**4.11.4.4 Training Mandated by other Agencies.**

Training required by federal, state, or local regulations that is required based on the quantity or type of ~~GH<sub>2</sub>~~ or ~~LH<sub>2</sub>~~ stored, dispensed, handled, or used shall be conducted in accordance with the requirements of and under the jurisdiction of the governing agency. ~~[400:6.1.4.5]~~

**4.11.4.5 Documentation.**

Training shall be documented and the documentation made available to the AHJ upon written request.

[400:6.1.4.6]

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#### **4.12 Ignition Source Controls.**

##### **4.12.1 Smoking.**

Smoking shall be prohibited in the following locations:

- (1) Within 25 ft (7.6 m) of outdoor storage ~~or~~ areas, dispensing areas, or open use areas.
- (2) In rooms or areas where ~~[GH<sub>2</sub> or LH<sub>2</sub>]~~ are stored or dispensed or used in open systems in amounts requiring a permit in accordance with Section 4.5

~~[400:6.1.5.1]~~

##### **4.12.2 Open Flames and High-Temperature Devices.**

Open flames and high-temperature devices shall not be used in a manner that creates a hazardous condition. ~~[400:6.1.5.2]~~

##### **4.12.3 Energy-Consuming Equipment.**

Energy-consuming equipment with the potential to serve as a source of ignition shall be listed or approved for use with ~~[GH<sub>2</sub> or LH<sub>2</sub>]~~ stored or used. ~~[400:6.1.5.3]~~

##### **4.13.1.1\* Design and Construction.**

Signs shall be durable, and the size, color, and lettering of signs shall be in accordance with nationally recognized standards. ~~[400:6.1.8.1.1]~~

##### **4.13.1.2 Language.**

Signs shall be in English as the primary language or in symbols permitted by this code. ~~[400:6.1.8.1.2]~~

##### **4.13.1.3 Maintenance.**

Signs shall meet the following criteria:

- (1) They shall not be obscured.
- (2) They shall be maintained in a legible condition.
- (3) They shall not be removed, unless for replacement.

~~[400:6.1.8.1.3]~~

##### **4.13.2 Hazard Identification Signs.**

###### **4.13.2.1**

Visible hazard identification signs in accordance with NFPA 704 shall be placed at the following locations, except where the AHJ has received a hazardous materials management plan and a hazardous materials inventory statement in accordance with 4.9.1 and 4.9.2 and has determined that omission of such signs is consistent with safety:

- (1) On stationary aboveground tanks
- (2) On stationary aboveground containers
- (3) At entrances to locations where hazardous materials are stored, dispensed, used, or handled in quantities requiring a permit
- (4) \*At other entrances and locations designated by the AHJ

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[400:6.1.8.2.1]

#### **4.13.3 No Smoking Signs.**

Where “no smoking” is not applicable to an entire site or building, signs shall be provided as follows:

- (1) In rooms or areas where ~~[GH<sub>2</sub> or LH<sub>2</sub>]~~ is stored or dispensed or used in open systems in amounts requiring a permit in accordance with Section 1.8 of NFPA 400
- (2) Within 25 ft (7.6 m) of outdoor storage, dispensing, or open-use areas

~~[400:6.1.8.3]~~

#### **4.14.1.1**

Guard posts or other approved means shall be provided to protect the following where subject to vehicular damage:

- (1) \*Storage tanks and connected piping, valves, and fittings
- (2) Storage areas containing tanks or portable containers except where the exposing vehicles are powered industrial trucks used for transporting the ~~[GH<sub>2</sub> or LH<sub>2</sub>]~~
- (3) Use areas

~~[400:6.1.9.1]~~

#### **4.14.1.2**

Where guard posts are installed, the posts shall meet the following criteria:

- (1) They shall be constructed of steel not less than 4 in. (102 mm) in diameter and concrete filled.
- (2) They shall be spaced not more than 4 ft (1.2 m) between posts on center.
- (3) They shall be set not less than 3 ft (0.9 m) deep in a concrete footing of not less than a 15 in. ~~(380-381~~ mm) diameter.
- (4) They shall be set with the top of the posts not less than 3 ft (0.9 m) above ground.
- (5) They shall be located not less than 3 ft (0.9 m) from the tank.

[400:6.1.9.2]

#### **6.3.2.2**

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

[400:5.2.2.2]

#### **16.2.5.3\* Emergency Plans.**

##### **16.2.5.3.1**

The emergency action plan shall include the following procedures in the event of a chemical emergency, fire, or explosion:

- (1) Procedures for sounding the alarm
- (2) Procedures for notifying and coordinating with the fire department, governmental agencies, or other emergency responders or contacts, as required

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- (3) Procedures for evacuating and accounting for personnel, as applicable
- (4) Procedures for establishing requirements for rescue and medical duties for those requiring or performing these duties
- (5) Procedures and schedules for conducting drills
- (6) Procedures for shutting down and isolating equipment under emergency conditions to include the assignment of personnel responsible for maintaining critical plant functions or for shutdown of process operations
- (7) Appointment and training of personnel to carry out assigned duties, including steps to be taken at the time of initial assignment, as responsibilities or response actions change, and at the time anticipated duties change
- (8) Alternative measures for occupant safety, when applicable
- (9) Aisles designated as necessary for movement of personnel and emergency response
- (10) Maintenance of fire protection equipment
- (11) Safe procedures for startup to be taken following the abatement of an emergency

[400:7.2.3.2]

#### **A.4.11**

The hazard potential of a facility is not dependent on any single factor. Physical size, number of employees, and the quantity and the nature of the hazardous materials are important considerations. The level of training can vary with the complexity of the facility under consideration. [400:A.6.1.4]

##### **A.4.11.4**

Emergency responders can include on-site personnel that have been designated and trained to respond to emergencies, persons from the public sector such as fire department personnel, or persons from the private sector that can be contracted or otherwise engaged to perform emergency response duties. (*See Annex I in NFPA 400 for additional information.*) [400:A.6.1.4.4]

##### **A.4.11.4.1**

OSHA describes an Incident Command System as a standardized on-scene incident management concept designed specifically to allow responders to adopt an integrated organizational structure equal to the complexity and demands of any single incident or multiple incidents without being hindered by jurisdictional boundaries. [400:A.6.1.4.4.1]

##### **A.4.11.4.2**

Responses to releases of hazardous materials where there is no potential safety or health hazard such as fire, explosion, or chemical exposure are not considered emergency responses as defined within the context of this code. [400:A.6.1.4.4.2]

##### **A.4.11.4.3**

Emergency response training will vary depending on the level of emergency response required and by the requirements of the governmental agency. [400:A.6.1.4.4.3]

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### 3.3.31 CFR.

The Code of Federal Regulations of the United States Government. [1, 2021~~4~~]

### 3.3.32 CGA.

Compressed Gas Association. [1, 2021]

### 4.2.1\* Goals.

The goals of this *Code* shall be to provide a reasonable level of safety, property protection, and public welfare from the hazards created by fire, explosion, and other hazardous conditions. [1:4.1.1]

### 4.2.2\* Objectives.

To achieve the goals stated in 4.2.1, the goals and objectives of 4.2.3 through 4.2.5 shall be used to determine the intent of this *Code*. [1:4.1.2]

### 4.2.3\* Safety.

This *Code* shall provide for life safety by reducing the probability of injury or death from fire, explosions, or events involving ~~[GH<sub>2</sub> or LH<sub>2</sub>]~~. ~~[1:4.1.3]~~

#### 4.2.3.1 Safety from Fire.

##### 4.2.3.1.1\* Safety-from-Fire Goals.

The fire safety goals of this *Code* shall be as follows:

- (1) To provide an environment for the occupants in a building or facility and for the public near a building or facility that is reasonably safe from fire and similar emergencies
- (2) To protect fire fighters and emergency responders

[1:4.1.3.1.1]

##### 4.2.3.1.2 Safety-from-Fire Objectives.

###### 4.2.3.1.2.1

Buildings and facilities shall be designed, constructed, and maintained to protect occupants who are not intimate with the initial fire development for the amount of time needed to evacuate, relocate, or defend in place.

[1:4.1.3.1.2.1]

###### 4.2.3.1.2.2\*

Buildings shall be designed and constructed to provide reasonable safety for fire fighters and emergency responders during search and rescue operations. [1:4.1.3.1.2.2]

###### 4.2.3.1.2.3

Buildings shall be designed, located, and constructed to reasonably protect adjacent persons from injury or death as a result of a fire. [1:4.1.3.1.2.3]

###### 4.2.3.1.2.4

Buildings shall be designed, located, and constructed to provide reasonable access to the building for emergency responders. [1:4.1.3.1.2.4]

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#### 4.2.3.1.2.5\*

Operations shall be conducted at facilities in a safe manner that minimizes, reduces, controls, or mitigates the risk of fire injury or death for the operators, while protecting the occupants not intimate with initial fire development for the amount of time needed to evacuate, relocate, or defend in place. [1:4.1.3.1.2.5]

#### 4.2.3.2 Safety During Building Use.

##### 4.2.3.2.1\* Safety-During-Building-Use Goal.

The safety-during-building-use goal of this *Code* shall be to provide an environment for the occupants of the building that is reasonably safe during the normal use of the building. [1:4.1.3.2.1]

##### 4.2.3.3.1 Safety-from-Hydrogen-Hazards Goal.

The safety-from-~~[hydrogen-hazards]~~ goal of this code shall be to provide an environment for the occupants in a building or facility and to those adjacent to a building or facility that is reasonably safe from exposures to adverse effects from ~~[hydrogen-hydrogen-hazards]~~ present therein. ~~[1:4.1.3.3.1]~~

##### 4.2.3.3.2 Safety-from-Hydrogen-Hazards Objectives.

###### 4.2.3.3.2.1

The storage, use, or handling of ~~[hydrogen]~~ in a building or facility shall be accomplished in a manner that provides a reasonable level of safety for occupants and for those adjacent to a building or facility from health hazards, illness, injury, or death during normal storage, use, or handling operations and conditions. ~~[1:4.1.3.3.2.1]~~

###### 4.2.3.3.2.2\*

The storage, use, or handling of ~~[hydrogen]~~ in a building or facility shall be accomplished in a manner that provides a reasonable level of safety for occupants and for those adjacent to a building or facility from illness, injury, or death due to the following conditions:

- (1) An unplanned release of ~~[hydrogen]~~
- (2) A fire impinging upon the ~~[hydrogen piping or containment system]~~ or the involvement of ~~[hydrogen]~~ in a fire
- (3) The application of an external force on the ~~[hydrogen piping or containment system]~~ that is likely to result in an unsafe condition

~~[1:4.1.3.3.2.2]~~

#### 4.2.4 Property Protection.

##### 4.2.4.1 Property Protection Goal.

The property protection goal of this *Code* shall be to limit damage created by a fire, explosion, or event associated with ~~[GH<sub>2</sub> or LH<sub>2</sub>]~~ to a reasonable level to the building or facility and adjacent property. ~~[1:4.1.4.1]~~

##### 4.2.4.2 Property Protection Objectives.

###### 4.2.4.2.1\* Prevention of Ignition.

The facility shall be designed, constructed, and maintained, and operations associated with the facility shall be conducted, to prevent unintentional explosions and fires that result in failure of or damage to adjacent compartments, emergency life safety systems, adjacent properties, adjacent outside storage, and the facility's structural elements. [1:4.1.4.2.1]

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#### **4.2.4.2.2\* Fire Spread and Explosions.**

In the event that a fire or explosion occurs, the building or facility shall be sited, designed, constructed, or maintained, and operations associated with the facility shall be conducted and protected, to reasonably reduce the impact of unwanted fires and explosions on the adjacent compartments, emergency life safety systems, adjacent properties, adjacent outside storage, and the facility's structural elements. [1:4.1.4.2.2]

#### **4.2.4.2.3 Structural Integrity.**

The facility shall be designed, constructed, protected, and maintained, and operations associated with the facility shall be conducted, to provide a reasonable level of protection for the facility, its contents, and adjacent properties from building collapse due to a loss of structural integrity resulting from a fire. [1:4.1.4.2.3]

#### **4.2.4.2.4 Hydrogen Hazards.**

The facility shall be designed, constructed, and maintained, and operations associated with the facility shall be conducted, to provide reasonable property protection from damage resulting from fires, explosions, and other unsafe conditions associated with the storage, use, and handling of {hydrogen} therein. [1:4.1.4.2.4]

### **4.2.5 Public Welfare.**

#### **4.2.5.1\* Public Welfare Goal.**

The public welfare goal of this *Code* shall be to maintain a high probability that buildings and facilities that provide a public welfare role for a community continue to perform the function for their intended purpose following a fire, explosion, or hazardous materials event. [1:4.1.5.1]

#### **4.2.5.2\* Public Welfare Objective.**

Buildings and facilities that provide a public welfare role for a community shall be designed, constructed, maintained, and operated to provide reasonable assurance of continued function following a fire, explosion, or hazardous materials event. [1:4.1.5.2]

### **4.3 Assumptions.**

#### **4.3.1\* Single Fire Source.**

##### **4.3.1.1**

The fire protection methods of this *Code* shall assume that multiple simultaneous fire incidents will not occur. [1:4.2.1.1]

##### **4.3.1.2**

The single fire source assumption shall not preclude the evaluation of multiple design fire scenarios as required by Section 5.4. [1:4.2.1.2]

#### **4.3.2\* Single Hazardous Material Release.**

##### **4.3.2.1**

The protection methods of this *Code* shall assume that multiple simultaneous unauthorized releases of hazardous materials from different locations will not occur. [1:4.2.2.1]

##### **4.3.2.2**

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The single hazardous material release assumption shall not preclude the evaluation of multiple design scenarios as required by Section 5.4. [1:4.2.2.2]

#### **4.3.3\* Incidents Impinging on Hazardous Materials.**

The protection methods of this *Code* shall assume that a fire, explosion, hazardous materials release, or external force that creates a dangerous condition has the potential to impinge on hazardous materials being stored, handled, or used in the building or facility under normal conditions. (See Section 5.4 for performance-based design scenarios.) [1:4.2.3]

#### **4.4 Compliance Options.**

Compliance with the goals and objectives of Section 4.2 shall be provided in accordance with either of the following:

- (1) The prescriptive-based provisions per 4.4.1
- (2) The performance-based provisions per 4.4.2

[1:4.3]

#### **4.4.2 Performance-Based Option.**

##### **4.4.2.1**

A performance-based option shall be in accordance with Chapter 1 through Chapter 5 of this *Code*. [1:4.3.2.1]

##### **4.4.2.2**

Prescriptive requirements shall be permitted to be used as part of the performance approach, if they, in conjunction with the performance features, meet the overall goals and objectives of this *Code*. [1:4.3.2.2]

#### **4.12.4 Powered Industrial Trucks.**

Powered industrial trucks shall be operated and maintained in accordance with NFPA 505. [1:10.1.7.8]

#### **5.1.1 Application.**

The requirements of this chapter shall apply to facilities designed to the performance-based option permitted by Section 4.4. [1:5.1.1]

#### **5.1.3\* Approved Qualifications.**

The performance-based design shall be prepared by a person with qualifications acceptable to the AHJ. [1:5.1.3]

#### **5.1.4\* Plan Submittal Documentation.**

When a performance-based design is submitted to the AHJ for review and approval, the owner shall document, in an approved format, each performance objective and applicable scenario, including any calculation methods or models used in establishing the proposed design's fire and life safety performance. [1:5.1.4]

#### **5.1.5\* Independent Review.**

The AHJ shall be permitted to require an approved, independent third party to review the proposed design and provide an evaluation of the design to the AHJ at the expense of the owner. [1:5.1.5]

#### **5.1.6 Sources of Data.**

The task group has decided to maintain the edits made by the technical committee to previously extracted text and delete the associated extract tags. This puts the previously extracted material under the control of this technical committee.

Data sources shall be identified and documented for each input data requirement that is required to be met using a source other than a required design scenario, an assumption, or a facility design specification. [1:5.1.6]

### 5.1.6.1

The degree of conservatism reflected in such data shall be specified, and a justification for the source shall be provided. [1:5.1.6.1]

### 5.1.6.2

Copies of all references relied upon by the performance-based design to support assumptions, design features, or any other part of the design shall be made available to the AHJ if requested. [1:5.1.6.2]

### 5.1.7 Final Determination.

The AHJ shall make the final determination as to whether the performance objectives have been met. [1:5.1.7]

### 5.1.8\* Operations and Maintenance Manual.

An approved Operations and Maintenance (O&M) Manual shall be provided by the owner to the AHJ and the fire department and shall be maintained at the facility in an approved location. [1:5.1.8]

### 5.1.9\* Information Transfer to the Fire Service.

Where a performance-based design is approved and used, the designer shall ensure that information regarding the operating procedures of the performance-based designed fire protection system is transferred to the owner and to the local fire service for inclusion in the pre-fire plan. [1:5.1.9]

### 5.1.10\* Design Feature Maintenance.

#### 5.1.10.1

The design features required for the facility to meet the performance goals and objectives shall be maintained by the owner and be readily accessible to the AHJ for the life of the facility. [1:5.1.10.1]

#### 5.1.10.2

The facility shall be maintained in accordance with all documented assumptions and design specifications. [1:5.1.10.2]

#### 5.1.10.2.1

Any proposed changes or variations from the approved design shall be approved by the AHJ prior to the actual change. [1:5.1.10.2.1]

#### 5.1.10.2.2

Any approved changes to the original design shall be maintained in the same manner as the original design. [1:5.1.10.2.2]

### 5.1.11\* Annual Certification.

Where a performance-based design is approved and used, the property owner shall annually certify that the design features and systems have been maintained in accordance with the approved original performance-based design and assumptions and any subsequent approved changes or modifications to the original performance-based design. [1:5.1.11]

### 5.1.12 Hazardous Materials.

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#### **5.1.12.1**

Performance-based designs for facilities containing high hazard contents shall identify the properties of hazardous materials to be stored, used, or handled and shall provide adequate and reliable safeguards to accomplish the following objectives, considering both normal operations and possible abnormal conditions:

- (1) Minimize the potential occurrence of unwanted releases, fire, or other emergency incidents resulting from the storage, use, or handling of hazardous materials
- (2) Minimize the potential failure of buildings, equipment, or processes involving hazardous materials by ensuring that such buildings, equipment, or processes are reliably designed and are suitable for the hazards present
- (3) Minimize the potential exposure of people or property to unsafe conditions or events involving an unintended reaction or release of hazardous materials
- (4) Minimize the potential for an unintentional reaction that results in a fire, explosion, or other dangerous condition
- (5) Provide a means to contain, treat, neutralize, or otherwise handle plausible releases of hazardous materials to minimize the potential for adverse impacts to persons or property outside of the immediate area of a release
- (6) Provide appropriate safeguards to minimize the risk of and limit damage and injury that could result from an explosion involving hazardous materials that present explosion hazards
- (7) Detect hazardous levels of gases or vapors that are dangerous to health and alert appropriate persons or mitigate the hazard when the physiological warning properties for such gases or vapors are inadequate to warn of danger prior to personal injury
- (8) Maintain power to provide for continued operation of safeguards and important systems that are relied upon to prevent or control an emergency condition involving hazardous materials
- (9) Maintain ventilation where ventilation is relied upon to minimize the risk of emergency conditions involving hazardous materials
- (10) Minimize the potential for exposing combustible hazardous materials to unintended sources of ignition and for exposing any hazardous material to fire or physical damage that can lead to endangerment of people or property

[1:5.1.12.1]

#### **5.1.12.2**

A process hazard analysis and off-site consequence analysis shall be conducted when required by the AHJ to ensure that people and property are satisfactorily protected from potentially dangerous conditions involving hazardous materials. The results of such analyses shall be considered when determining active and passive mitigation measures used in accomplishing the objectives of 4.2.3.3.2 and 4.2.4.2. [1:5.1.12.2]

#### **5.1.12.3**

Written procedures for pre-start-up safety reviews, normal and emergency operations, management of change, emergency response, and accident investigation shall be developed prior to beginning operations at a facility ~~[-]~~. ~~Such procedures shall be developed~~ with the participation of employees. ~~[-1:5.1.12.3]~~

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### 5.1.13 Special Definitions.

A list of special terms used in this chapter shall be as follows:

- (1) Design Fire Scenario. (See 3.4.9.1.)
- (2) Design Specification. (See 3.4.20.1.)
- (3) Design Team. (See 3.4.6.)
- (4) Exposure Fire. (See 3.4.7.)
- (5) Fire Model. (See 3.4.8.)
- (6) Fire Scenario. (See 3.4.9.)
- (7) Fuel Load. (See 3.4.10.)
- (8) Input Data Specification. (See 3.4.20.2.)
- (9) Occupant Characteristics. (See 3.4.13.)
- (10) Performance Criteria. (See 3.4.14.)
- (11) Proposed Design. (See 3.4.15.)
- (12) Safety Factor. (See 3.4.17.)
- (13) Safety Margin. (See 3.4.18.)
- (14) Sensitivity Analysis. (See 3.4.2.1.)
- (15) Stakeholder. (See 3.4.21.)
- (16) Uncertainty Analysis. (See 3.4.2.2.)
- (17) Verification Method. (See 3.4.23.)

[1:5.1.13]

## 5.2 Performance Criteria.

### 5.2.1 General.

A design shall meet the objectives specified in Section 4.2 if, for each required design scenario, assumption, and design specification, the performance criteria of 5.2.2 are met. [1:5.2.1]

### 5.2.2\* Specific Performance Criteria.

#### 5.2.2.1\* Fire Conditions.

No occupant who is not intimate with ignition shall be exposed to instantaneous or cumulative untenable conditions. [1:5.2.2.1]

#### 5.2.2.2\* 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]

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**5.2.2.3\* 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]

**5.2.2.4\* 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]

**5.2.2.5\* Public Welfare.**

For facilities that serve a public welfare role as defined in 4.2.5, 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]

**5.2.2.6 Occupant Protection from Untenable Conditions.**

Means shall be provided to evacuate, relocate, or defend in place occupants not intimate with ignition for sufficient time so that they are not exposed to instantaneous or cumulative untenable conditions from smoke, heat, or flames. [1:5.2.2.6]

**5.2.2.7 Emergency Responder Protection.**

Buildings shall be designed and constructed to reasonably prevent structural failure under fire conditions for sufficient time to enable fire fighters and emergency responders to conduct search and rescue operations. [1:5.2.2.7]

**5.2.2.8\* Occupant Protection from Structural Failure.**

Buildings shall be designed and constructed to reasonably prevent structural failure under fire conditions for sufficient time to protect the occupants. [1:5.2.2.8]

**5.3 Retained Prescriptive Requirements.**

**5.3.1 Systems and Features.**

All fire protection systems and features of the building shall comply with applicable NFPA standards for those systems and features. [1:5.3.1]

**5.3.2 Electrical Systems.**

Electrical systems shall comply with applicable NFPA standards for those systems. [1:5.3.2]

**5.3.5 Equivalency.**

Equivalent designs for the features covered in the retained prescriptive requirements mandated by 5.3.1 through 5.3.4 shall be addressed in accordance with the equivalency provisions of Section 1.5. [1:5.3.5]

**5.4\* Design Scenarios.**

**5.4.1 General.**

**5.4.1.1**

The proposed design shall be considered to meet the goals and objectives if it achieves the performance criteria for each required design scenario. The AHJ shall approve the parameters involved with required design scenarios. [1:5.4.1.1]

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**5.4.1.2\***

Design scenarios shall be evaluated for each required scenario using a method acceptable to the AHJ and appropriate for the conditions. Each scenario shall be as challenging and realistic as any that could realistically occur in the building. [1:5.4.1.2]

**5.4.1.3\***

Scenarios selected as design scenarios shall include, but not be limited to, those specified in 5.4.2 through 5.4.5. [1:5.4.1.3]

**5.4.1.3.1**

Design fire scenarios demonstrated by the design team to the satisfaction of the AHJ as inappropriate for the building use and conditions shall not be required to be evaluated fully. [1:5.4.1.3.1]

**5.4.1.4**

Each design scenario used in the performance-based design proposal shall be translated into input data specifications, as appropriate for the calculation method or model. [1:5.4.1.4]

**5.4.1.5**

Any design scenario specifications that the design analyses do not explicitly address or incorporate and that are, therefore, omitted from input data specifications shall be identified, and a sensitivity analysis of the consequences of that omission shall be performed. [1:5.4.1.5]

**5.4.1.6**

Any design scenario specifications modified in input data specifications, because of limitations in test methods or other data generation procedures, shall be identified, and a sensitivity analysis of the consequences of the modification shall be performed. [1:5.4.1.6]

**5.4.4.1 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]

**5.4.4.2 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]

**5.4.4.3 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]

**5.4.4.4 Hazardous Materials Design Scenario 4.**

**5.4.4.4.1**

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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]

**5.4.4.4.2\***

Hazardous Materials Design Scenario 4 shall not be required to be applied to protection systems or features for which both the level of reliability and the design performance in the absence of the system are acceptable to the AHJ. [1:5.4.4.4.2]

**5.4.5 Required Design Scenarios — Safety During Building Use.**

**5.4.5.1\* Building Use Design Scenario 1.**

Building Use Design Scenario 1 involves an event in which the maximum occupant load is in the assembly building and an emergency event occurs blocking the principal exit/entrance to the building. This design scenario shall address the concern of occupants having to take alternative exit routes under crowded conditions. [1:5.4.5.1]

**5.4.5.2 Building Use Design Scenario 2.**

Building Use Design Scenario 2 involves a fire in an area of a building undergoing construction or demolition while the remainder of the building is occupied. The normal fire suppression system in the area undergoing construction or demolition has been taken out of service. This design scenario shall address the concern regarding the inoperability of certain building fire safety features during construction and demolition in a partially occupied building. [1:5.4.5.2]

**5.5 Evaluation of Proposed Designs.**

**5.5.1 General.**

**5.5.1.1**

A proposed design's performance shall be assessed relative to each performance objective in Section 4.2 and each applicable scenario in Section 5.4, with the assessment conducted through the use of appropriate calculation methods. [1:5.5.1.1]

**5.5.1.2**

The choice of assessment methods shall require the approval of the AHJ. [1:5.5.1.2]

**5.5.2 Use.**

The design professional shall use the assessment methods to demonstrate that the proposed design achieves the goals and objectives, as measured by the performance criteria in light of the safety margins and uncertainty analysis, for each scenario, given the assumptions. [1:5.5.2]

**5.5.3 Input Data.**

**5.5.3.1 Data.**

**5.5.3.1.1**

Input data for computer fire models shall be obtained in accordance with ASTM E1591, *Standard Guide for Obtaining Data for Fire Growth Models*. [1:5.5.3.1.1]

**5.5.3.1.2**

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Data for use in analytical models that are not computer-based fire models shall be obtained using appropriate measurement, recording, and storage techniques to ensure the applicability of the data to the analytical method being used. [1:5.5.3.1.2]

**5.5.3.2 Data Requirements.**

A complete listing of input data requirements for all models, engineering methods, and other calculation or verification methods required or proposed as part of the performance-based design shall be provided. [1:5.5.3.2]

**5.5.3.3 Uncertainty and Conservatism of Data.**

Uncertainty in input data shall be analyzed and, as determined appropriate by the AHJ, addressed through the use of conservative values. [1:5.5.3.3]

**5.5.4 Output Data.**

The assessment methods used shall accurately and appropriately produce the required output data from input data based on the design specifications, assumptions, and scenarios. [1:5.5.4]

**5.5.5 Validity.**

Evidence shall be provided confirming that the assessment methods are valid and appropriate for the proposed facility, use, and conditions. [1:5.5.5]

**5.6\* Safety Factors.**

Approved safety factors shall be included in the design methods and calculations to reflect uncertainty in the assumptions, data, and other factors associated with the performance-based design. [1:5.6]

**5.7 Documentation Requirements.**

**5.7.1\* General.**

**5.7.1.1**

All aspects of the design, including those described in 5.7.2 through 5.7.14, shall be documented. [1:5.7.1.1]

**5.7.1.2**

The format and content of the documentation shall be acceptable to the AHJ. [1:5.7.1.2]

**5.7.2\* Technical References and Resources.**

**5.7.2.1**

The AHJ shall be provided with sufficient documentation to support the validity, accuracy, relevance, and precision of the proposed methods. [1:5.7.2.1]

**5.7.2.2**

The engineering standards, calculation methods, and other forms of scientific information provided shall be appropriate for the particular application and methodologies used. [1:5.7.2.2]

**5.7.3 Facility Design Specifications.**

All details of the proposed facility design that affect the ability of the facility to meet the stated goals and objectives shall be documented. [1:5.7.3]

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**5.7.4 Performance Criteria.**

Performance criteria, with sources, shall be documented. [1:5.7.4]

**5.7.5 Occupant Characteristics.**

Assumptions about occupant characteristics shall be documented. [1:5.7.5]

**5.7.6 Design Scenarios.**

Descriptions of design hazard scenarios shall be documented. [1:5.7.6]

**5.7.7 Input Data.**

Input data to models and assessment methods, including sensitivity analysis, shall be documented. [1:5.7.7]

**5.7.8 Output Data.**

Output data from models and assessment methods, including sensitivity analysis, shall be documented. [1:5.7.8]

**5.7.9 Safety Factors.**

Safety factors utilized shall be documented. [1:5.7.9]

**5.7.10 Prescriptive Requirements.**

Retained prescriptive requirements shall be documented. [1:5.7.10]

**5.7.11\* Modeling Features.**

**5.7.11.1**

Assumptions made by the model user, and descriptions of models and methods used, including known limitations, shall be documented. [1:5.7.11.1]

**5.7.11.2**

Documentation shall be provided that the assessment methods have been used validly and appropriately to address the design specifications, assumptions, and scenarios. [1:5.7.11.2]

**5.7.12 Evidence of Modeler Capability.**

The design team's relevant experience with the models, test methods, databases, and other assessment methods used in the performance-based design proposal shall be documented. [1:5.7.12]

**5.7.13 Performance Evaluation.**

The performance evaluation summary shall be documented. [1:5.7.13]

**5.7.14 Use of Performance-Based Design Option.**

Design proposals shall include documentation that provides anyone involved in ownership or management of the facility with all of the following notification:

- (1) The facility was approved as a performance-based design with certain specified design criteria and assumptions.
- (2) Any remodeling, modification, renovation, change in use, or change in the established assumptions requires a re-evaluation and reapproval.

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[1:5.7.14]

### A.4.2.1

These highest level goals are intentionally general in nature. Each includes a broad spectrum of topics as shown in 4.2.3. The property protection goal is not just a goal unto itself, as it is also achieved in part as a result of designing to achieve the other stated goals. A reasonable level of safety is further defined by subsequent language in the Code. The facility/property owner or an insurance representative might also have other goals, which might necessitate more stringent objectives as well as more demanding criteria. [1:A.4.1.1]

### A.4.2.2

The objectives apply regardless of which option a user of the Code selects for a design — the performance-based option or the prescriptive-based option. The objectives are stated in more specific terms than the goals and tend to be more quantitative. The goals and objectives, taken together, form the broad, general targets at which a performance-based design can take aim. Specific criteria for design follow in Chapter 5. [1:A.4.1.2]

### A.4.2.3

The concept of providing for safety applies not only to safety during a fire, explosion, or hazardous materials incident, but also during the normal use of a building or facility. A reasonable level of safety should be provided for occupants in and individuals near the facility or building in question. The resultant design in addition to providing for occupant's safety also promotes the public welfare. Public welfare is also provided as a result of the mission continuity provisions of this Code. [1:A.4.1.3]

#### A.4.2.3.1.1

The phrase *reasonably safe* from fire is defined by subsequent language in this Code, primarily in the objectives. [1:A.4.1.3.1.1]

#### A.4.2.3.1.2.2

In many cases, the provisions of the Code to provide safety for occupants satisfies this goal for protection of emergency responders. [1:A.4.1.3.1.2.2]

#### A.4.2.3.1.2.5

This provision addresses the fire safety objectives of operations addressed elsewhere in the Code, such as hot work, tar kettle operation, and so forth, that are not directly related to building construction and use. [1:A.4.1.3.1.2.5]

#### A.4.2.3.2.1

The phrase *reasonably safe during normal use* is defined by subsequent language in this Code, primarily in the objectives. Certain requirements, such as heights of guards and stair dimensions, are provided to ensure that the occupants are safe during nonemergency use of the buildings. Failure to address these features could result in falls or other injuries to occupants in their normal day-to-day activities in the building. [1:A.4.1.3.2.1]

#### A.4.2.3.3.2.2

For item 3, the phrase *external force* refers to the application of factors such as heat, water, shock, or other phenomenon onto hazardous materials that are sensitive to such factors and could react vigorously to produce unsafe conditions. [1:A.4.1.3.3.2.2]

#### A.4.2.4.2.1

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Ignition occurs when combustible materials come into contact with a source of heat of sufficient temperature and power for a requisite time in an atmosphere where oxygen is present. Combustible material does not necessarily ignite immediately upon contact with a source of heat. [1:A.4.1.4.2.1]

#### A.4.2.4.2.2

Examples of specific conditions to avoid include, but are not limited to, flashover, fire spread beyond the item or room of fire origin, overheating of equipment, and overpressure of exterior walls. [1:A.4.1.4.2.2]

#### A.4.2.5.1

This goal is applicable to certain buildings and facilities that have been deemed to be necessary to the continued welfare of a community. Depending on the nature of the critical mission provided by the building, various stakeholders, including community leaders, AHJs, and owners will identify the mission critical buildings. Mission critical areas should be identified and appropriately protected. The objectives for property protection and mission continuity are sometimes difficult to differentiate. Achieving the objectives for property protection could, to a certain extent, accomplish the objectives for mission continuity. [1:A.4.1.5.1]

#### A.4.2.5.2

Examples of buildings and facilities that provide a public welfare role for a community could include hospitals, police and fire stations, evacuation centers, schools, water and sewerage facilities, and electrical generating plants. Also included are buildings and facilities with significant impact on the economic viability of the community. This objective is intended to ensure that such buildings and facilities are capable of providing essential services following a disaster since the community's well-being depends on such service being available. [1:A.4.1.5.2]

#### A.4.3.1

Additional assumptions that need to be identified for a performance-based design are addressed in Chapter 5. [1:A.4.2.1]

#### A.4.3.2

It is not assumed that a design scenario will be considered that simulates the hazards produced when unauthorized releases of hazardous materials occur simultaneously at different locations within a facility, unless it is reasonable to expect that a single incident, such as a fork lift accident or pipe failure, could be expected to create such a condition. However, when hazardous materials are in close proximity to one another, such as on a shelf or in adjacent storage cabinets, it could be reasonable to apply a design scenario where multiple releases of the hazardous materials occur simultaneously from these close proximity areas. In this case, it is not unreasonable to expect the shelf to collapse or a forklift to damage adjacent hazardous materials containers. [1:A.4.2.2]

#### A.4.3.3

It is not assumed that a design scenario will be considered that simulates the hazards produced when a fire, explosion, or external force that creates a dangerous condition occurs at the same time that hazardous materials have been subject to an unauthorized release. This does not preclude considering a scenario where a fire or explosion occurs and impinges on hazardous materials that are in their normal storage, use, or handling conditions. [1:A.4.2.3]

The phrase *external force that creates a dangerous condition* refers to the application of factors such as heat, water, shock, or other phenomenon onto hazardous materials that are sensitive to such factors and could react vigorously to produce unsafe conditions. [1:A.4.2.3]

#### A.5.1

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The performance option of this *Code* establishes acceptable levels of risk for facilities (i.e., buildings and other structures and the operations therewith associated) as addressed in Section 1.3. (Note that “facility” and “building” can be used interchangeably with facility being the more general term.) While the performance option of this *Code* does contain goals, objectives, and performance criteria necessary to provide for an acceptable level of risk, it does not describe how to meet these goals, objectives, and performance criteria. Design and engineering are needed to meet the provisions of Chapter 5. For fire protection designs, the *SFPE Engineering Guide to Performance-Based Fire Protection* provides a framework for these assessments. [1:A.5.1]

Pre-construction design requirements address those issues, which have to be considered before the certificate of occupancy is issued for a facility. [1:A.5.1]

#### **A.5.1.3**

Qualifications should include experience, education, and credentials that demonstrate knowledgeable and responsible use of applicable models and methods. [1:A.5.1.3]

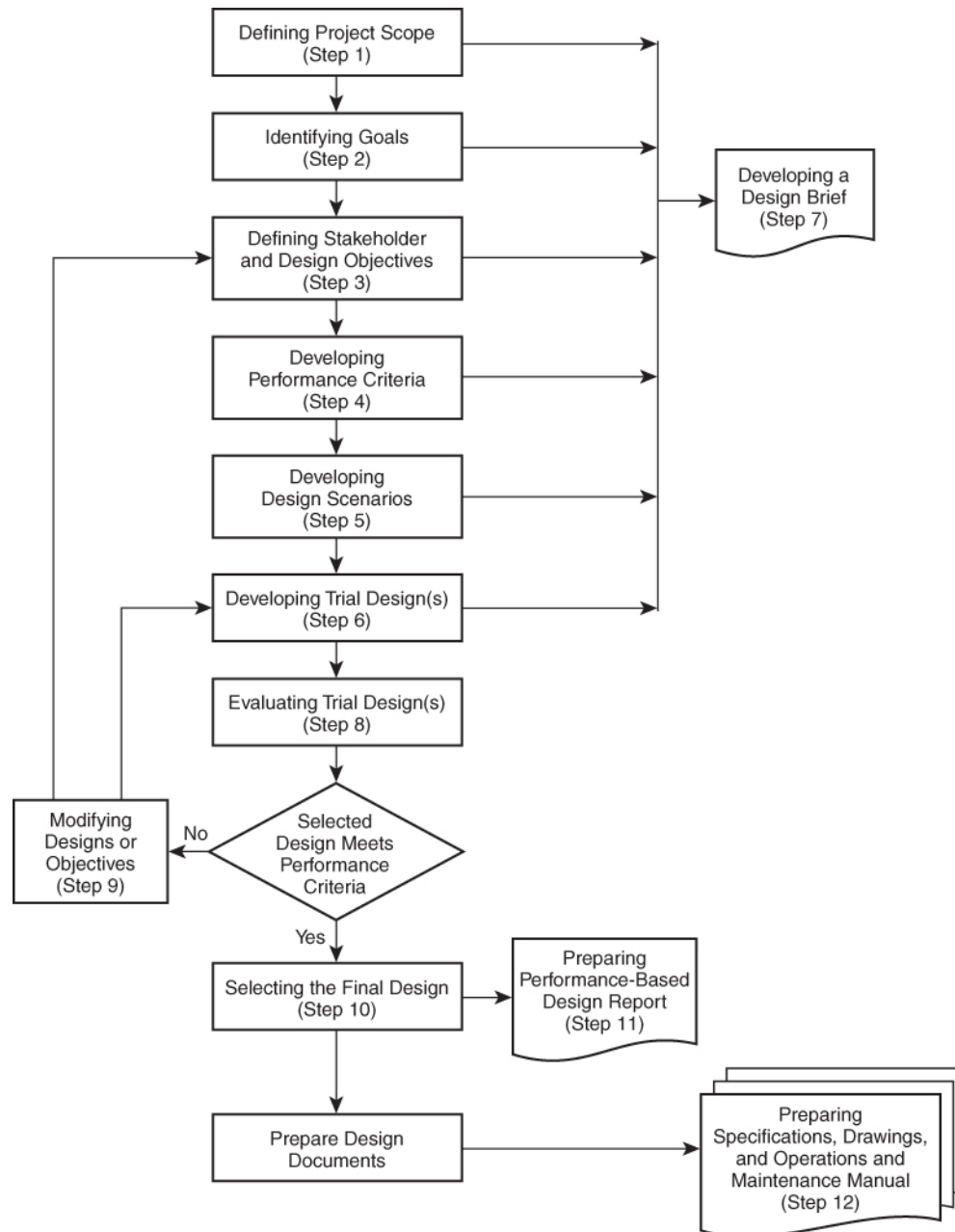
#### **A.5.1.4**

The *SFPE Engineering Guide to Performance-Based Fire Protection* outlines a process for using a performance-based approach in the design and assessment of building fire safety design and identifies parameters that should be considered in the analysis of a performance-based design. As can be seen this process requires the involvement of all stakeholders who have a share or interest in the successful completion of the project. The steps that are recommended by the *SFPE Engineering Guide to Performance-Based Fire Protection* for this process are shown in Figure A.5.1.4. [1:A.5.1.4]

The guide specifically addresses building fire safety performance-based design. It might not be directly applicable to performance-based designs involving other systems and operations covered within this *Code*, such as hot work operations or hazardous materials storage. However, the various steps for defining, developing, evaluating, and documenting the performance-based design should still provide a useful framework for the overall design process. [1:A.5.1.4]

**Figure A.5.1.4 Steps in the Performance-Based Analysis and the Conceptual Design Procedure for Fire Protection Design. [1:Figure A.5.1.4]**

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The steps in the performance-based design process are as follows:

- (1) *Step 1: Defining Project Scope.* The first step in a performance-based design is to define the scope of the project. Defining the scope consists of identifying and documenting the following:
  - (a) Constraints on the design and project schedule

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- (b) The stakeholders associated with project
- (c) The proposed building construction and features desired by the owner or tenant
- (d) Occupant and building characteristics
- (e) The intended use and occupancy of the building
- (f) Applicable codes and regulations

An understanding of these items is needed to ensure that a performance-based design meets the stakeholders' needs.

- (2) *Step 2: Identifying Goals.* Once the scope of the project is defined, the next step in the performance-based design process is to identify and document the fire safety goals of various stakeholders. Fire safety goals could include levels of protection for people and property, or they could provide for continuity of operations, historical preservation, and environmental protection. Goals could be unique for different projects, based on the stakeholders needs and desires. The stakeholders should discuss which goals are the most important for the project. In order to avoid problems later in the design process, all stakeholders should be aware of and agree to the goals prior to proceeding with the performance-based design process (see Step 7).
- (3) *Step 3: Defining Stakeholder and Design Objectives.* The third step in the design process is to develop objectives. The objectives are essentially the design goals that are further refined into tangible values that can be quantified in engineering terms. Objectives could include mitigating the consequences of a fire expressed in terms of dollar values, loss of life, or other impact on property operations, or maximum allowable conditions, such as extent of fire spread, temperature, spread of combustion products, and so forth.
- (4) *Step 4: Developing Performance Criteria.* The fourth step in the design process is the development of performance criteria to be met by the design. These criteria are a further refinement of the design objectives and are numerical values to which the expected performance of the trial designs can be compared. Performance criteria could include threshold values for temperatures of materials, gas temperatures, carboxyhemoglobin (COHb) levels, smoke obscuration, and thermal exposure levels.
- (5) *Step 5: Developing Design Scenarios.* Once the performance criteria have been established, the engineer will develop and analyze design alternatives to meet performance criteria. The first part of this process is the identification of possible scenarios and design scenarios. Fire scenarios are descriptions of possible fire events, and consist of fire characteristics, building characteristics (including facility operations), and occupant characteristics. The fire scenarios identified will subsequently be filtered (i.e., combined or eliminated) into a subset of design fire scenarios against which trial designs will be evaluated. Hazardous materials scenarios can be treated similarly.
- (6) *Step 6: Developing Trial Design(s).* Once the project scope, performance criteria, and design scenarios are established, the engineer develops preliminary designs, referred to as trial designs, intended to meet the project requirements. The trial design(s) include proposed fire protection systems, construction features, and operation that are provided in order for a design to meet the performance criteria when evaluated using the design fire scenarios. The evaluation method should also be determined at this point. The evaluation methods used should be appropriate for the situation and agreeable to the stakeholders.
- (7) *Step 7: Developing a Fire Protection Engineering Design Brief.* At this point in the process a fire protection engineering design brief should be prepared and provided to all stakeholders for their review and concurrence. This brief should document the project scope, goals, objectives, trial designs, performance criteria, design fire scenarios, and analysis methods. Documenting and agreeing upon these factors at this point in the design process will help avoid possible misunderstandings later.

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- (8) *Step 8: Evaluating Trial Designs.* Each trial design is then evaluated using each design scenario. The evaluation results will indicate whether the trial design will meet the performance criteria. Only trial design(s) that meet the performance criteria can be considered as final design proposals. Yet, the performance criteria can be revised with the stakeholders' approval. The criteria cannot be arbitrarily changed to ensure that a trial design meets a criterion, but can be changed based on additional analysis and the consideration of additional data.
- (9) *Step 9: Modifying Designs or Objectives.* If none of the trial designs evaluated comply with the previously agreed upon performance criteria, it could be necessary to either develop and evaluate new trial designs, or revisit the objectives and performance criteria previously agreed upon by the stakeholders to determine if stakeholder objectives and performance criteria should be modified.
- (10) *Step 10: Selecting the Final Design.* Once an acceptable trial design is identified using the evaluation, it can be considered for the final project design. If multiple trial designs are evaluated, further analysis will be needed to select a final design. The selection of an acceptable trial design for the final design could be based on a variety of factors, such as financial considerations, timeliness of installation, system and material availability, ease of installation, maintenance and use, and other factors.
- (11) *Step 11: Preparing Performance-Based Design Report.* Once the final design is identified, design documents need to be prepared. Proper documentation will ensure that all stakeholders understand what is necessary for the design implementation, maintenance, and continuity of the fire protection design. The documentation should include the fire protection engineering design brief, a performance design report, detailed specifications and drawings, and a facility operations and maintenance manual.
- (12) *Step 12: Preparing Specifications, Drawings, and Operations and Maintenance Manual.* The specifications and drawings portion of the performance-based design report convey to building and system designers and installing contractors how to implement the performance design. Specifications and drawings could include required sprinkler densities, hydraulic characteristics and spacing requirements, the fire detection and alarm system components and programming, special construction requirements including means of egress and location of fire-resistive walls, compartmentation, and the coordination of interactive systems. The detailed specifications are the implementation document of the performance-based design report. The detailed drawings will graphically represent the results of the performance design. The Operations and Maintenance (O&M) Manual clearly states the requirement of the facility operator to ensure that the components of the performance design are in place and operating properly. The O&M Manual describes the commissioning requirements and the interaction of the different systems' interfaces. All subsystems are identified, and inspection and testing regimes and schedules are created.

### [1:A.5.1.4]

The O&M Manual also gives instruction to the facility operator on restrictions placed on facility operations. These limitations are based on the engineering assumptions made during the design and analysis. These limiting factors could include critical fire load, sprinkler design requirements, building use and occupancy, and reliability and maintenance of systems. The O&M Manual can be used to communicate to tenants and occupants these limits and their responsibilities as a tenant. It could also be used as a guide for renovations and changes. It also can be used to document agreements between stakeholders. [1:A.5.1.4]

### A.5.1.5

A third-party reviewer is a person or group of persons chosen by the AHJ to review proposed performance-based designs. Qualifications of the third-party reviewer should include experience, education, and credentials that demonstrate knowledgeable and responsible use of applicable models and methods. The *SFPE Guide for Peer Review in the Fire Protection Design Process* provides a method for the initiation, scope, conduct, and report of a peer review for a fire protection engineering design. [1:A.5.1.5]

### A.5.1.8

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See Step 12 of A.5.1.4 for a description of these documents. [1:A.5.1.8]

**A.5.1.9**

Information that could be needed by the fire service arriving at the scene of a fire in a performance-based designed facility includes, but is not limited to, the following:

- (1) Safe shutdown procedures of equipment and processes
- (2) Facility personnel responsible for assisting the fire service
- (3) Operating procedures required to maintain the effectiveness of the performance-based designed fire protection system: when it is and is not appropriate to alter, shut down, or turn off a design feature; assumptions that have to be maintained if a fire occurs; suggested fire-fighting tactics that relate to the specific nature of the performance-based design

[1:A.5.1.9]

The design specifications and O&M Manual documentation described in 5.1.8 should provide a guide for the facility owner and tenants to follow in order to maintain the required level of safety anticipated by the original design. It should also provide a guide for the AHJ to use in conducting ongoing inspections of the facility. [1:A.5.1.9]

**A.5.1.10**

Continued compliance with the goals and objectives of the *Code* involves many factors. The building construction, including openings, interior finish, and fire- and smoke-resistive construction, and the building and fire protection systems need to retain at least the same level of performance as is provided for by the original design parameters. The use and occupancy should not change to the degree that assumptions made about the occupant characteristics, combustibility of furnishings, and existence of trained personnel are no longer valid. In addition, actions provided by other personnel, such as emergency responders, should not be diminished below the documented assumed levels. Also, actions needed to maintain reliability of systems at the anticipated level need to meet the initial design criteria. [1:A.5.1.10]

Subsection 5.1.10 deals with issues that arise after the facility has been constructed and a certificate of occupancy has been issued. Therefore, any changes to the facility, or the operations conducted therein, up to and including the demolition of the facility, that affect the assumptions of the original design are considered as part of the management of change. [1:A.5.1.10]

The following is a process for evaluating performance-based facilities:

- (1) Review of original design analysis and documentation as follows:
  - (a) Assumptions
  - (b) Input parameter values
  - (c) Predictions and/or results of other calculations
- (2) Review of design analysis and documentation for any subsequent renovations, additions, modifications, and so forth, as in Step 1 of A.5.1.4
- (3) Review of the facility's operations and maintenance manual, including any and all revisions to it
- (4) On-site inspection, involving the following:
  - (a) Consideration of "prescriptive" issues (e.g., blocked egress paths, poor maintenance of systems)

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- (b) Comparison of assumptions to specific, pertinent on-site conditions
  - (c) Comparison of input parameter values to pertinent on-site conditions
  - (d) Review of maintenance and testing documentation to ensure adherence to the schedules detailed in the facility's O&M Manual
- (5) Reconciliation of discrepancies as follows:
- (a) Develop a list of discrepancies
  - (b) Consultation with the facility owner and/or their representative
  - (c) Preparation of a schedule that reconciles the discrepancies

[1:A.5.1.10]

### A.5.1.11

Private fire inspection services can be used to meet this provision provided that they are qualified to assess the impact of changes on the performance-based design and assumptions. [1:A.5.1.11]

### A.5.2.2

The performance criteria in 5.2.2 define an acceptable level of performance that should be agreed upon by the stakeholders, including the owner and the AHJ. The acceptable level of performance can vary widely between different facilities based on a number of factors, including the existence of potential ignition sources, potential fuel loads present, reactivity and quantity of hazardous materials present, the nature of the operations conducted at the facility, and the characteristics and number of personnel likely to be present at the facility. [1:A.5.2.2]

#### A.5.2.2.1

Many of the performance criteria related to safety from fire can also be found in the annex of NFPA 101. [1:A.5.2.2.1]

#### A.5.2.2.2

It is anticipated that the design provides protection for occupants who are not intimate with the initial unintentional detonation or deflagration of explosive materials, and individuals immediately adjacent to the property. It is recognized that employees should be trained and knowledgeable in the hazards of the materials present in the workplace. It is recognized that some of these individuals could experience psychological and physical injuries, such as hearing problems, on either a short- or long-term basis. However, the intent is that they do not experience thermal burns or loss of life or limb as a direct result of the explosion. [1:A.5.2.2.2]

It is not the intent of the *Code* to provide protection against explosions caused by acts of terrorism. This would involve the introduction of an unknown quantity of explosives in an unknown location within or adjacent to a building. Where protection is needed against such acts of terrorism, the appropriate military and law enforcement agencies should be consulted. [1:A.5.2.2.2]

#### A.5.2.2.3

Given the nature and variety of hazardous materials, more than one performance criterion for a specific facility could need to be developed. Criteria have to be developed for each hazardous material and possibly for different personnel; for example, higher levels of exposure can be tolerated by personnel that are in some way protected than those personnel having no protection. Development of performance criteria for hazardous materials should be developed by the facility owner and the facility's safety personnel in conjunction with the AHJ and the emergency response personnel expected to respond to an incident. [1:A.5.2.2.3]

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It is anticipated that the design provides protection for occupants inside or immediately adjacent to the facility who are not intimate with the initial unauthorized release of hazardous materials, or the initial unintentional reaction of hazardous materials. However, it is assumed that these individuals depart from the area of the incident in a time frame reasonable for their circumstances, based on their observation of the event, or some other form of notification. [1:A.5.2.2.3]

It is also anticipated that employees and emergency response personnel are trained and aware of the hazardous materials present in the facility, and the potential consequences of their involvement in the incident, and take appropriate measures to ensure their own safety during search and rescue operations. [1:A.5.2.2.3]

It is not the intent of the *Code* to provide protection against acts of terrorism involving the introduction of hazardous materials into a facility. This involves the introduction of an unknown quantity of materials in an unknown location within or adjacent to a building. Where protection is needed against such acts of terrorism, the appropriate military and law enforcement agencies should be consulted. [1:A.5.2.2.3]

#### A.5.2.2.4

Each facility designed using a performance-based approach most likely has different levels of acceptable and unacceptable property damage. This reflects the unique aspects of the performance-based designed facility and the reasons for pursuing a performance-based design. Therefore, the definition of an acceptable and an unacceptable level of property damage results from discussions between the facility's owner, manager and engineer, the designer, (possibly) the insurance underwriter and field engineer, and the AHJ. There could be cases where a property damage criterion is not needed. [1:A.5.2.2.4]

Note that the structural integrity performance criteria for property damage most likely differs from the structural integrity performance criteria for life safety. This reflects the difference in the associated objectives: a life safety criterion probably is more restrictive than one for property damage. [1:A.5.2.2.4]

#### A.5.2.2.5

Each facility designed using a performance-based approach most likely has a different level of acceptable and unacceptable interruption of the facility's mission. This reflects the unique aspects of the performance-based designed facility and the reasons for pursuing a performance-based design. Therefore, the definition of an acceptable and an unacceptable interruption of the facility's mission results from discussions between the facility's owner, manager and engineer, the designer, (possibly) the insurance underwriter and field engineer, and the AHJ. There could be cases where a mission continuity criterion is not needed. [1:A.5.2.2.5]

#### A.5.2.2.8

Performance-based design of structural fire resistance requires three major steps:

- (1) Determination of the thermal exposure to a structure resulting from a fire
- (2) Determination of the temperature history within the structure, or portion thereof
- (3) Determination of the structural response

[1:A.5.2.2.8]

SFPE Standard S.01, *Calculating Fire Exposures to Structures*, provides methodologies to predict thermal boundary conditions for fully developed fires to a structure (Step 1). SFPE Standard S.02, *Calculation Methods to Predict the Thermal Performance of Structural and Fire Resistive Assemblies*, provides methodologies to predict the thermal response of structures (Step 2). Appendix E, *Performance-Based Design Procedures for Fire Effects on Structures*, of ASCE/SEI 7, *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*, provides methodologies to predict the structural response (Step 3). [1:A.5.2.2.8]

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### A.5.4

Many events can occur during the life of a facility; some have a higher probability of occurrence than others. Some events, though not typical, could have a devastating effect on the facility. A reasonable design should be able to achieve the goals, objectives, and performance criteria of this *Code* for any typical or common design scenario and for some of the non-typical, potentially devastating scenarios, up to some level commensurate with society's expectations as reflected in this *Code*. [1:A.5.4]

The challenge in selecting design scenarios is finding a manageable number that are sufficiently diverse and representative so that, if the design is reasonably safe for those scenarios, it should then be reasonably safe for all scenarios, except for those specifically excluded as being unrealistically severe or sufficiently infrequent to be fair tests of the design. [1:A.5.4]

#### A.5.4.1.2

The *SFPE Engineering Guide to Performance-Based Fire Protection* identifies methods for evaluating fire scenarios. [1:A.5.4.1.2]

#### A.5.4.1.3

It is desirable to consider a wide variety of different design scenarios to evaluate the complete capabilities of the building or structure. Design scenarios should not be limited to a single or a couple of worst-case events. [1:A.5.4.1.3]

#### A.5.4.4

Design hazardous materials scenarios should explicitly account for the following:

- (1) Occupant activities, training, and knowledge
- (2) Number and location of occupants
- (3) Discharge location and surroundings
- (4) Hazardous materials' properties
- (5) Ventilation, inerting, and dilution systems and conditions
- (6) Normal and emergency operating procedures
- (7) Safe shutdown and other hazard mitigating systems and procedures
- (8) Weather conditions affecting the hazard
- (9) Potential exposure to off-site personnel

[1:A.5.4.4]

Design hazardous materials scenarios should be evaluated as many times as necessary by varying the factors previously indicated. Design hazardous materials scenarios could need to be established for each different type of hazardous material stored or used at the facility. [1:A.5.4.4]

#### A.5.4.4.2

This provision should be applied to each protection system individually and requires two different types of information to be developed by analysis and approved by the AHJ. System reliability is to be analyzed and accepted. Design performance in the absence of the system is also to be analyzed and accepted, but acceptable

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performance does not require fully meeting the stated goals and objectives. It might not be possible to meet fully the goals and objectives if a key system is unavailable, and yet no system is totally reliable. The AHJ determines which level of performance, possibly short of stated goals and objectives, is acceptable, given the very low probability (that is, the systems' unreliability probability) that the system will be unavailable. [1:A.5.4.4.2]

### A.5.4.5.1

An example of such a scenario would involve a fire or earthquake effectively blocking the principal entrance/exit but not immediately endangering the occupants. The full occupant load of the assembly space has to exit using secondary means. [1:A.5.4.5.1]

### A.5.6

The assessment of precision required in 5.7.2 requires a sensitivity and uncertainty analysis, which can be translated into safety factors. [1:A.5.6]

*Sensitivity Analysis.* The first run a model user makes should be labeled as the base case, using the nominal values of the various input parameters. However, the model user should not rely on a single run as the basis for any performance-based fire safety system design. Ideally, each variable or parameter that the model user made to develop the nominal input data should have multiple runs associated with it, as should combinations of key variables and parameters. Thus, a sensitivity analysis should be conducted that provides the model user with data that indicates how the effects of a real fire could vary and how the response of the proposed fire safety design could also vary. [1:A.5.6]

The interpretation of a model's predictions can be a difficult exercise if the model user does not have knowledge of fire dynamics or human behavior. [1:A.5.6]

*Reasonableness Check.* The model user should first try to determine whether the predictions actually make sense, that is, they don't upset intuition or preconceived expectations. Most likely, if the results don't pass this test, an input error has been committed. [1:A.5.6]

Sometimes the predictions appear to be reasonable but are, in fact, incorrect. For example, a model can predict higher temperatures farther from the fire than close to it. The values themselves could be reasonable, for example, they are not hotter than the fire, but they don't "flow" down the energy as expected. [1:A.5.6]

A margin of safety can be developed using the results of the sensitivity analysis in conjunction with the performance criteria to provide the possible range of time during which a condition is estimated to occur. [1:A.5.6]

Safety factors and margin of safety are two concepts used to quantify the amount of uncertainty in engineering analyses. Safety factors are used to provide a margin of safety and represent, or address, the gap in knowledge between the theoretically perfect model, that is, reality and the engineering models that can only partially represent reality. [1:A.5.6]

Safety factors can be applied to either the predicted level of a physical condition or to the time at which the condition is predicted to occur. Thus, a physical or a temporal safety factor, or both, can be applied to any predicted condition. A predicted condition (that is, a parameter's value) and the time at which it occurs are best represented as distributions. Ideally, a computer fire model predicts the expected or nominal value of the distribution. Safety factors are intended to represent the spread of these distributions. [1:A.5.6]

Given the uncertainty associated with data acquisition and reduction, and the limitations of computer modeling, any condition predicted by a computer model can be thought of as an expected or nominal value within a broader range. For example, an upper layer temperature of 1110°F (600°C) is predicted at a given time. If the modeled scenario is then tested (that is, full-scale experiment based on the computer model's input data), the actual temperature at that given time could be 1185°F or 1085°F (640°C or 585°C). Therefore, the temperature should

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be reported as 1110°F + 75°F, -25°F (600°C + 40°C, -15°C) or as a range of 1085°F to 1184°F (585°C to 640°C). [1:A.5.6]

Ideally, predictions are reported as a nominal value, a percentage, or an absolute value. As an example, an upper layer temperature prediction could be reported as 1112°F (600°C), 86°F (30°C) or 1112°F (600°C), 5 percent. In this case, the physical safety factor is 0.05 (that is, the amount by which the nominal value should be degraded and enhanced). Given the state-of-the-art of computer fire modeling, this is a very low safety factor. Physical safety factors tend to be on the order of tens of percent. A safety factor of 50 percent is not unheard of. [1:A.5.6]

Part of the problem in establishing safety factors is that it is difficult to state the percentage or range that is appropriate. These values can be obtained when the computer model predictions are compared to test data. However, using computer fire models in a design mode does not facilitate this since (1) the room being analyzed has not been built yet and (2) test scenarios do not necessarily depict the intended design. [1:A.5.6]

A sensitivity analysis should be performed based on the assumptions that affect the condition of interest. A base case that uses all nominal values for input parameters should be developed. The input parameters should be varied over reasonable ranges, and the variation in predicted output should be noted. This output variation can then become the basis for physical safety factors. [1:A.5.6]

The temporal safety factor addresses the issue of when a condition is predicted and is a function of the rate at which processes are expected to occur. If a condition is predicted to occur 2 minutes after the start of the fire, then this can be used as a nominal value. A process similar to that described for physical safety factors can also be employed to develop temporal safety factors. In this case, however, the rates (for example, of heat release and toxic product generation) will be varied instead of absolute values (for example, material properties). [1:A.5.6]

The margin of safety can be thought of as a reflection of societal values and can be imposed by the AHJ for that purpose. Since the time for which a condition is predicted is most likely the focus of the AHJ (for example, the model predicts occupants have 5 minutes to safely evacuate), the margin of safety is characterized by temporal aspects and tacitly applied to the physical margin of safety. [1:A.5.6]

Escaping the harmful effects of fire (or mitigating them) is, effectively, a race against time. When assessing fire safety system designs based on computer model predictions, the choice of an acceptable time is important. When an AHJ is faced with the predicted time of untenability, a decision needs to be made regarding whether sufficient time is available to ensure the safety of facility occupants. The AHJ is assessing the margin of safety. Is there sufficient time to get everyone out safely? If the AHJ feels that the predicted egress time is too close to the time of untenability, then the AHJ can impose an additional time that the designer has to incorporate into the system design. In other words, the AHJ can impose a greater margin of safety than that originally proposed by the designer. [1:A.5.6]

The *SFPE Handbook of Fire Protection Engineering* has a discussion on the use of safety factors and the evaluation of uncertainty in a performance-based design. [1:A.5.6]

### A.5.7.1

The *SFPE Engineering Guide to Performance-Based Fire Protection* describes the documentation that should be provided for a performance-based design. [1:A.5.7.1]

Proper documentation of a performance design is critical to the design acceptance and construction. Proper documentation also ensures that all parties involved understand what is necessary for the design implementation, maintenance, and continuity of the fire protection design. If attention to details is maintained in the documentation, then there should be little dispute during approval, construction, start-up, and use. [1:A.5.7.1]

Poor documentation could result in rejection of an otherwise good design, poor implementation of the design, inadequate system maintenance and reliability, and an incomplete record for future changes or for testing the design forensically. [1:A.5.7.1]

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### A.5.7.2

The sources, methodologies, and data used in performance-based designs should be based on technical references that are widely accepted and used by the appropriate professions and professional groups. This acceptance is often based on documents that are developed, reviewed, and validated under one of the following processes:

- (1) Standards developed under an open consensus process conducted by recognized professional societies, codes or standards organizations, or governmental bodies
- (2) Technical references that are subject to a peer review process and published in widely recognized peer-reviewed journals, conference reports, or other publications
- (3) Resource publications such as the *SFPE Handbook of Fire Protection Engineering*, which are widely recognized technical sources of information

#### [1:A.5.7.2]

The following factors are helpful in determining the acceptability of the individual method or source:

- (1) Extent of general acceptance in the relevant professional community. Indications of this acceptance include peer-reviewed publication, widespread citation in the technical literature, and adoption by or within a consensus document.
- (2) Extent of documentation of the method, including the analytical method itself, assumptions, scope, limitations, data sources, and data reduction methods.
- (3) Extent of validation and analysis of uncertainties. This includes comparison of the overall method with experimental data to estimate error rates as well as analysis of the uncertainties of input data, uncertainties and limitations in the analytical method, and uncertainties in the associated performance criteria.
- (4) Extent to which the method is based on sound scientific principles.
- (5) Extent to which the proposed application is within the stated scope and limitations of the supporting information, including the range of applicability for which there is documented validation. Factors such as spatial dimensions, occupant characteristics, and ambient conditions can limit valid applications.

#### [1:A.5.7.2]

In many cases, a method is built from and includes numerous component analyses. These component analyses should be evaluated using the same factors that are applied to the overall method as outlined in items (1) through (5). [1:A.5.7.2]

A method to address a specific fire safety issue, within documented limitations or validation regimes, might not exist. In such a case, sources and calculation methods can be used outside of their limitations, provided that the design team recognizes the limitations and addresses the resulting implications. [1:A.5.7.2]

The technical references and methodologies to be used in a performance-based design should be closely evaluated by the design team and the AHJ, and possibly by a third-party reviewer. The strength of the technical justification should be judged using criteria in items (1) through (5). This justification can be strengthened by the presence of data obtained from fire testing. [1:A.5.7.2]

### A.5.7.11

Documentation for modeling should conform to ASTM E1472, *Standard Guide for Documenting Computer Software for Fire Models*, and the *SFPE Guide for Substantiating a Fire Model for a Given Application*. [1:A.5.7.11]

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### **B.1.2 Referenced Standards.**

#### **B.1.2.1**

Details regarding processes, methods, specifications, equipment testing and maintenance, design standards, performance, installation, or other pertinent criteria contained in those codes and standards listed in Chapter 2 of this *Code* shall be considered a part of this *Code*. [1:1.3.2.1]

#### **B.1.2.3**

Nothing herein shall diminish the authority of the AHJ to determine compliance with codes or standards for those activities or installations within the AHJ's responsibility. [1:1.3.2.3]

### **B.1.3 Conflicts.**

#### **B.1.3.1**

When a requirement differs between this *Code* and a referenced document, the requirement of this *Code* shall apply. [1:1.3.3.1]

#### **B.1.3.2**

When a conflict between a general requirement and a specific requirement occurs, the specific requirement shall apply. [1:1.3.3.2]

### **B.1.4 Installations.**

#### **B.1.4.1**

Buildings permitted for construction after the adoption of this *Code* shall comply with the provisions stated herein for new buildings. [1:1.3.6.1]

#### **B.1.4.2**

Buildings in existence or permitted for construction prior to the adoption of this *Code* shall comply with the provisions stated herein or referenced for existing buildings. (see 10.3.2 of NFPA 1). [1:1.3.6.2]

#### **B.1.4.4**

Newly introduced equipment, materials, and operations regulated by this *Code* shall comply with the requirements for new construction or processes. [1:1.3.6.4]

#### **B.1.4.5 Severability.**

If any provision of this *Code* or the application thereof to any person or circumstance is held invalid, the remainder of the *Code* and the application of such provision to other persons or circumstances shall not be affected thereby. [1:1.3.7]

### **B.2 Equivalencies, Alternatives, and Modifications.**

#### **B.2.1 Equivalencies.**

Nothing in this *Code* is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety to those prescribed by this *Code*, provided technical documentation is submitted to the AHJ to demonstrate equivalency and the system, method, or device is approved for the intended purpose. [1:1.4.1]

#### **B.2.2 Alternatives.**

The task group has decided to maintain the edits made by the technical committee to previously extracted text and delete the associated extract tags. This puts the previously extracted material under the control of this technical committee.

The specific requirements of this *Code* shall be permitted to be altered by the AHJ to allow alternative methods that will secure equivalent fire safety, but in no case shall the alternative afford less fire safety than, in the judgment of the AHJ, that which would be provided by compliance with the provisions contained in this *Code*. [1:1.4.2]

### **B.2.3 Modifications.**

The AHJ is authorized to modify any of the provisions of this *Code* upon application in writing by the owner, a lessee, or a duly authorized representative where there are practical difficulties in the way of carrying out the provisions of the *Code*, provided that, in the judgment of the AHJ, the intent of the *Code* shall be complied with, public safety secured, and substantial justice done. [1:1.4.3]

### **B.2.4**

Buildings with equivalency, alternatives, or modifications<sup>7</sup> approved by the AHJ shall be considered as conforming with this *Code*. [1:1.4.4]

### **B.2.7 Tests.**

#### **B.2.7.1**

Whenever evidence of compliance with the requirements of this *Code* is insufficient or evidence that any material or method of construction does not conform to the requirements of this *Code*, or to substantiate claims for alternative construction systems, materials, or methods of construction, the AHJ shall be permitted to require tests for proof of compliance to be made by an approved agency at the expense of the owner or his/her agent. [1:1.4.7.1]

#### **B.2.7.2**

Test methods shall be as specified by this *Code* for the material in question. If appropriate test methods are not specified in this *Code*, the AHJ is authorized to accept an applicable test procedure from another recognized source. [1:1.4.7.2]

#### **B.2.7.3**

Copies of the results of all such tests shall be retained in accordance with Section B.7. [1:1.4.7.3]

### **B.3 Units.**

#### **B.3.1 International System of Units.**

Metric units of measurement in this *Code* are in accordance with the modernized metric system known as the International System of Units (SI). [1:1.5.1]

#### **B.3.2 Primary and Equivalent Values.**

If a value for a measurement as given in this *Code* is followed by an equivalent value in other units, the first stated value shall be regarded as the requirement. A given equivalent value could be approximate. [1:1.5.2]

### **B.4 Enforcement.**

This *Code* shall be administered and enforced by the AHJ designated by the governing authority. (*See Annex C for sample wording for enabling legislation.*) [1:1.6]

### **B.5 Authority.**

#### **B.5.1 Administration.**

The task group has decided to maintain the edits made by the technical committee to previously extracted text and delete the associated extract tags. This puts the previously extracted material under the control of this technical committee.

The provisions of this *Code* shall apply without restriction, unless specifically exempted. [1:1.7.1]

**B.5.2 Minimum Qualifications to Enforce this Code.**

The AHJ shall establish minimum qualifications for all persons assigned the responsibility of enforcing this *Code*. [1:1.7.2]

**B.5.3 Interpretations.**

**B.5.3.1**

The AHJ is authorized to render interpretations of this *Code* and to make and enforce rules and supplemental regulations in order to carry out the application and intent of its provisions. [1:1.7.3.1]

**B.5.3.2**

Such interpretations, rules, and regulations shall be in conformance with the intent and purpose of this *Code* and shall be available to the public during normal business hours. [1:1.7.3.2]

**B.5.4 Enforcement Assistance.**

Police and other enforcement agencies shall have authority to render necessary assistance in the enforcement of this *Code* when requested to do so by the AHJ. [1:1.7.4]

**B.5.5 Delegation of Authority.**

The AHJ shall be permitted to delegate to other qualified individuals such powers as necessary for the administration and enforcement of this *Code*. [1:1.7.5]

**B.5.6 Inspection.**

**B.5.6.1**

The AHJ shall be authorized to inspect, at all reasonable times, any ~~hydrogen installation or operation~~ for dangerous or hazardous conditions or materials as set forth in this *Code*. ~~[1:1.7.7.1]~~

**B.5.6.2**

The AHJ shall have authority to order any person(s) to remove or remedy such dangerous or hazardous condition or material. Any person(s) failing to comply with such order shall be in violation of this *Code*. [1:1.7.8.1]

**B.5.6.3**

To the full extent permitted by law, any AHJ engaged in fire prevention and inspection work shall be authorized at all reasonable times to enter and examine any building, structure, marine vessel, vehicle, or premises for the purpose of making fire safety inspections ~~of hydrogen installations and/or~~ operations]. ~~[1:1.7.7.2]~~

**B.5.6.4**

Before entering, the AHJ shall obtain the consent of the occupant thereof or obtain a court warrant authorizing entry for the purpose of inspection except in those instances where an emergency exists. [1:1.7.7.3]

**B.5.6.6**

Persons authorized to enter and inspect buildings, structures, marine vessels, vehicles, and premises as herein set forth shall be identified by credentials issued by the governing authority. [1:1.7.7.5]

**B.5.7**

The task group has decided to maintain the edits made by the technical committee to previously extracted text and delete the associated extract tags. This puts the previously extracted material under the control of this technical committee.

Where conditions exist and are deemed hazardous to life or property by the AHJ, the AHJ shall have the authority to summarily abate such hazardous conditions that are in violation of this *Code*. [1:1.7.8.2]

**B.5.8 Interference with Enforcement.**

Persons shall not interfere or cause conditions that would interfere with an AHJ carrying out any duties or functions prescribed by this *Code*. [1:1.7.9]

**B.5.9 Impersonation.**

Persons shall not use a badge, uniform, or other credentials to impersonate the AHJ. [1:1.7.10]

**B.5.10 Investigation.**

**B.5.10.1 Authority.**

The AHJ shall have the authority to investigate the cause, origin, and circumstances of any fire, explosion, ~~for~~ uncontrolled release of hydrogen gas or liquid}. ~~[1:1.7.11.1]~~

**B.5.10.2 Evidence.**

The AHJ shall have the authority to take custody of all physical evidence relating to the origin and cause of ~~the a~~ fire, explosion, ~~for~~ uncontrolled release of hydrogen gas or liquid}. ~~[1:1.7.11.2]~~

**B.5.10.3 Limiting Access.**

The AHJ shall have the authority to limit access to emergencies or other similar situations. [1:1.7.11.3]

**B.5.11 Plans and Specifications.**

**B.5.11.1**

The AHJ shall have the authority to require plans and specifications to ensure compliance with applicable codes and standards. [1:1.7.12.1]

**B.5.11.2**

Plans shall be submitted to the AHJ prior to construction unless otherwise permitted by B.5.11.4. [1:1.7.12.2]

**B.5.11.4**

The AHJ is authorized to exempt detached one- and two-family dwellings and accessory structures from the submittal of plans and permit requirements in B.5.11.8. [1:1.7.12.4]

**B.5.11.5**

Plans shall be submitted to the AHJ prior to the change of occupancy of any existing building. [1:1.7.12.5]

**B.5.11.6**

Plans shall be submitted to the AHJ prior to the alteration of the means of egress or fire protection systems of any existing building. [1:1.7.12.6]

**B.5.11.7**

Plans shall be submitted to the AHJ for other conditions as deemed necessary by the AHJ to determine compliance with the applicable codes and standards. [1:1.7.12.7]

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### B.5.11.8

The AHJ shall be authorized to require permits for conditions listed in B.5.11.2, B.5.11.5, and B.5.11.6, unless otherwise permitted by [B.5.4.11.4](#)~~B.5.11.9~~. [1:1.7.12.8]

### ~~B.5.11.9~~

~~The AHJ is authorized to exempt detached one- and two-family dwellings and accessory structures from the permit requirement of B.5.11.8. [1:1.7.12.9]~~

### B.5.11.10

No construction work shall proceed until the AHJ has reviewed the plans for compliance with the applicable codes and standards and the applicable permits have been issued. [1:1.7.12.9~~10~~]

## B.5.12 Inspection of Construction and Installation.

### B.5.12.1

The AHJ shall be notified by the person performing the work when the installation is ready for a required inspection. [1:1.7.13.1]

### B.5.12.2

Whenever any installation subject to inspection prior to use is covered or concealed without having first been inspected, the AHJ shall have the authority to require that such work be exposed for inspection. [1:1.7.13.2]

### B.5.12.3

When any construction or installation work is being performed in violation of the plans and specifications as approved by the AHJ, a written notice shall be issued to the responsible party to stop work on that portion of the work that is in violation. [1:1.7.13.3]

### B.5.12.4

The notice shall state the nature of the violation, and no work shall be continued on that portion until the violation has been corrected. [1:1.7.13.4]

## B.5.14 Stop Work Order.

The AHJ shall have the authority to order an operation, construction, or use stopped when any of the following conditions exists:

- (1) Work is being done contrary to provision of this *Code*.
- (2) Work is occurring without a permit required by B.8.
- (3) An imminent danger has been created.

[1:1.7.15]

## B.5.15 Imminent Dangers and Evacuation.

### B.5.15.1

When, in the opinion of the AHJ, an imminent danger exists, the AHJ shall be authorized to order the occupants to vacate, or temporarily close for use or occupancy, a building, the right-of-way, sidewalks, streets, or adjacent buildings or nearby areas. [1:1.7.16.1]

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### B.5.15.2

~~When~~Where, in the opinion of the AHJ, an imminent danger exists, the AHJ shall be authorized to order the immediate disconnection or reconnection of utilities to a structure or property. [1:1.7.16.2]

### B.5.15.3

The AHJ shall be authorized to employ the necessary resources to perform the required work in order to mitigate the imminent danger. [1:1.7.16.3]

### B.5.15.4

Costs incurred by the AHJ in the performance of emergency work shall be the responsibility of the property owner or other responsible party creating such imminent danger. [1:1.7.16.4]

## B.6 Fire Code Board of Appeals.

### B.6.1 Establishment of Fire Code Board of Appeals.

A Board of Appeals shall be established to rule on matters relating to the fire code and its enforcement. [1:1.11.1~~10.1~~]

#### B.6.1.1 Membership.

##### B.6.1.1.1

The members of the Board of Appeals shall be appointed by the governing body of the jurisdiction. [1:1.11~~10~~.1.1.1]

##### B.6.1.1.2

The Board of Appeals shall consist of five or seven principal members and one ex officio member representative of the AHJ. Each principal member shall be permitted to have an alternate with similar experience to serve in his or her stead when necessary. [1:1.11~~10~~.1.1.2]

##### B.6.1.1.3

Members and alternate members shall be appointed based on their education, experience, and knowledge. [1:1.~~10~~11.1.1.3]

##### B.6.1.1.4

Members and alternates shall be appointed to a 3-year term. [1:1.10.1.1.4]

##### B.6.1.1.5

Members and alternates shall be composed of individuals experienced in the following fields or professions:

- (1) Engineering or architectural design
- (2) General contracting
- (3) Fire protection contracting
- (4) Fire department operations or fire code enforcement
- (5) Building code enforcement

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(6) Legal

(7) General public

[1:1.11+0.1.1.5]

#### **B.6.1.1.5.1**

Members and alternates shall not be employees, agents, or officers of the jurisdiction. [1:1.11+0.1.1.5.1]

#### **B.6.1.1.5.2**

Members and alternates shall be residents of the jurisdiction. [1:1.11+0.1.1.5.2]

#### **B.6.1.1.5.3**

No more than one member shall represent the same field or provision listed in B.6.1.1.5. [1:1.11+0.1.1.5.3]

#### **B.6.1.1.6**

The representative of the AHJ shall be an ex officio member and shall be entitled to participate in all discussions. The ex officio member shall not be entitled to a vote. [1:1.11+0.1.1.6]

#### **B.6.1.1.7**

No member of the Board of Appeals shall sit in judgment on any case in which the member holds a direct or indirect property or financial interest in the case. [1:1.11+0.1.1.7]

#### **B.6.1.1.8**

The board shall select one of its members to serve as chair and one member to serve as vice chair.

[1:1.11+0.1.1.8]

### **B.6.2 Rules and Procedures of the Board of Appeals.**

The Board of Appeals shall have the authority to establish rules and regulations for conducting its business that are consistent with the provisions of this *Code*. [1:1.11+0.2]

### **B.6.3 Authority of the Board of Appeals.**

#### **B.6.3.1**

The Board of Appeals shall provide for the reasonable interpretation of the provisions of this *Code* and issue rulings on appeals of the decisions of the AHJ. [1:1.11+0.3.1]

#### **B.6.3.2**

The ruling of the Board of Appeals shall be consistent with the letter of the *Code* or when involving issues of clarity, ensuring that the intent of the *Code* is met with due consideration for public safety and fire fighter safety.

[1:1.+011.3.2]

#### **B.6.3.3**

The Board of Appeals shall have the authority to grant alternatives or modifications through procedures outlined in Section B.2 of the *Code*. [1:1.+011.3.3]

#### **B.6.3.4**

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The Board of Appeals shall not have the authority to waive the requirements of the *Code*. [1:1.~~10~~11.3.4]

### B.6.3.5

The Board of Appeals decisions shall not be precedent setting. [1:1.~~10~~11.3.5]

### B.6.4 Means of Appeals.

#### B.6.4.1

Any person with standing shall be permitted to appeal a decision of the AHJ to the Board of Appeals when it is claimed that any one or more of the following conditions exist:

- (1) The true intent of the *Code* has been incorrectly interpreted.
- (2) The provisions of the *Code* do not fully apply.
- (3) A decision is unreasonable or arbitrary as it applies to alternatives or new materials.

[1:1.~~10~~11.4.1]

#### B.6.4.2

An appeal shall be submitted to the AHJ in writing within 30 calendar days of notification of violation. The appeal shall outline all of the following:

- (1) The *Code* provision(s) from which relief is sought
- (2) A statement indicating which provisions of B.6.4.1 apply
- (3) Justification as to the applicability of the provision(s) cited in B.6.4.1
- (4) A requested remedy
- (5) Justification for the requested remedy stating specifically how the *Code* is complied with, public safety is secured, and fire fighter safety is secured

[1:1.~~10~~11.4.2]

#### B.6.4.3

Documentation supporting an appeal shall be submitted to the AHJ at least 7 calendar days prior to the Board of Appeals hearing. [1:1.~~10~~11.4.3]

##### B.6.4.3.1

No additional information should be submitted to review by the Board of Appeals without the information submitted to the AHJ for their review prior to the hearing date. Additional information submitted after the filing of the appeal to the Board and AHJ should be made available to the Board and AHJ in a time frame that permits adequate review before the hearing date. [1:A.1.~~10~~11.4.3]

### B.6.5 Meetings and Records.

#### B.6.5.1

The task group has decided to maintain the edits made by the technical committee to previously extracted text and delete the associated extract tags. This puts the previously extracted material under the control of this technical committee.

Meetings of the Board of Appeals shall be held at the call of the chair, at such other times as the board determines, and within 30 calendar days of the filing of a notice of appeal. [1:1.1011.5.1]

**B.6.5.2**

All hearings before the Board of Appeals shall be open to the public. [1:1.1011.5.2]

**B.6.5.3**

The Board of Appeals shall keep minutes of its proceedings showing the vote of each member on every question or, if the member is absent or fails to vote, these actions shall be recorded. [1:1.1011.5.3]

**B.6.5.4**

The Board of Appeals shall keep records of its examinations and other official actions. [1:1.1011.5.4]

**B.6.5.5**

Minutes and records of the Board of Appeals shall be public record. [1:1.1011.5.5]

**B.6.5.7**

In varying the application of any provision of this *Code*, or in modifying an order of the AHJ, a two-thirds vote of the quorum shall be required. [1:1.1011.5.7]

**B.6.6 Decisions.**

**B.6.6.1**

Every decision of the Board of Appeals shall be entered in the minutes of the board meeting. [1:1.1011.6.1]

**B.6.6.2**

A decision of the Board of Appeals to modify an order of the AHJ shall be in writing and shall specify the manner in which such modification is made, the conditions upon which it is made, the reasons therefore, and justification linked to specific *Code* sections. [1:1.1011.6.2]

**B.6.6.3**

Every decision shall be promptly filed in the office of the AHJ and shall be open for public inspection. [1:1.1011.6.3]

**B.6.6.4**

A certified copy shall be sent by mail or delivered in person to the appellant, and a copy shall be publicly posted in the office of the AHJ for 2 weeks after filing. [1:1.1011.6.4]

**B.6.6.5**

The decision of the Board of Appeals shall be final, subject to such remedy as any aggrieved party might have through legal, equity, or other avenues of appeal or petition. [1:1.1011.6.5]

**B.6.6.6**

If a decision of the Board of Appeals reverses or modifies a refusal, order, or disallowance of the AHJ, or varies the application of any provision of this *Code*, the AHJ shall take action immediately in accordance with such decision. [1:1.1011.6.6]

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### **B.7 Records and Reports.**

#### **B.7.1**

A record of examinations, approvals, equivalencies, and alternates shall be maintained by the AHJ and shall be available for public inspection during business hours in accordance with applicable laws. [1:1.12.1]

#### **B.7.2**

Documents requested from a property owner ~~for fire protection systems with deficiencies~~ shall be maintained by the AHJ. [1:1.12.1.1]

#### **B.7.3**

The AHJ shall keep a record of all fire prevention inspections, including the date of such inspections and a summary of any violations found to exist, the date of the services of notices, and a record of the final disposition of all violations. [1:1.12.2]

#### **B.7.4**

The AHJ shall keep a record of all permits and plans reviewed, including the dates of such reviews and a summary of any comments, denials, or approvals. [1:1.12.3]

### **B.8 Permits and Approvals.**

#### **B.8.1**

The AHJ shall be authorized to establish and issue permits, certificates, and approvals pertaining to conditions, operations, or materials hazardous to life or property pursuant to Section B.8. [1:1.13.1]

#### **B.8.2**

Applications for permits shall be made to the AHJ on forms provided by the jurisdiction and shall include the applicant's answers in full to inquiries set forth on such forms. [1:1.13.2]

##### **B.8.2.1**

Applications for permits shall be accompanied by such data as required by the AHJ and fees as required by the jurisdiction. [1:1.13.2.1]

##### **B.8.2.2**

The AHJ shall review all applications submitted and issue permits as required. [1:1.13.2.2]

##### **B.8.2.3**

If an application for a permit is rejected by the AHJ, the applicant shall be advised of the reasons for such rejection. [1:1.13.2.3]

##### **B.8.2.4**

Permits for activities requiring evidence of financial responsibility by the jurisdiction shall not be issued unless proof of required financial responsibility is furnished. [1:1.13.2.4]

### **B.8.3 Conditions of Approval.**

#### **B.8.3.1**

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Any conditions of the initial approval by the AHJ of a use, occupancy, permit, or construction shall remain with the use, occupancy, permit, or construction unless modified by the AHJ. [1:1.~~12~~13.3.1]

#### **B.8.3.2**

The AHJ shall be permitted to require conditions of approval be memorialized via recording in the public records, as part of the plat, permit, or other method as approved by the AHJ. [1:1.~~12~~13.3.2]

### **B.8.4 Approvals by Other AHJs.**

#### **B.8.4.1**

The AHJ shall have the authority to require evidence to show that other regulatory agencies having jurisdiction over the design, construction, alteration, repair, equipment, maintenance, process, and relocation of structures have issued appropriate approvals. [1:1.~~12~~13.4.1]

#### **B.8.4.2**

The AHJ shall not be held responsible for enforcement of the regulations of such other regulatory agencies unless specifically mandated to enforce those agencies' regulations. [1:1.~~12~~13.4.2]

### **B.8.5 Misrepresentation.**

#### **B.8.5.1**

Any attempt to misrepresent or otherwise deliberately or knowingly design; install; service; maintain; operate; sell; represent for sale; falsify records, reports, or applications; or other related activity in violation of the requirements prescribed by this *Code* shall be a violation of this *Code*. [1:1.~~12~~13.5.1]

#### **B.8.5.2**

Such violations shall be cause for immediate suspension or revocation of any related approvals, certificates, or permits issued by this jurisdiction. [1:1.~~12~~13.5.2]

#### **B.8.5.3**

Such violations shall be subject to any other criminal or civil penalties as available by the laws of this jurisdiction. [1:1.~~12~~13.5.3]

### **B.8.6 Permits.**

#### **B.8.6.1**

A permit shall be predicated upon compliance with the requirements of this *Code* and shall constitute written authority issued by the AHJ to maintain, store, use, or handle materials; to conduct processes that could produce conditions hazardous to life or property; or to install equipment used in connection with such activities. [1:1.~~12~~13.6.1]

#### **B.8.6.2**

Any permit issued under this *Code* shall not take the place of any other approval, certificate, license, or permit required by other regulations or laws of this jurisdiction. [1:1.~~12~~13.6.2]

#### **B.8.6.3**

Where additional permits, approvals, certificates, or licenses are required by other agencies, approval shall be obtained from those other agencies. [1:1.~~12~~13.6.3]

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**B.8.6.4**

The AHJ shall have the authority to require an inspection prior to the issuance of a permit. [1:1.~~12~~13.6.4]

**B.8.6.5**

A permit issued under this *Code* shall continue until revoked or for the period of time designated on the permit. [1:1.~~12~~13.6.5]

**B.8.6.6**

The permit shall be issued to one person or business only and for the location or purpose described in the permit. [1:1.~~12~~13.6.6]

**B.8.6.7**

Any change that affects any of the conditions of the permit shall require a new or amended permit. [1:1.~~12~~13.6.7]

**B.8.6.8**

The AHJ shall have the authority to grant an extension of the permit time period upon presentation by the permittee of a satisfactory reason for failure to start or complete the work or activity authorized by the permit. [1:1.~~12~~13.6.8]

**B.8.6.9**

A copy of the permit shall be posted or otherwise readily accessible at each place of operation and shall be subject to inspection as specified by the AHJ. [1:1.~~12~~13.6.9]

**B.8.6.10**

Any activity authorized by any permit issued under this *Code* shall be conducted by the permittee or the permittee's agents or employees in compliance with all requirements of this *Code* applicable thereto and in accordance with the approved plans and specifications. [1:1.~~12~~13.6.10]

**B.8.6.11**

No permit issued under this *Code* shall be interpreted to justify a violation of any provision of this *Code* or any other applicable law or regulation. [1:1.~~12~~13.6.11]

**B.8.6.12**

Any addition or alteration of approved plans or specifications shall be approved in advance by the AHJ, as evidenced by the issuance of a new or amended permit. [1:1.~~12~~13.6.12]

**B.8.6.13**

Permits shall be issued by the AHJ and shall indicate the following:

- (1) Operation, activities, or construction for which the permit is issued
- (2) Address or location where the operation, activity, or construction is to be conducted
- (3) Name, address, and phone number of the permittee
- (4) Permit number
- (5) Period of validity of the permit

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- (6) Inspection requirements
- (7) Name of the agency authorizing the permit (AHJ)
- (8) Date of issuance
- (9) Permit conditions as determined by the AHJ

[1:1.~~12~~13.6.13]

#### **B.8.6.14**

Any application for, or acceptance of, any permit requested or issued pursuant to this *Code* shall constitute agreement and consent by the person making the application or accepting the permit to allow the AHJ to enter the premises at any reasonable time to conduct such inspections as required by this *Code*. [1:1.~~12~~13.6.14]

#### **B.8.7 Revocation or Suspension of Permits.**

##### **B.8.7.1**

The AHJ shall be permitted to revoke or suspend a permit or approval issued if any violation of this *Code* is found upon inspection or in case any false statements or misrepresentations have been submitted in the application or plans on which the permit or approval was based. [1:1.~~12~~13.7.1]

##### **B.8.7.2**

Revocation or suspension shall be constituted when the permittee is duly notified by the AHJ. [1:1.~~12~~13.7.2]

##### **B.8.7.3**

Any person who engages in any business, operation, or occupation, or uses any premises, after the permit issued therefore has been suspended or revoked pursuant to the provisions of this *Code*, and before such suspended permit has been reinstated or a new permit issued, shall be in violation of this *Code*. [1:1.~~12~~13.7.3]

#### **B.9 Plan Review.**

##### **B.9.1**

Where required by the AHJ for new construction, modification, or rehabilitation, construction documents and shop drawings shall be submitted, reviewed, and approved prior to the start of such work as provided in Section B.9. [1:1.~~14~~15.1]

##### **B.9.2**

The applicant shall be responsible to ensure that the following conditions are met:

- (1) The construction documents include all of the fire protection requirements.
- (2) The shop drawings are correct and in compliance with the applicable codes and standards.
- (3) The contractor maintains an approved set of construction documents on site. [1:1.~~14~~15.2]

##### **B.9.3**

It shall be the responsibility of the AHJ to promulgate rules that cover the following:

- (1) Criteria to meet the requirements of Section B.9

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- (2) Review of documents and construction documents within established time frames for the purpose of acceptance or providing reasons for nonacceptance

[1:1.1415.3]

#### **B.9.4**

Review and approval by the AHJ shall not relieve the applicant of the responsibility of compliance with this *Code*.

[1:1.1415.4]

#### **B.10.2**

The independent reviewer shall provide an evaluation and recommend necessary changes of the proposed design, operation, process, or new technology to the AHJ. [1:1.1516.2]

#### **B.10.3**

The AHJ shall be authorized to require design submittals to bear the stamp of a registered design professional.

[1:1.1516.3]

#### **B.10.4**

The AHJ shall make the final determination as to whether the provisions of this *Code* have been met. [1:1.1516.4]

### **B.11 Notice of Violations and Penalties.**

#### **B.11.1 Where Required.**

Whenever the AHJ determines violations of this *Code*, a written notice shall be issued to confirm such findings.

[1:1.1617.1]

#### **B.11.2 Serving Notice of Violation.**

##### **B.11.2.1**

Any order or notice of violation issued pursuant to this *Code* shall be served upon the owner, operator, occupant, registered agent, or other person responsible for the condition or violation by one of the following means:

- (1) Personal service
- (2) Mail to last known address of the owner, operator, or registered agent

[1:1.1617.2.1]

##### **B.11.2.2**

For unattended or abandoned locations, a copy of such order or notice of violation shall be posted on the premises in a conspicuous place at or near the entrance to such premises, and the order or notice shall be disseminated in accordance with one of the following:

- (1) Mailed to the last known address of the owner, occupant, or registered agent
- (2) Published in a newspaper of general circulation wherein the property in violation is located

[1:1.1617.2.2]

##### **B.11.2.3**

The task group has decided to maintain the edits made by the technical committee to previously extracted text and delete the associated extract tags. This puts the previously extracted material under the control of this technical committee.

Refusal of an owner, occupant, operator, or other person responsible for the violation to accept the violation notice shall not be cause to invalidate the violation or the notice of violation. When acceptance of a notice of violation is refused, valid notice shall have deemed to have been served under this section provided the methods of service in B.11.2.1 or B.11.2.2 have been followed. [1:1.1617.2.3]

#### B.11.3 Destruction or Removal of Notice.

The mutilation, destruction, or removal of a posted order or violation notice without authorization by the AHJ shall be a separate violation of this *Code* and punishable by the penalties established by the AHJ. [1:1.1617.3]

#### B.11.4 Penalties.

##### B.11.4.1

Any person who fails to comply with the provisions of this *Code*, fails to carry out an order made pursuant to this *Code*, or violates any condition attached to a permit, approval, or certificate shall be subject to the penalties established by the AHJ. [1:1.1617.4.1]

##### B.11.4.5 Abatement.

Where a violation creates an imminent danger, the AHJ is authorized to abate such hazard in accordance with B.5.15. [1:1.1617.5]

### Annex E.1

**Table E.1(b) Hazard Scenario Rationale Notes to Table E.1(a) of NFPA 55**

| Note Number | Statement                                                              | Performance Criteria                                                                                                                                                                                                                          | Hazardous Materials Design Scenario                                                                                                                                                                                                                                                                                                                             |
|-------------|------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1           | Gas release and subsequent entrainment or accumulation by the receptor | <b>Explosion Conditions.</b> 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] | <b>Hazardous Materials Design Scenario 1.</b> 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                 | <b>Property Protection.</b> 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]                                                                   | <b>Hazardous Materials Design Scenario 2.</b> 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] |

The task group has decided to maintain the edits made by the technical committee to previously extracted text and delete the associated extract tags. This puts the previously extracted material under the control of this technical committee.

| Note Number | Statement                                                                        | Performance Criteria                                                                                                                                                                                                                                                                                             | Hazardous Materials Design Scenario                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------------|----------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3           | Gas explosion hazard on site or affecting adjacent property                      | <b>Explosion Conditions.</b> 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]                                                                    | <b>Hazardous Materials Design Scenario 1.</b> 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                                  | <b>Hazardous Materials Exposure.</b> 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] | <b>Hazardous Materials Design Scenario 2.</b> 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]<br><br><b>Hazardous Materials Design Scenario 4.</b> 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                                 | <b>Explosion Conditions.</b> 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]                                                                    | <b>Hazardous Materials Design Scenario 1.</b> 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 | <b>Property Protection.</b> 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]                                                                                                                                      | <b>Hazardous Materials Design Scenario 1.</b> 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]                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

The task group has decided to maintain the edits made by the technical committee to previously extracted text and delete the associated extract tags. This puts the previously extracted material under the control of this technical committee.

| Note Number | Statement                                                                                                                                       | Performance Criteria                                                                                                                                                                                                                                                                                                                                                                                                                    | Hazardous Materials Design Scenario                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 7           | Damage to aboveground system due to function of explosion control system used to vent underground vault or structure                            | <p><b>Property Protection.</b> 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]</p> <p><b>Explosion Conditions.</b> 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]</p> | <p><b>Hazardous Materials Design Scenario 3.</b> 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]</p> |
| 8           | Fire or explosion in other hazardous materials resulting in release of hydrogen                                                                 | <p><b>Hazardous Materials Exposure.</b> 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]</p>                                                                                                                 | <p><b>Hazardous Materials Design Scenario 3.</b> 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]</p> |
| 9           | Fire or explosion in hydrogen system resulting in release of other hazardous materials                                                          | <p><b>Hazardous Materials Exposure.</b> 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]</p>                                                                                                                 | <p><b>Hazardous Materials Design Scenario 2.</b> 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]</p>                                                                                                                                                   |
| 10          | Failure of equipment exposing hydrogen system to electrical hazard, physical, or health hazard; failure of system exposing utilities to failure | <p><b>Property Protection.</b> 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]</p>                                                                                                                                                                                                                                                      | <p><b>Hazardous Materials Design Scenario 3.</b> 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.</p>                                                                                                                                                                                                                                                             |

## NFPA 1, 2024 Extracts

The task group has decided to maintain the edits made by the technical committee to previously extracted text and delete the associated extract tags. This puts the previously extracted material under the control of this technical committee.

| Note Number | Statement | Performance Criteria                                                                                                                                                                                                                                                | Hazardous Materials Design Scenario                                                                                                                                                                                                                         |
|-------------|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|             |           | <b>Public Welfare.</b> 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] | 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] |

## ASME B31 Reference Task Group

The following revisions reflect proposals from the ASME B31 Task Group based of the First Draft Report (F2025).

### 6.5\* Piping.

#### **A.6.5**

Some hydrogen systems include pressures above the limits of ASME B31.12, *Hydrogen Piping and Pipelines*. In such cases, another section of ASME B31, such as ASME B31.3, *Process Piping*, might be more appropriate.

Some hydrogen generators (e.g., reformers or gasifiers) can produce a gas mixture that is less than 95 percent hydrogen or above the temperature limits of ASME B31.12, *Hydrogen Piping and Pipelines*. In such cases, another section of ASME B31 might be more appropriate.

**Commented [HD1]:** Applicable contents have been moved to A.6.5.X.

#### **6.5.X\* ASME Piping Requirements.**

Where required by this code, piping systems shall comply with the applicable provisions of the following:

- (1) ASME B31.1, *Power Piping*
- (2) ASME B31.3, *Process Piping*
- (3) ASME B31.8, *Gas Transmission and Distribution Piping Systems*
- (4) ASME B31.12, *Hydrogen Piping and Pipelines*

#### **A.6.5.X**

Where 6.5.X is required within this code, it is intended that only the applicable provisions from the listed documents be used.

ASME has a set of comprehensive standards which govern the design, fabrication, installation, inspection, and maintenance of various piping systems. Within the industry, this collective set of ASME documents is commonly known as the B31 Code of Pressure Piping, and each document within this set is referred to as a section of the ASME B31 code.

The ASME B31 sections that are applicable to the user should be determined based specific designs and uses. For instance, some hydrogen systems include pressures above the limits of ASME B31.12, *Hydrogen Piping and Pipelines*. In such cases, another section of ASME B31, such as ASME B31.3, *Process Piping*, might be applicable.

Some hydrogen generators (e.g., reformers or gasifiers) can produce a gas mixture that is less than 95 percent hydrogen or above the temperature limits of ASME B31.12, *Hydrogen Piping and Pipelines*. In such cases, another section of ASME B31 might be applicable.

**Commented [HD2]:** This content originated from A.6.5.

ASME B31.1, *Power Piping* provides requirements for the design, installation, and maintenance of piping systems within power plants.

## ASME B31 Reference Task Group

The following revisions reflect proposals from the ASME B31 Task Group based of the First Draft Report (F2025).

The ASME B31.3, *Process Piping* encompasses the design, construction, and inspection of process piping systems.

The ASME B31.8, *Gas Transmission and Distribution Piping System* covers gas transmission and distribution piping systems, including gas pipelines, gas compressor stations, gas metering and regulation stations.

The ASME B31.12, *Hydrogen Piping and Pipelines* is applicable to piping and pipelines handling gaseous hydrogen and gaseous hydrogen mixtures and to piping in liquid hydrogen service.

### 6.5.1 Piping Systems.

#### 6.5.1.1 Design and Installation.

Hydrogen piping, tubing, valves, and fittings shall be designed and installed in accordance with ~~6.5.X~~ applicable sections of ASME B31, Code for Pressure Piping.

#### 6.5.1.2 Inspection and Testing.

Prior to acceptance and initial operation, all piping installations shall be inspected and pressure tested in accordance with ~~6.5.X~~ ASME B31, Code for Pressure Piping, and or Section 705 of the ICC *International Fuel Gas Code (IFGC)*.

### 7.3.2.4.4 Piping Systems.

#### 7.3.2.4.4.1

Joints in the piping system shall be installed and inspected in accordance with ~~6.5.X~~ the requirements of ASME B31, Code for Pressure Piping, or other approved standards.

#### 8.1.3.1.1.2

Piping or tubing used at operating temperatures below –20°F (–29°C) shall be fabricated from materials meeting the impact test in accordance with 6.5.X ~~requirements of ASME B31, Code for Pressure Piping.~~

#### 8.1.3.1.2 Joints.

##### 8.1.3.1.2.1

Joints in piping and tubing shall be in accordance ~~6.5.X~~ with the requirements of ASME B31, Code for Pressure Piping.

#### 8.3.1.2.3\* Piping, Tubing, and Fittings.

##### 8.3.1.2.3.1

Piping and tubing shall be in accordance with ~~6.5.X~~ the requirements of ASME B31, Code for Pressure Piping.

##### 8.3.1.2.3.2\*

Piping or tubing used at operating temperatures below –20°F (–29°C) shall be fabricated from materials meeting the impact test in accordance with 6.5.X ~~requirements of ASME B31, Code for Pressure Piping.~~

##### 8.3.1.2.3.3

**Commented [HD3]:** This is unenforceable language and is covered by the equivalency clause of section 1.5.

## ASME B31 Reference Task Group

The following revisions reflect proposals from the ASME B31 Task Group based of the First Draft Report (F2025).

Piping and tubing materials that have a minimum design metal temperature (MDMT) of –425°F (254°C) or lower, as defined and specified in [in accordance with 6.5.XASME B31, Code for Pressure Piping](#), shall be permitted to be used without impact testing.

### 8.3.1.2.3.5

Joints in piping and tubing shall be in accordance with [6.5.Xthe requirements of ASME B31, Code for Pressure Piping](#).

### 8.3.1.2.4.2

Storage containers, piping, valves, regulating equipment, and other accessories shall be accessible and shall be protected against physical damage and tampering.

#### (A)

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.

#### (B)

Containers exceeding 2000 gal (7570 L) capacity shall be provided with an automatic emergency shutoff valve.

- (1) The remotely operated emergency isolation valve shall be operated by a remotely located, manually activated shutdown control.
- (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.
- (3) Connections downstream of the shutoff valve shall be in accordance with [6.5.XASME B31, Code for Pressure Piping](#).

### 10.3.2.2

Pressure relief devices for piping and dispensing systems shall [be in accordance with 6.5.Xcomply with ASME B31, Code for Pressure Piping](#).

### 10.3.4 Pressure Regulators.

#### 10.3.4.1

A pressure regulator inlet and each chamber shall be designed in accordance with [6.5.XASME B31, Code for Pressure Piping](#).

#### 10.3.5.3\*

Hydrogen gas [piping](#) pipe, tubing, and fittings shall be designed, fabricated, and tested in accordance with [6.5.XASME B31, Code for Pressure Piping](#).

#### 10.4.3.7

A bend in piping or tubing shall have the pressure rating reduced [in accordance with 6.5.Xaccording toASME B31, Code for Pressure Piping](#).

## ASME B31 Reference Task Group

The following revisions reflect proposals from the ASME B31 Task Group based of the First Draft Report (F2025).

### 10.4.5 System Testing.

#### 10.4.5.1\*

Hydrogen dispensing systems shall be leak tested for mechanical integrity after final installation in accordance with [6.5.X](#)~~ASME B31, Code for Pressure Piping~~.

#### 11.2.8.3

Hydrogen gas piping shall be fabricated and tested in accordance with [6.5.X](#)~~ASME B31, Code for Pressure Piping~~.

#### 11.3.1.5.2.2

An overpressure protection device meeting the requirements of ~~ASME B31, Code for Pressure Piping~~[6.5.X](#), other than a rupture disc, shall be installed in the fueling transfer system to prevent overpressure in the vehicle.

#### 11.3.1.10.2

This leak test shall be in addition to the ~~ASME B31, Code for Pressure Piping~~ testing required by 11.2.8.3.

#### 12.2.2 Piping.

Piping, valves, and fittings shall comply with [6.5.X](#)~~ASME B31, Code for Pressure Piping~~.

#### 13.5.3.9.1

Piping, valves, and fittings from the gasifier chamber to the end use or storage system shall conform to [6.5.X](#)~~ASME B31, Code for Pressure Piping~~.

**Commented [HD4]:** This isn't necessary since 11.2.8.3 already points you to the ASME B31 documents listed in 6.5.X.

## NFPA 45, 2024 Extracts

The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

### 3.3.4.1 Auxiliary Air.

Supply or supplemental air delivered near the outside face of a chemical fume hood to reduce room air consumption. [45, 20192024]

### 3.3.5 Apparatus.

Furniture, chemical fume hoods, centrifuges, refrigerators, and commercial or made-on-site equipment used in a laboratory. [45, 20192024]

### 3.3.7.3 Laboratory Work Area.

A room or space ~~[regulated by Chapter 16 used]~~ for testing, analysis, research, instruction, or similar activities that involve the use of chemicals. [45, 20242019]

#### ~~A.3.3.139~~ A.3.3.7.3 Laboratory Work Area.

This work area can be enclosed. [45, 20192024]

### 3.3.7.4 Nonlaboratory Area.

Any space within a ~~[laboratory]~~ building not included in a laboratory unit. (See ~~also 3.3.14.2 and 3.3.245.1.~~) [45, 20192024]

### 3.3.14.2 Laboratory Building.

A structure consisting wholly or principally of one or more laboratory units. (See ~~also 3.3.245.1, Laboratory Unit.~~) [45, 20242019]

### 3.3.22 Bypass ~~[Laboratory Hoods]~~.

An airflow-compensating opening that maintains a relatively constant volume exhaust through a chemical fume hood regardless of sash position, serving to limit the maximum face velocity as the sash is lowered. [45, 20242019]

### 3.3.23.2 Laminar Flow Cabinet.

A ventilated, partially enclosed cabinet primarily intended to provide filtered airflow over the work surface by use of laminar airflow methods. [45, 20242019]

### 3.3.82 Face Velocity.

The rate of flow or velocity of air moving into the chemical fume hood entrance or face, as measured at the plane of the chemical fume hood face. [45, 20242019]

### 3.3.83 Facility.

#### 3.3.83.1 Incidental Testing Facility.

An area within a production facility set aside for the purpose of conducting in-process control tests that are related to the production process. [45, 20242019]

#### 3.3.120.1\* Canopy Hood.

A suspended ventilating device used only to exhaust heat, water vapor, odors, and other nonhazardous materials. [45, 20192024]

##### A.3.3.120.1 Canopy Hood.

This is not a chemical fume hood and generally is not as effective for exhausting toxic or flammable materials. [45, 20242019]

#### 3.3.120.2\* Chemical Fume Hood.

## NFPA 45, 2024 Extracts

The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

A ventilated enclosure designed to contain and exhaust fumes, gases, vapors, mists, and particulate matter generated within the hood interior. [45, 20192024]

### A.3.3.120.2 Chemical Fume Hood.

For further information on descriptions of types of chemical fume hoods and exhaust ventilation devices, see ANSI/AIHA Z9.5, *Laboratory Ventilation*. The following are types of chemical fume hoods:

- (1) *Conventional hood*. A square-post hood without an airfoil directional vane across the bottom of the hood face, and in most cases without provision for a bypass. As the sash is lowered in hoods without an air bypass, the face velocity increases rapidly. The square-post design and absence of a deflector vane have been known to create turbulence at the hood face. The turbulence at the hood face can bring fumes from the hood interior out to the hood face, where they are easily drawn out into the room by the air turbulence caused by a person working at the hood, persons passing the hood, or minor room cross drafts. If hoods are not equipped with a bypass, face velocities could become objectionably high as the sash is closed, and with the sash completely closed, airflow can be insufficient to carry vapors away.
- (2) *Bypass air hood*. A hood having a bypass protected by a grille that serves to maintain a relatively constant volume of airflow regardless of sash position. Current design recommends a streamlined entry profile with a deflector vane across the bottom of the hood to direct the airflow across the work surface.
- (3) *Auxiliary air hood*. A bypass air hood with the addition of an auxiliary air bonnet to provide a direct source of makeup air in addition to the makeup air from the laboratory work area.
- (4) ~~Special~~ Special-purpose hoods are as follows:
  - (a) *Radioisotope hoods*. Designed primarily for use with radiochemicals
  - (b) *Perchloric acid hoods*. Designed primarily for use with perchloric acid
  - (c) ~~Walk-in~~ Floor-mounted hoods. Designed primarily for extra headroom to accommodate tall equipment

[45, 20192024]

### 3.3.121 Hood Interior.

The volume enclosed by the side, back, and top enclosure panels, the work surface, the access opening (called the face), the sash or sashes, and the exhaust plenum, including the baffle system for airflow distribution. [45, 20192024]

### 3.3.141 Lecture Bottle.

A small compressed gas cylinder up to ~~a size of approximately 2 in. × 13 in. (5 cm × 33 cm)~~ 0.3 scm (10 scf) volume. [45, 20242019]

### 3.3.190 Pilot Plant.

An experimental assembly of equipment for exploring process variables or for producing semicommercial quantities of materials. [45, 20242019]

### 3.3.209 Qualified Person.

A person who, by possession of a recognized degree, certificate, professional standing, or skill, and who, by knowledge, training, and experience, has demonstrated the ability to deal with problems relating to a particular subject matter, work, or project. [45, 20242019]

### 3.3.220 Sash.

A movable panel or panels set in the hood entrance. [45, 20242019]

## NFPA 45, 2024 Extracts

The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

### 3.3.245.1\* Laboratory Unit.

An enclosed space ~~[within a laboratory building]~~ used for experiments or tests. [45, 2024~~2019~~]

#### A.3.3.245.1 Laboratory Unit.

A laboratory unit can include offices, lavatories, and other incidental contiguous rooms maintained for or used by laboratory personnel, and corridors within the unit. It can contain one or more separate laboratory work areas. It can be an entire building. A laboratory unit is classified as A, B, C, or D in accordance with Section 4.2 of NFPA 45. [45, 2019~~2024~~]

#### 3.3.245.1.1 Instructional Laboratory Unit.

A laboratory unit, under the direct supervision of an instructor, that is used for the purposes of instruction for students beyond the twelfth grade. [45, 2019~~2024~~]

#### 16.2.1.1\*

A second means of access to an exit shall be provided from a laboratory work area if any of the following situations exist: [45:5.3.1]

- (1) A laboratory work area contains an explosion hazard located so that an incident would block escape from or access to the laboratory work area. [45:5.3.1(1)]
- (2) ~~A laboratory work area within a Class A laboratory unit exceeds 46.5 m<sup>2</sup> (500 ft<sup>2</sup>). [45:5.3.1(2)]~~ ~~A hood in a laboratory work area is located adjacent to the primary means of exit access. [45:5.3.1(4)]~~
- (3) ~~A laboratory work area within a Class B, Class C, or Class D laboratory unit exceeds 93 m<sup>2</sup> (1000 ft<sup>2</sup>). [45:5.3.1(3)]~~
- (3~~4~~) A compressed gas cylinder larger than lecture bottle size [approximately 2 in. × 13 in. (5 cm × 33 cm)] is located ~~such so~~ that it could prevent safe egress in the event of accidental release of cylinder contents. [45:5.3.1(4~~5~~)]
- (4~~5~~) A cryogenic container is located ~~such so~~ that it could prevent safe egress in the event of accidental release of container contents. [45:5.3.1(6~~5~~)]

#### A.16.2.1.1

A door to an adjoining laboratory work area or laboratory unit is considered to be a second means of access to an exit, provided that the laboratory unit is not of a higher fire hazard classification. [45:A.5.3~~4~~.1]

#### 16.2.1.2

Emergency lighting shall be provided for laboratory work areas. [45:5.5.4~~3~~.1]

#### 16.2.1.3

Emergency lighting shall be installed in accordance with Section 7.9 of NFPA 101. [45:5.3~~5~~.4.2]

#### 16.2.2 Electrical Installation.

All electrical installations, including wiring and appurtenances, apparatus, lighting, signal systems, alarm systems, remote control systems, or parts thereof, shall comply with NFPA 70. [45:5.5]

#### 16.2.2.1\*

Electrical receptacles, switches, and controls shall be located so as not to be subject to liquid spills. [45:5.5.1]

#### A.16.2.2.1

~~Almost any liquid spill could affect electrical equipment located in the immediate area. Therefore, electrical receptacles, switches, and controls should not be located on, adjacent to, or directly below horizontal surfaces where a liquid spill could directly impact the equipment. [45:A.5.5.1]~~

#### 16.2.2.2

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## NFPA 45, 2024 Extracts

The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

Electrical receptacles mounted above the work surface shall be at least 4 in. (100 mm) above the work surface unless a greater separation is required to protect against spills. [45:5.5.2]

### ~~16.2.2.1~~ 16.2.2.3\*

Laboratory work areas, laboratory units, and chemical fume hood interiors shall be considered as unclassified electrically with respect to Article 500 ~~for Article 505~~ of NFPA 70, unless operations are determined to cause a hazardous atmosphere. [45:5.5.2 5.5.3]

#### A.16.2.2.1

A qualified design professional and owner safety officer should review the laboratory conditions through a hazard analysis and/or risk assessment to determine if a hazardous (~~ignitable~~ignitable) atmosphere could be developed within the laboratory work area, ~~laboratory area~~, laboratory unit, and/or fume hood. If a hazardous atmosphere could be developed, these areas should be electrically classified per NFPA 70, Article 500. [45:A.5.5.2 45:A.5.5.2]

### 16.2.3.1.1.2\*

Quick-response sprinklers shall be installed throughout~~Fire sprinklers in~~ laboratory units ~~shall be the quick-response (QR) sprinkler type installed in accordance with NFPA 13.~~ [45:6.1.1.2]

#### A.16.2.3.1.1.2

A series of fire tests in typical chemical laboratories was conducted to evaluate quick-response sprinkler technology and the use of quick-response sprinklers in chemical laboratories. Fire test results demonstrated that both ~~standard~~ ~~standard~~-response and quick-response sprinklers were effective in controlling fires. Additionally, fire test results of the quick-response sprinklers showed lower maximum temperatures at the 5 ft level consistent with what is considered acceptable tenability in the room of fire origin, as discussed in NFPA 13D, and evaluated by ANSI/UL 1626, *Residential Sprinklers for Fire Protection Service*. Also see NISTIR 89-4200, "Quick Response Sprinklers in Chemical Laboratories: Fire Test Results", sponsored by the National Institutes of Health, Bethesda, MD. [45:A.6.1.1.2]

### 16.2.3.1.1.3

~~Automatic sprinkler systems shall be regularly inspected, tested, and maintained in accordance with NFPA 25. [45:6.1.1.3]~~ A sprinkler system installed in accordance with NFPA 13 shall be properly inspected, tested, and maintained by the property owner or their authorized representative in accordance with NFPA 25 to provide at least the same level of performance and protection as designed. [13:32.1]

### 16.2.3.2.2

The fire alarm system shall activate fire alarm notification appliances and notify the fire department. [45:6.4.3]

### 16.2.3.3 Standpipe and Hose Systems.

#### 16.2.3.3.1\*

Class I wet standpipe systems shall be installed in laboratory buildings where the floor of the highest story is located more than 30 ft (9.14 m) above the lowest level of fire department vehicle access, or where the floor level of the lowest story is located more than 30 ft (9.14 m) below the highest level of fire department vehicle access in accordance with NFPA 14. [45:6.2.1]

#### A.16.2.3.3.1

For laboratory buildings where trained personnel are available, Class III standpipe systems can be installed [45:A.6.2.1]

#### 16.2.3.3.2\*

Standpipe systems shall be regularly inspected, tested, and maintained in accordance with NFPA 25. [45:6.2.2]

### 16.2.3.4 Portable Fire Extinguishers.

## NFPA 45, 2024 Extracts

The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

Portable fire extinguishers shall be installed, located, and maintained in accordance with NFPA 10. [45:6.3.1]

### 16.2.5.1.1

Fire prevention procedures shall be established for all new and existing laboratories. [45:6.5.1.1]

### 16.2.5.1.2

Fire prevention procedures shall include, but not be limited to, the following:

- (1) Handling and storage of chemicals, ignitable (flammable and combustible) liquids, pyrophoric and other reactive compounds, and compressed gases~~[GH<sub>2</sub> and LH<sub>2</sub>]~~
- (2) Open flame and spark-producing equipment work permit system
- (3) Arrangements and use of portable electric cords
- (4) Smoking area controls

[45:6.5.1.2]

### 16.2.5.2\* Maintenance Procedures.

Maintenance procedures shall be established for all new and established laboratories. [45:6.5.2]

#### A.16.2.5.2

Maintenance procedures should include inspection, testing, and maintenance of the following:

- (1) Utilities (steam, gas, electrical)
- (2) Air supply and exhaust systems
- (3) Fire protection equipment
- (4) Detectors and alarms
- (5) Compressed gas regulators and pressure relief valves
- (6) Waste disposal systems
- (7) Fire doors
- (8) Emergency lighting and exit signs
- (9) Electrically operated equipment

[45:A.6.5.2]

### 16.2.5.3.2\*

Procedures for extinguishing clothing fires shall be established for all new and existing laboratories.

~~[45:6.5.3-26.5.3.3]~~

#### A.16.2.5.3.2

Laboratory personnel should be thoroughly indoctrinated in procedures to follow in cases of clothing fires. The most important instruction, one that should be stressed until it becomes second nature to all personnel, is to immediately drop to the floor and roll. All personnel should recognize that, in ~~the~~ case of ignition of another person's clothing, they should immediately knock that person to the floor and roll that person around to smother the flames. Too often a person will panic and run if clothing ignites, resulting in more severe, often fatal, burn injuries. ~~[45:A.6.5.3-2A.6.5.3.3]~~

## NFPA 45, 2024 Extracts

The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

Flame-resistant clothing is one option available to help reduce the occurrence of clothing fires. Refer to NFPA 2112 for performance requirements and test methods for flame-resistant clothing. [45:A-6.5.3.2 A.6.5.3.3]

It should be emphasized that the use of safety showers, fire blankets, or fire extinguishers are of secondary importance. These items should be used only when immediately at hand. It should be recognized that rolling on the floor not only smothers the fire but also helps to keep flames out of the victim's face, reducing inhalation of smoke. [45:A-6.5.3.2 A.6.5.3.3]

### 16.2.5.3.3

All laboratory users, including, but not limited to, instructors and students, shall be trained prior to laboratory use and at least annually thereafter on the emergency plan. [45:6.5.3.3]

### 16.3.1.2.14

Cylinders, except cylinders containing less than 0.3 scm (10 scf) that are not "in use" per 16.3.1.2.2 through 16.3.1.2.4 shall not be stored outside in the laboratory unit in accordance with this code. [45:10.1.6.4 10.1.2]

### 16.3.1.2.12

Cylinders, when in use, shall be connected to gas delivery systems designed by a qualified person. [45:10.1.6.1]

### 16.3.1.2.23

Cylinders shall be attached to an instrument for use by means of a regulator. [45:10.1.6.2]

### 16.3.1.2.34

A compressed gas cylinder shall be considered to be "in use" if it is in compliance with one of the following:

- (1) Connected through a regulator to deliver gas to a laboratory operation
- (2) Connected to a manifold being used to deliver gas to a laboratory operation
- (3) A single cylinder secured alongside the cylinder described in 16.3.1.2.3(1) as the reserve cylinder for the cylinder described in 16.3.1.2.3(1).

[45:10.1.6.3]

## 16.3.2 Indoor Use.

### 16.3.2.1 Laboratory Ventilating Systems and Hood Requirements.

#### 16.3.2.1.1\* General.

##### A.16.3.2.1.1

NFPA 90A<sup>7</sup> and NFPA 91 contain additional requirements for general environmental ventilating systems. [45:A.7.1]

##### 16.3.2.1.1.1

This chapter shall apply to laboratory exhaust systems, including chemical fume hoods, local ventilated enclosures, fume arms, special local exhaust devices, and other systems for exhausting air from laboratory work areas in which hazardous materials under the scope of NFPA 45 [CH<sub>2</sub> or LH<sub>2</sub>] are released. [45:7.1.1]

##### 16.3.2.1.1.2

This chapter shall apply to laboratory air supply systems and shall provide requirements for identification, inspection, and maintenance of laboratory ventilation systems and hoods. [45:7.1.2]

#### 16.3.2.1.2 Basic Requirements.

**Commented [HD1]:** The NFPA 45 committee identified that this requirement has a significant overlap with 10.1.2. and has been merged with 10.1.2 in NFPA 45. Additionally, this requirement has been moved by staff to 16.3.1.2.1 for better flow.

**Commented [RP2R1]:** The TG accepted this extract as it exists in NFPA 45

**Commented [DH3]:** This may not be an appropriate extract since hydrogen is under the scope of NFPA 2 and not NFPA 45.

**Commented [RP4R3]:** After discussion, the TG accepted that this language is not an issue and so accepted extractign the current NFPA 45 language as shown.

## NFPA 45, 2024 Extracts

The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

### 16.3.2.1.2.1\*

Laboratory ventilation systems shall be designed to ensure that fire hazards and risks are minimized. [45:7.2.1]

#### A.16.3.2.1.2.1

For additional information on laboratory ventilation, see ANSI/ASHRAE 119.5, *Laboratory Ventilation*. For information on preventing the spread of smoke by means of utilizing supply and exhaust systems to create airflows and pressure differences between rooms or building areas, see NFPA 92. [45:A.7.2.1]

### 16.3.2.1.2.2\*

Laboratory units and laboratory hoods in which ~~[GH<sub>2</sub> or LH<sub>2</sub>]~~chemicals are present, regardless of the presence and types of installed fume hoods, shall be continuously ventilated under normal operating conditions. [45:7.2.2.2.1]

#### A.16.3.2.1.2.2

A minimum ventilation rate for unoccupied laboratories (e.g., nights and weekends) can be as low as four room air changes per hour with proper laboratory operations and storage of chemicals. Occupied laboratories typically operate at rates greater than six air changes per hour, consistent with the conditions of use for the laboratory. Occupied laboratories should determine their supply airflow rates based on cooling requirements, amount of exhaust air required for the hoods, or exhaust devices in the lab, whichever is greatest. Use of only an "air change per hour" criteria is not considered proper design. Adequate ventilation should be provided to ensure occupant safety and safe operation of exhaust devices inside the laboratory. [45:A.7.2.2.1]

Laboratory ventilation operating at lower rates should employ specific measures to monitor for potentially hazardous conditions and increase the ventilation automatically upon detection of any condition within 25 percent of the level of concern. If such a monitoring system is to be used, it should be fail-safe and be of such a nature that it will detect all potential leakage throughout the entire laboratory area. These systems should be reserved for locations where the anticipated contaminants can be measured reliably and activate the control system within a sufficiently rapid time period to provide occupant protection. In the event of a failure of the monitoring system or control components, the ventilation system should return to the designated occupied ventilation rate. Detailed analyses of flow paths, dead pockets, and failure modes under all credible scenarios should be performed to avoid exposure. [45:A.7.2.2.1]

It is not the intent of ~~[this code]~~ to require emergency or standby power for laboratory ventilation systems. [45:A.7.2.2.1]

### 16.3.2.1.2.3\*

Chemical fume hoods shall not be relied upon to provide explosion (blast) protection unless specifically designed to do so. (See also H.6.4 and H.6.5 for further information on explosion-resistant hoods and shields.) [45:7.2.3]

#### A.16.3.2.1.2.3

Hoods having explosionproof electrical devices are sometimes referred to as *explosionproof hoods*. This term does not imply that they will contain an explosion, only that the electrical equipment will not provide a source of ignition. [45:A.7.2.3]

### 16.3.2.1.2.4

Exhaust and supply systems shall be designed to prevent a pressure differential that would impede egress or ingress when either system fails or during a fire or emergency scenario. This design includes reduced operational modes or shutdown of either the supply or exhaust ventilation ~~systems~~system. [45:7.2.5]

### 16.3.2.1.2.5

The release of ~~[GH<sub>2</sub>]~~chemical vapors into the laboratory shall be controlled by enclosure(s) or captured to prevent any flammable and/or combustible concentrations of vapors from reaching any source of ignition. [45:7.2.6]

## NFPA 45, 2024 Extracts

The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

### 16.3.2.1.3 Supply Systems.

#### 16.3.2.1.3.1\*

Laboratory ventilation systems shall be designed to ensure that ~~{GH<sub>2</sub>}~~chemical fumes, vapors, or gases originating from the laboratory shall not be recirculated. [45:7.3.1]

##### A.16.3.2.1.3.1

This is not meant to prevent recirculation within a laboratory unit for heating or cooling. Recirculation of air within a laboratory work area from ductless fume hoods is permitted for ductless fume hoods that meet the requirements in Chapter 16. [45:7.3.1]

#### 16.3.2.1.3.2\*

The location and configuration of fresh air intakes shall be chosen so as to avoid drawing in ~~{GH<sub>2</sub>}~~chemicals or products of combustion coming either from the laboratory building itself or from other structures and devices. [45:7.3.2]

##### A.16.3.2.1.3.2

Special studies such as air-dispersion modeling might be necessary to determine the location of air intakes for laboratories away from the influence of laboratory exhaust and other local point source emissions. [45:A.7.3.2]

#### 16.3.2.1.3.3

The air pressure in the laboratory work areas shall be negative with respect to corridors and non-laboratory areas of the laboratory unit except in the following instances:

- (1) Where operations such as those requiring clean rooms preclude a negative pressure relative to surrounding areas, alternate means shall be provided to prevent escape of the atmosphere in the laboratory work area or unit to the surrounding spaces.
- (2) The desired static pressure level with respect to corridors and non-laboratory areas shall be permitted to undergo momentary variations as the ventilation system components respond to door openings, changes in chemical fume hood sash positions, and other activities that can for a short term affect the static pressure level and its negative relationship.
- (3) Laboratory work areas located within a designated electrically classified hazardous area with a positive air pressure system as described in NFPA 496, in accordance with Chapter 7, Pressurized Control Rooms, shall be permitted to be positive with respect to adjacent corridors.

[45:7.3.3]

#### 16.3.2.1.3.4\*

The location of air supply diffusion devices shall be chosen so as to avoid air currents that would adversely affect the performance of chemical fume hoods, exhaust systems, and fire detection or fire-extinguishing systems. (See 16.2.3.1, 16.2.3.2, and 16.3.2.1.8.1.) [45:7.3.4]

##### A.16.3.2.1.3.4

Room air current velocities in the vicinity of fume hoods should be as low as possible, ideally less than 30 percent of the face velocity of the fume hood. Air supply diffusion devices should be as far away from fume hoods as possible and have low exit velocities. [45:A.7.3.4]

### 16.3.2.1.4 Exhaust Air Discharge.

#### 16.3.2.1.4.1\*

Air exhausted from chemical fume hoods and other special local exhaust systems shall not be recirculated. (See also 16.3.2.1.3.1.) [45:7.4.1]

## NFPA 45, 2024 Extracts

The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

### A.16.3.2.1.4.1

Ductless ~~chemical fume hoods~~enclosures that pass air from the hood interior through an absorption filter and then discharge the air into the laboratory are only applicable for use with nuisance vapors and dusts that do not present a fire or toxicity hazard. Ductless fume hoods can be used to contain specific chemicals for which they were designed and in amounts that are consistent with the design. Ductless fume hoods have significant potential hazards not inherent in standard fume hoods including exceeding treatment capacities, failure of treatment media, inability to treat certain chemicals or chemical combinations, difficulties in reliably alarming for failure of the treatment media, misuse, and similar issues. As a result, all proposed chemicals and operations and the details of the proposed unit must be carefully reviewed and assessed for safety. See ANSI/AIHA Z9.5, *Laboratory Ventilation*, and other applicable standards for additional information for the proper use and application.

[45:A.7.4.1]

### 16.3.2.1.4.2\* Energy Conservation Devices.

#### (A)

If energy conservation devices are used, they shall be designed in accordance with 16.3.2.1.3.1 and 16.3.2.1.3.3.

[45:7.4.2.1]

#### (B)

Energy conservation devices shall only be used in a laboratory ventilation system when evaluated and approved by a qualified person. These systems must meet, or exceed, the criteria established by Section 5.4.7 and Section 5.4.7.1 of ANSI/AIHA Z9.5, *Laboratory Ventilation*. Systems that recirculate within their respective laboratory work area, such as fan coil units for sensible heat loads, are exempt from these requirements.

[45:7.4.2.2]

#### (C)

Energy conservation devices shall be designed and installed in a manner that safely facilitates anticipated service and maintenance requirements and does not adversely impact the proper operation of the exhaust system.

[45:7.4.2.3]

### A.16.3.2.1.4.2

Consideration should be made of ~~the~~ potential contamination of the fresh air supply by exhaust air containing vapors of flammable or toxic chemicals when using devices for energy conservation purposes.

[45:A.7.4.2]

Where fume hood exhaust is manifolded with general laboratory exhaust, energy recovery devices should be evaluated to ensure they would not recirculate contaminants through an active purge or filtration treatment. Energy recovery systems should be designed with a fail-safe alarm(s) and equipment interlocks to prevent cross contamination or recirculation from occurring, including shutdown of systems if needed. [45:A.7.4.2]

Membrane-type enthalpy~~Enthalpy~~ wheels, in particular, have potential for cross-contamination and should be carefully evaluated for all potential hazards and failure modes. Coil-type enthalpy wheels with a purge section can be used with approval of the AHJ. [45:A.7.4.2]

### 16.3.2.1.4.3

Air exhausted from laboratory work areas shall not pass unducted through other areas. [45:7.4.3]

### 16.3.2.1.4.4\*

Air from laboratory units and laboratory work areas in which ~~[GH<sub>2</sub>]~~is chemicals are present shall be continuously discharged through duct systems maintained at a negative pressure relative to the pressure of normally occupied areas of the building. [45:7.4.4]

## NFPA 45, 2024 Extracts

The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

### A.16.3.2.1.4.4

Ducts should be sealed to prevent condensation, and so forth, from leaking into occupied areas. [45:A.7.4.4]

### 16.3.2.1.4.5

Positive pressure portions of the lab hood exhaust systems (e.g., fans, coils, flexible connections, and ductwork) located within the laboratory building shall be sealed airtight or located in a continuously mechanically ventilated room. [45:7.4.5]

### 16.3.2.1.4.6

Chemical fume hood face velocities and exhaust volumes shall be sufficient to contain [GH<sub>2</sub>]contaminants generated within the hood and exhaust them outside of the laboratory building. [45:7.4.6]

### 16.3.2.1.4.7\*

The hood shall provide containment of the possible hazards and protection for personnel at all times when [GH<sub>2</sub> is]chemicals are present in the hood. [45:7.4.7]

### A.16.3.2.1.4.7

Laboratory fume hood containment can be evaluated using the procedures contained in ASHRAE 110, *Method of Testing Performance of Laboratory Fume Hoods*. Face velocities of 0.4 m/sec to 0.6 m/sec (80 ft/min to 120 ft/min) generally provide containment if the hood location requirements and laboratory ventilation criteria of this standard are met. [45:A.7.4.7]

Lower flow fume hoods (those with an average face velocity or 0.3 to 0.4 m/sec (60 to 80 ft/min) are often desirable for energy conservation. Lower hood face velocities are effective with hoods designed for lower face velocities. However, many circumstances can lead to inadequate contaminant containment. These include crowding, larger equipment, high thermal loads, internal circulation from equipment and numerous other issues. Hence the owner should carefully consider all potential applications when determining the face velocity to use. [45:A.7.4.7]

In addition to maintaining proper fume hood face velocity, fume hoods that reduce the exhaust volume as the sash opening is reduced should maintain a minimum exhaust volume to ensure that contaminants are diluted and exhausted from a hood. The chemical fume hood exhaust airflow should not be reduced to less than the flow rate recommended in ANSI/AIHA Z9.5, *Laboratory Ventilation*. [45:A.7.4.7]16.3.2.1.4.8

[Special local exhaust systems, such as snorkels or "elephant trunks," shall have sufficient capture velocities to entrain the [GH<sub>2</sub>]chemicals being released. [45:7.4.8]]

### 16.3.2.1.4.9\*

Canopy hoods, laminar flow cabinets, and ductless enclosures shall not be used in lieu of chemical fume hoods. [45:7.4.9]

### A.16.3.2.1.4.9

Due to their low capture efficiency, canopy hoods should ~~only~~ be used only for exhausting heat and nuisance odors and not for exhausting chemicals. It is not the intent of this standard to prohibit the use of ductless enclosures (often incorrectly called "ductless hoods"). However, the use of such devices requires careful hazard analysis and risk assessment of all potential failure modes (mechanical, breakthrough, contamination, off gassing, etc.), how the owner is able to control uses for which the enclosure will not be adequate, how the user can continuously verify that the adsorption media is working properly, and how the spent media is to be safely removed and replaced, among numerous other concerns. The committee does not believe these enclosures are a suitable replacement for a chemical fume hood except after careful and thorough analysis. [45:A.7.4.9]

### 16.3.2.1.4.11\*

**Commented [DH5]:** This is a requirement in NFPA 45, but appears as an extract in the annex of NFPA 2, which is a violation of the extract policy. For instance, this statement says "shall" which is not allowed in the annex.

**Commented [RP6R5]:** After discussion, the TG felt just deleting this from the annex made the most sense.

**NFPA 45, 2024 Extracts**

The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

Air exhausted from chemical fume hoods and special exhaust systems shall be discharged above the roof at a location, height, and velocity sufficient to prevent re-entry of chemicals and to prevent exposures to personnel. [45:7.4.11]

**A.16.3.2.1.4.11**

Exhaust stacks should extend at least 3 m (10 ft) above the highest point on the roof to protect personnel on the roof. Exhaust stacks might need to be much higher to dissipate effluent effectively, and studies might be necessary to determine adequate design. Related information on stack height can be found in Chapter 14, Airflow Around Buildings, of the ASHRAE *Handbook of Fundamentals*. [45:A.7.4.11]

**16.3.2.1.5 Duct Construction for Hoods and Local Exhaust Systems.**

**16.3.2.1.5.1**

Ducts from chemical fume hoods and from local exhaust systems shall be constructed entirely of noncombustible materials except in the following cases:

- (1) Flexible ducts of combustible construction shall be permitted to be used for special local exhaust systems within a laboratory work area. (See 16.3.2.1.5.2.)
- (2) Combustible ducts shall be permitted to be used if enclosed in a shaft of noncombustible or limited-combustible construction where they pass through non-laboratory areas or through laboratory units other than the one they serve. (See 16.3.2.1.5.2.)
- (3) Combustible ducts shall be permitted to be used if all areas through which they pass are protected with an approved automatic fire-fire-extinguishing system, as described in 16.2.3. (See 16.3.2.1.5.2.)

[45:7.5.1]

**16.3.2.1.5.2**

Combustible ducts or duct linings shall have a flame spread index of 25 or less 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*. Test specimens shall be of the minimum thickness used in the construction of the duct or duct lining. [45:7.5.2]

**16.3.2.1.5.3**

Ducts shall be of adequate strength and rigidity to meet the conditions of service and installation requirements and shall be protected against mechanical damage. [45:7.5.5]

**16.3.2.1.5.4**

Materials used for vibration isolation connectors shall comply with 16.3.2.1.5.2. [45:7.5.6]

**16.3.2.1.5.5**

Controls and dampers, where required for balancing or control of the exhaust system, shall be of a type that, in the event of failure, will fail open to ensure continuous draft. (See 16.3.2.1.9.3 through 16.3.2.1.9.5.) [45:7.5.10.1.1]

**16.3.2.1.5.6**

Hand holes, where installed for damper, sprinkler, or fusible link inspection or resetting and for residue clean-out purposes, shall be equipped with tight-fitting covers provided with substantial fasteners. [45:7.5.8]

**16.3.2.1.5.7 Manifolding of Chemical Fume Hood and Ducts.**

**(A)**

Exhaust ducts from each laboratory unit shall be separately ducted to a point outside the building, to a mechanical room, or to a shaft. [45:7.5.9.1]

**(B)**

## NFPA 45, 2024 Extracts

The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

Connection to a common chemical fume hood exhaust duct system shall be permitted to occur within a building only in ~~any of~~ the following locations:

- (1) A mechanical room, not connected to a shaft, shall be protected in accordance with Table 5.1.1 of NFPA 45.
- (2) A shaft or a mechanical room connected to a shaft, shall be protected in accordance with the chapter on protection of vertical openings of NFPA 101
- (3) A point outside the building

[45:7.5.9.2]

### (C)

Exhaust ducts from chemical fume hoods and other exhaust systems within the same laboratory unit shall be permitted to be combined within that laboratory unit. (See 16.3.2.1.4.1.) [45:7.5.9.3]

#### 16.3.2.1.6 Exhausters (Fans), Controls, Velocities, and Discharge.

##### 16.3.2.1.6.1

Fans shall be selected to meet requirements for fire, explosion, and corrosion. [45:7.7.1]

##### 16.3.2.1.6.2

Fans conveying both corrosive and flammable or combustible materials shall be permitted to be lined with or constructed of corrosion-resistant materials having a flame spread index of 25 or less 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*. [45:7.7.2]

##### 16.3.2.1.6.3

Fans shall be located and arranged so as to afford ready access for repairs, cleaning, inspection, and maintenance. [45:7.7.3]

##### 16.3.2.1.6.4\*

Where ~~flammable gases, flammable vapors, or combustible dusts are~~~~[GH<sub>2</sub>-is]~~ passed through the fans, the rotating element shall be of nonferrous or spark-resistant construction; alternatively, the casing shall be constructed of or lined with such material. [45:7.7.4]

### (A)

~~Where there is the possibility of solid material passing through the fan that would produce a spark, both the rotating element and the casing shall be constructed of such material.~~ [45:7.7.4.1]

### (B)

Nonferrous or spark-resistant materials shall have a flame spread index of 25 or less 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*. [45:7.7.4.2]

#### A.16.3.2.1.6.4

For informative material regarding spark-resistant fan construction, see ANSI/Air Movement and Control Association (AMCA) *Standard 99-0401, Classification of Spark Resistant Construction Standards* for classifications for spark-resistant construction. [45:A.7.7.4]

##### 16.3.2.1.6.5

Motors and their controls shall be located outside the location where ~~flammable or combustible vapors or combustible dusts are~~~~[GH<sub>2</sub>-is]~~ generated or conveyed, unless specifically approved for that location and use. [45:7.7.5]

**NFPA 45, 2024 Extracts**

The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

**16.3.2.1.6.6\***

Fans shall be marked with an arrow or other means to indicate direction of rotation and with the location of chemical fume hoods and exhaust systems served. [45:7.7.6]

**A.16.3.2.1.6.6**

Exhaust fans should be tested to ensure they do not rotate backward in new installations or after repair on motors. [45:A.7.7.6]

**16.3.2.1.7 Chemical Fume Hood Requirements.**

(See also 16.3.2.1.2.2.) [45:7.8]

**16.3.2.1.7.1 Chemical Fume Hood Interiors.**

**(A)\***

Materials of construction used for the interiors of new chemical fume hoods or for the modification of the interiors of existing chemical fume hoods shall have a flame spread index of 25 or less 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~~, unless the interior of the hood is provided with automatic fire protection in accordance with 16.3.2.1.9.2. [45:7.8.1.17.8.2.1]

**A.16.3.2.1.7.1(A)**

Specifying the flame spread rating alone does not ensure that the liner will provide containment of a small fire. [45:A.7.8.1.17.8.2.1]

**(B)**

Chemical fume hoods shall meet the requirements of UL 1805, *Safety Laboratory Hoods and Cabinets*, or other approved standards. [45:7.8.2.2]

**(B.1)\***

Baffles shall be constructed so that they are unable to be adjusted to materially restrict the volume of air exhausted through the chemical fume hood. [45:7.8.1.37.8.2.3]

**A.16.3.2.1.7.1(B)**

Baffles normally should be adjusted for the best operating position for general use. Only where high heat loads or the routine use of large quantities of light or heavy gases occur should compensating adjustment be made. In most cases, however, the low concentrations of heavier-than-air and lighter-than-air vapors take on the characteristics of the large volumes of air going through the hood. It is recommended that the total adjustment not exceed 20 percent of the total airflow. [45:A.7.8.1.3A.7.8.2.3]

**(C)\***

~~Chemical fume hoods shall be provided with a means of preventing overflow of a spill of 0.5 gal (2 L) of liquid. [45:7.8.1.4]~~

~~**A.16.3.2.1.7.1(C)**~~

~~The means of containing minor spills might consist of a 6.4 mm (1/4 in.) recess in the work surface, use of pans or trays, or creation of a recess by installing a curb across the front of the hood and sealing the joints between the work surface and the sides, back, and curb of the hood. [45:A.7.8.1.4]~~

**16.3.2.1.7.2\* Chemical Fume Hood Sash Glazing.**

The sash, if provided, shall be glazed with material that will provide protection to the operator against the hazards associated with the use of the hood. (See also Annex H.) [45:7.8.27.8.3]

**A.16.3.2.1.7.2**

**NFPA 45, 2024 Extracts**

The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

A hood sash greatly enhances the safety provided by a chemical fume hood, and it is recommended that the hood design incorporate this feature. For example, a hood sash can be adjusted to increase the face velocity when working on high hazard material. The sash can be used as a safety shield. It can be closed to contain a fire or runaway reaction, and it can be closed to contain experiments when the hood is left unattended. [45:A.7.8.2A.7.8.3]

Hoods without sashes or hoods with a side or rear sash in addition to a front sash do not offer the same degree of protection as do hoods with protected single face openings, and, thus, their use is not recommended. A small face opening can be desirable to save exhaust air and energy or to increase the maximum face velocity on existing hoods.

[See the sash requirements of UL 1805, Laboratory Hoods and Cabinets.](#)

[45:A.7.8.2A.7.8.3]

**16.3.2.1.7.3\* Chemical Fume Hood Sash Closure.**

(A)

Chemical fume hood sashes shall be kept closed whenever possible. [45:7.8.3.11.2.2.1]

**[A.16.3.2.1.7.3](#)**

[Fully closing the sash will provide a layer of protection from an upset condition inside of the chemical fume hood. Modern hood designs allow airflow at all times, even when the sash is closed. Fully closed allows space between the work surface and the bottom of the sash for cables, hoses, and tubes to exit the hood. The intent of closing the sash is not to prevent airflow from entering the hood through the airfoil or other features designed in a hood. \[45:A.11.2.2.1\]](#)

(B)

~~When~~ [Where](#) a fume hood is unattended, its sash shall remain fully closed. [45:7.8.3.211.2.2.2]

**[A.16.3.2.1.7.3](#)**

[It is not the intent of this standard to require automatic sash closing devices. Users should be instructed and periodically reminded not to open sashes rapidly and to allow hood sashes to be open only when needed and only as much as necessary. \[45:A.7.8.3A.11.2.2.2\]](#)

**16.3.2.1.7.4\* Electrical Devices. [45:7.8.4]**

(A)

In installations where services and controls are within the hood, additional electrical disconnects shall be located within 50 ft (15 m) of the hood and shall be accessible and clearly marked. [45:7.8.4.1]

(B)

If electrical receptacles are located external to the hood, no additional electrical disconnect shall be required. [45:7.8.4.2]

**[A.16.3.2.1.7.4](#)**

Locating services, controls, and electrical fixtures external to the hood minimizes the potential hazards of corrosion and arcing. [45:A.7.8.4]

**16.3.2.1.7.5 Other Hood Services.**

(A)

For new installations or modifications of existing installations, controls for chemical fume hood services (gas, air, water, etc.) shall be located external to the hood and within easy reach. [45:7.8.5.1]

(B)

## NFPA 45, 2024 Extracts

The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

In existing installations where service controls are within the hood, additional shutoffs shall be located within 50 ft (15 m) of the hood and shall be accessible and clearly marked. [45:7.8.5.2]

### 16.3.2.1.7.6 Auxiliary Air.

For auxiliary air hoods, auxiliary air shall be introduced exterior to the hood face in such a manner that the airflow does not compromise the protection provided by the hood and so that an imbalance of auxiliary air to exhaust air will not pressurize the hood interior. [45:7.8.6]

### 16.3.2.1.7.7 Hood Proper Function Alarm.

#### (A)\*

A measuring device for indicating that the hood airflow remains within safe design limits shall be provided on each chemical fume hood. [45:7.8.7.1]

#### A.16.3.2.1.7.7(A)

Where a laboratory exhaust system can be overdrawn (as in a VAV system, for which it is assumed that all hoods are not at full capacity all the time — the so-called diversity factor) the hood alarm provides immediate warning to all users that their hood is no longer working properly. Hence, an indication that the exhaust system capacity has been breached is not required, although it might be desired by the owner. [45:A.7.8.7A.7.8.7.1]

#### (B)\*

The measuring device for hood airflow shall be a permanently installed device and shall provide continuous indication to the hood user of adequate airflow and alert inadequate hood airflow by a combination of an audible and visual alarm. Where an audible alarm could compromise the safety of the user or the research, alternative means of alarm shall be considered. [45:7.8.7.2]

#### A.16.3.2.1.7.7(B)

The intent of previous versions of this standard was to provide a local device that alerted users to improper hood performance. However, many commercially common installations showed face velocities that varied slightly, particularly during operation. This has led to frequent "alarms" even when the hoods were still within their design limits. Hence a Go/No Go-type sensor is actually preferred. ANSI/AIHA Z9.5, Laboratory Ventilation, recommends alarming if the average face velocity deviates by 20 percent or more; other sources and industry practice have suggested tighter limits of 10 percent. [45:A.7.8.7.1A.7.8.7.2]

### 16.3.2.1.8 Chemical Fume Hood Location.

#### 16.3.2.1.8.1\*

Chemical fume hoods shall be located in areas of minimum air turbulence. [45:7.9.1]

#### A.16.3.2.1.8.1

A person walking past the hood can create sufficient turbulence to disrupt a face velocity of 0.5 m/sec (100 ft/min). In addition, open windows or air impingement from an air diffuser can completely negate or dramatically reduce the face velocity and can also affect negative differential air pressure. [45:A.7.9.1]

#### ~~16.3.2.1.8.2~~

~~Chemical fume hoods shall not be located adjacent to a single means of access to an exit or to high-traffic areas. [45:7.9.2]~~

#### 16.3.2.1.8.3\*

Work stations not directly related to the chemical fume hood activity shall not be located directly in front of chemical fume hood openings. [45:7.9.3A.7.9.2]

#### A.16.3.2.1.8.3

**Commented [DH7]:** NFPA 45 committee removed requirement per the following: New requirements and revisions to Chapters 3, 7, and 11 to address the installation, operations, maintenance, and training necessary for safe use of ductless chemical fume hoods. Submitted by Ductless Fume Hood Task Group.

**Commented [RP8R7]:** The TG accepted the new NFPA 45 text as suitable for extraction.

## NFPA 45, 2024 Extracts

The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

Place low-hazard activities (such as desks and microscope benches) away from the chemical fume hood. The term *directly in front of* does not include those areas that are separated by a barrier ~~such as a lab bench~~ or other large structure that would serve as a shield. [45:A.7.9.3A.7.9.2]

### 16.3.2.1.9 Chemical Fume Hood Fire Protection.

#### 16.3.2.1.9.1 Automatic Fire Protection.

##### (A)\*

Automatic fire ~~protection-extinguishing~~ systems shall be provided in chemical fume hoods as provided in 16.3.2.1.9.1(B) ~~and 16.3.2.1.9.1(C)~~. [45:7.10.1]

##### A.16.3.2.1.9.1(A)

A hazard and risk assessment should be conducted for fume hood operations. Circumstances exist where hood fire suppression systems might be appropriate as a stand-alone protection measure or as part of a more comprehensive strategy to reduce hazards and risks. This assessment should be reviewed when fume hood operations change. See the objectives of the ~~NFPA 45~~ ~~standard~~ stated in Section 1.2 of NFPA 45. [45:A.7.10.1]

##### (B)

~~Existing hoods having interiors with a flame spread index greater than 25 in which Class I liquids [flash point < 100°F (37.8°C)] are handled. [45:7.10.1(1)]~~

##### (C)

If a hazard assessment ~~shows-determines~~ that an automatic extinguishing system is required for the chemical fume hood, then the applicable automatic fire protection system standard shall be followed. [45:~~7.10.2.1~~7.10.1(2)]

##### 16.3.2.1.9.2\*

Automatic fire protection systems, where provided, shall comply ~~NFPA 11, NFPA 12, NFPA 12A, NFPA 13, NFPA 15, NFPA 17, NFPA 17A, NFPA 69, NFPA 750, and NFPA 2001, as applicable.~~ ~~with the following standards, as applicable:~~

- (1) ~~NFPA 11~~
- (2) ~~NFPA 12~~
- (3) ~~NFPA 12A~~
- (4) ~~NFPA 13~~
- (5) ~~NFPA 15~~
- (6) ~~NFPA 17~~
- (7) ~~NFPA 17A~~
- (8) ~~NFPA 69~~
- (9) ~~NFPA 750~~
- (10) ~~\*NFPA 2001~~

[45:7.10.2.1]

##### ~~A.16.3.2.1.9.2(10)~~A.16.3.2.1.9.2

For further information, see ~~the report~~ entitled "An Investigation of Chemical Fume Hood Fire Protection Using Sprinkler and Water Mist Nozzles" prepared by Factory Mutual Research Corporation. [45:A.7.10.2.1]

**Commented [HD9]:** To extract 7.10.1 you must also extract 7.10.1(1) and 7.10.1(2) from NFPA 45.

**Commented [RP10R9]:** The TG agreed to abstract 7.10.1(2) from NFPA 45 as well.

**Commented [HD11]:** Annex A.16.3.2.1.9.2(12) is to be moved here.

**Commented [RP12R11]:** The TG accepted this.

## NFPA 45, 2024 Extracts

The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

### ~~(A)~~16.3.2.1.9.X

The fire extinguishing system shall be designed to extinguish fires within the chemical fume hood under the anticipated conditions of use. [45:7.10.2.2]

### 16.3.2.1.9.3\*

The design and installation of laboratory exhaust ducts shall be in accordance with NFPA 91, except that the requirements of 7.5.10.1 through 7.5.12 in NFPA 45 shall take precedence. [45:7.5.10]

#### A.16.3.2.1.9.3

Subsection 4.2.2 of NFPA 91 states that incompatible materials shall not be conveyed in the same system. [Section]Subsection 16.3.2.1.5.7(B) allows exhaust ducts within a laboratory unit to be combined. The apparent inconsistency is due to the focus of both standards. NFPA 45 assumes that in normal routine laboratory operations, the amount of materials released into the exhaust system is small and will be diluted below any levels of concern. [45:A.7.5.10]

### (A)\*

Automatic fire dampers shall not be used in laboratory exhaust systems. [45:7.5.10.1.2]

#### A.16.3.2.1.9.3(A)

In 2001, at the University of California, a fire resulted in an injury and caused approximately \$3.5 million in damage. Based on the investigation, it was concluded that the practice of not having fire dampers on the exhaust duct of the ventilation system at the shaft wall appears to have been beneficial in this fire scenario. The investigation observed that the exhaust system was effective at removing significant quantities of combustion products from the building during the fire, thereby reducing the amount of combustion products spreading to other areas of the building. The shutting down of the supply air by fire dampers did not significantly hinder the exhaust system because fresh air was provided through a broken window. However, if the window had not failed, the team concluded that the exhaust system probably would not have performed as well. [45:A.7.5.10.1.2]

### (B)

A duct conveying laboratory exhaust that passes through a fire barrier shall provide an alternative means of protection equal to or greater than the rating through which the duct passes by one of the following or in accordance with 16.3.2.1.9.3(C): [45:7.5.10.2.1]

- (1) Wrapped or encased with listed or approved materials having a fire-resistance rating equal to the fire barrier for 3-05 m (10 ft.) of the duct on each side of the fire barrier including duct supports within this span [45:7.5.10.2.1(1)]
- (2) Constructed of materials and supports having a minimum fire resistance rating equal to the fire barrier [45:7.5.10.2.1(2)]
- (3) Enclosed with a shaft that is constructed of material having a fire resistance rating equal to the fire barrier for 3-05 m (10 ft.) of the duct on each side of the fire barrier with no inlets to the duct within this distance, and the duct entry into and exit from the shaft is protected in accordance with 4.2.13 of NFPA 91. [45:7.5.10.2.1(3)]

### (C)

If not protected in accordance with 16.3.2.1.9.3(B), when an exhaust duct enters an exhaust shaft, the penetration shall be protected by all of the following:

- (1) Branch ducts connect to enclosed exhaust risers meeting the requirements of 5.3.4.1 or 5.3.4.4 of NFPA 90A.
- (2) The airflow moves upward.
- (3) \*Steel subducts at least 560 mm (22 in.) in length are carried up inside the riser from each inlet.

## NFPA 45, 2024 Extracts

The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

- (4) The riser is appropriately sized to accommodate the flow restriction created by the subduct.

[45:7.5.10.2.2]

### A.16.3.2.1.9.3(C)(3)

See Figure A.5.3 of NFPA 90A. [45:A.7.5.10.2.2(3)]

### 16.3.2.1.9.4

Fire detection and alarm systems shall not be interlocked to automatically shut down laboratory exhaust fans. [45:5.11]

### 16.3.2.1.9.5

Door operation for egress shall be maintained when the supply system shuts down and the lab exhaust system operates, creating a pressure differential. [45:7.5.12]

### 16.3.2.1.9.6

Chemical fume hoods equipped with control systems that vary the hood exhaust airflow as the sash opening varies and/or in conjunction with whether the laboratory room is in use (occupied or unoccupied) shall be equipped with a user-accessible means to attain maximum exhaust hood airflow regardless of sash position when necessary or desirable to ensure containment and removal of a potential hazard within the hood. [45:7.10.3]

### 16.3.2.1.9.7\*

Chemical fume hoods shall be installed in a manner that prevents fire or smoke from a fire in the chemical fume hood from spreading into the voids above the ceiling. [45:7.10.4]

### A.16.3.2.1.9.7

Installation of sprinklers in the void area or in the chemical fume hood is an acceptable method to prevent flame spread. [45:A.7.10.7A.7.10.4]

### 16.3.2.1.10 Identification of Chemical Fume Hood Systems.

#### 16.3.2.1.10.1\*

Special-use chemical fume hoods and special-use local exhaust systems shall be identified to indicate their intended use. [45:7.13.1]

#### A.16.3.2.1.10.1

Laboratory hoods in which radioactive materials are handled should be identified with the radiation hazard symbol. For information, see NFPA 801. [45:A.7.13.1]

#### 16.3.2.1.10.2

A sign containing the following information from the last inspection shall be affixed to each hood, or a properly maintained log of all hoods providing the following information shall be maintained:

- (1) Inspection interval
- (2) Last inspection date
- (3) Average face velocity
- (4) Location of fan that serves hood
- (5) Inspector's name

[45:7.13.2]

## NFPA 45, 2024 Extracts

The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

### 16.3.2.1.11 Inspection, Testing, and Maintenance.

#### 16.3.2.1.11.1

Inspection, testing, and maintenance requirements shall be established for all new and existing laboratories. [45:7.14.1]

#### 16.3.2.1.11.1\*

When installed or modified and at least annually thereafter, chemical fume hoods, ductless fume chemical fume hood exhaust systems, and laboratory special exhaust systems shall be inspected and tested as applicable, as follows:

- (1) Visual inspection of the physical condition of the hood interior, sash, and ductwork
- (2) Measuring device for hood airflow
- (3) Low airflow and loss-of-airflow alarms at each alarm location
- (4) Face velocity
- (5) Verification of inward airflow over the entire hood face
- (6) Changes in work area conditions that might affect hood performance

[45:7.14.2]

#### A.16.3.2.1.11.1

The operating characteristics of some chemical fume hood designs, particularly auxiliary air chemical fume hoods, change at intermediate positions of sash height. It is, therefore, important to verify inward airflow over the face of the hood according to 16.3.2.1.11.1(5) at several sash heights from full open to closed. [45:A.7.14.2]

A number of test procedures for verifying performance of chemical fume hoods that have been installed in the field have been published. [45:A.7.14.1]

A test procedure is given in *Standard on Laboratory Fume Hoods*, by The Scientific Equipment and Furniture Association (SEFA), that uses a velometer and visible fume for checking hood performance. [45:A.7.14.2]

A standard has been issued by the American Society of Heating, Refrigerating, and Air Conditioning Engineers entitled ASHRAE 110, *Method of Testing Performance of Laboratory Fume Hoods*. [45:A.7.14.2]

The Environmental Protection Agency's *Procedure for Certifying Laboratory Fume Hoods to Meet EPA Standards* contains a test procedure utilizing sulfur hexafluoride as a test gas. [45:A.7.14.2]

#### 16.3.2.1.11.2

Deficiencies in hood performance shall result in immediate suspension of all activities inside the hood until the deficiencies can be corrected.

[45:7.14.3]

#### 16.3.2.1.11.3

Chemical fume hood face velocity profile or hood exhaust air quantity shall be checked after any adjustment to the ventilation system balance. [45:7.14.4]

#### 16.3.2.1.11.4 Detectors and Alarms.

Air system flow detectors, if installed, shall be inspected and tested annually. [45:7.13.414.5.1]

**Commented [HD13]:** This has been added by NFPA 45. Is it desired to be added here?

NFPA 45 Committee: New requirements and revisions to Chapters 3, 7, and 11 to address the installation, operations, maintenance, and training necessary for safe use of ductless chemical fume hoods. Submitted by Ductless Fume Hood Task Group.

**Commented [RP14R13]:** After discussion, the TG agreed to extract 45:7.14.1 as well.

**Commented [RP15]:** Heath: No matter what I do any change to these lines dateless your comment for which I apologize. The TG decided not to include 45:7.14.5.2 as an extract.

## NFPA 45, 2024 Extracts

The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

~~(B) Where potentially corrosive or obstructive conditions exist, the inspection and test frequency shall be increased. [45:7.14.5.2]~~

### 16.3.2.1.11.5 Fans and Motors.

#### (A)\*

Air supply and exhaust fans, motors, and components shall be inspected at least annually. [45:7.14.6.5.1]

#### A.16.3.2.1.11.5(A)

The annual inspection of air supply and exhaust fans, motors, and components should ensure that equipment is clean, dry, tight, and friction-free. Bearings should be properly lubricated on a regular basis, according to manufacturers' recommendations. Protective devices should be checked to ensure that settings are correct and that ratings have been tested under simulated overload conditions. Inspections should be made by personnel familiar with the manufacturers' instructions and equipped with proper instruments, gauges, and tools. [45:A.7.14.6.5.1]

#### (B)

Where airflow detectors are not provided or airflow-rate tests are not made, fan belts shall be inspected quarterly; double sheaves and belts shall be permitted to be inspected semiannually. [45:7.14.6.5.2]

#### (C)

Frayed or broken belts shall be replaced promptly. [45:7.14.6.5.3]

### 16.3.2.2 Laboratory Operations and Apparatus.

#### 16.3.2.2.1 Operations.

This chapter shall apply to new and existing laboratories. [45:11.1]

#### 16.3.2.2.1.1\* Hazards of Chemicals and Chemical Reactions.

##### (A)

Before laboratory tests or chemical reactions are begun, evaluations shall be made for hazards that can be encountered or generated during the course of the work. [45:11.2.1.1]

##### (B)

Evaluations shall include the hazards associated with the properties and the reactivity of the materials used and any intermediate and end products that can be formed, hazards associated with the operation of the equipment at the operating conditions, and hazards associated with the proposed reactions — for example, oxidation and polymerization. [See also 16.3.2.2.1.1(D).] [45:11.2.1.2]

##### (C)

Regular reviews of laboratory operations and procedures shall be conducted with special attention given to any change in materials, operations, or personnel. [45:11.2.1.3]

##### (D)\*

Where reactions are being performed to synthesize materials, the hazard characteristics of which have not yet been determined by test, precautions shall be employed to control the highest possible hazard based on a known hazard of similar material. [45:11.2.1.4]

#### A.16.3.2.2.1.1(D)

When a new chemical is produced, it should be subjected to a hazard analysis as appropriate to the reasonably anticipated hazard characteristics of the material. Such tests might include, but are not limited to, differential thermal analysis, accelerating rate calorimetry, drop weight shock sensitivity, autoignition

**Commented [HD16]:** Is it desirable to add this extract from NFPA 45 for Detectors and Alarms?

**Commented [RP17R16]:** The TG decided that the new NFPA 45 requirement 45:7.14.5.2 is not required.

## NFPA 45, 2024 Extracts

The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

temperature, flash point, thermal stability under containment, heat of combustion, and other appropriate tests. [45:A.11.2.1.4]

### (E)\*

Where use of a new material or the premixing of flammable and oxidizing materials might present an explosion potential, initial experiments or tests shall be conducted in an enclosure that is designed to protect people and property from potential explosion damage. (See 16.2.4.) [45:11.2.1.5]

#### A.16.3.2.2.1.1(E)

In 2016, an experiment involving the use of a hydrogen, oxygen, and carbon dioxide gas mixture exploded in a laboratory, causing a serious injury and destroying the laboratory. [45:A.11.2.1.5]

### (F)

Unattended or automatic laboratory operations involving hazardous chemicals shall be provided with regular surveillance for abnormal conditions. (See 11.3.3.4 and 11.3.4.1 of NFPA 45) [45:11.2.1.6]

~~(1) All heating operations whether attended or unattended shall be provided with an independent high-temperature alarm and an automatic shutdown with manual reset to prevent system failure that can result in fire or explosion. [45:11.3.3.4]~~

~~(2) Electrically heated constant temperature baths shall be equipped with over-temperature shutoff switches in addition to normal temperature controls, if overheating could result in a fire or an explosion. [45:11.3.4.1]~~

#### A.16.3.2.2.1.1

Hazard evaluations and risk assessments should be performed by a team of people who are familiar with hazardous chemicals, chemical reactions, equipment, and operational procedures prior to laboratory work. In particular, when new or existing experiments involve a scale-up, an increase in flow rate, changes in physical properties (such as temperature or pressure), changes in equipment or supplies, mixing of incompatible materials, or a potential for explosion, hazard evaluations and risk assessments should be performed prior to initiating research. The hazard evaluation and risk assessment team should include the stakeholders, such as the principal investigator, and representatives working in the laboratory, in addition to any experts on the design and controls of the chemical process.

The hazard evaluations and risk assessments should include understanding of the interactivity of materials, associated energies, side reactions, and temperature rise for worst-case reactions and side reactions. The evaluation should also consider evaluation with the materials and equipment associated with the laboratory operation.

Where the hazard evaluation identifies significant hazards, appropriate controls need to be implemented to mitigate the hazards to prevent fires or explosions. Mitigations could include adequate pressure relief/venting, limited size of vessels, shielding, controllers, and analyzers with automated shutdowns.

Reference sources include the following:

(1) NFPA 49, NFPA 325, and NFPA 491, which are contained in NFPA's *Fire Protection Guide to Hazardous Materials*.

(2) NFPA 551

(3) Chapter 4 of *Prudent Practices in the Laboratory*

(4) *Handbook of Chemical Health and Safety*

(5) A free tool for chemical reactivity, available at <https://www.aiiche.org/ccps/resources/chemical-reactivity-worksheet-40>

[45:A.11.2.1]

**Commented [RP18]:** The TG agreed that deleting these two extracted sections makes the most sense as they are, as Heath pointed out, out of order. They are already referenced in (F) above. (See 11.3.3.4 and 11.3.4.1 of NFPA 45).

**Commented [HD19]:** You cannot make these subsection to the above since that is not how NFPA 45 is organized.

**Commented [RP20R19]:** See answer above.

## NFPA 45, 2024 Extracts

The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

### 16.3.2.2.1.2 Other Operations. (A)

Other laboratory operations, such as reactions at temperatures and pressures either above or below ambient conditions, shall be conducted in a manner that minimizes hazards. [45:11.2.8.7.1]

#### (B)

Shielding shall be used whenever there is a reasonable probability of explosion or vigorous chemical reaction and associated hazards during charging, sampling, venting, and discharge of products. (See ~~16.2.4~~ [Annex H](#) and 16.3.2.2.2.3.) [45:11.2.8.2]

#### ~~(C)~~

~~Glass apparatus containing gas or vapors under vacuum or above ambient pressure shall be shielded, wrapped with tape, or otherwise protected from shattering (such as engineering controls or by apparatus design) during use. [45:11.2.7.3]~~

#### ~~(D)~~\* (E)\*

Quantities of reactants shall be limited and procedures shall be developed to control or isolate vigorous or exothermic reactions. [45:11.2.7.4.3]

#### A.16.3.2.2.1.2(D)

Procedures might include chilling, quenching, cutoff of reactant supply, venting, dumping, and "short-stopping" or inhibiting. [45:A.11.2.8.3.4]

#### ~~(E)~~

~~[GH:]~~ Flammable gases or vapors evolved during drying operations shall be condensed, trapped, or vented to avoid ignition. [45:11.2.7.5.11.2.8.4]

#### (E)\*

[Spraying of flammable or combustible paint and varnishes shall comply with the requirements of NFPA 33. \[45:11.2.8.5\]](#)

#### A.16.3.2.2.1.2(E)

[The use of fume hoods for spray operations of paints, adhesives, or other material that can stick and accumulate could result in a buildup of flammable material that can both change airflow in the hood as well as increase the potential for a fire in the ductwork. Installation of devoted spray booths is the best solution. If that is not done, additional maintenance activities, enhanced \(or increased\) inspections, and routine cleaning should be considered. \[45:A.11.2.8.5\]](#)

### 16.3.2.2.2 Apparatus.

#### 16.3.2.2.2.1 General.

##### (A)\*

[Laboratory apparatus shall have a hazard analysis and risk assessment of the potential for hazards, including stored energy, before use. \[45:11.3.1.1\]](#)

##### A.16.3.2.2.2.1(A)

[The hazard analysis should include the following:](#)

- [\(1\) Failure modes and consequences of failure](#)
- [\(2\) Evaluations of safeguards and mitigations](#)
- [\(3\) Routine inspections](#)

**Commented [HD21]:** This has been moved in NFPA 45, and now extracted in 16.3.2.2.2.3.

**Commented [RP22R21]:** The TG accepted the new NFPA 45 text as suitable for extraction in the proposed new location..

## NFPA 45, 2024 Extracts

The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

(4) [Leak testing](#).

(5) [Grounding and bonding requirements](#)

[One key aspect of the hazard analysis is pressure stored energy. This is a function of different factors. For more information on assessing the risk associated with the quantity of stored energy, see Pressure Systems Stored-Energy Threshold Risk Analysis. \[45:A.11.3.1.1\]](#)

(B)

[The hazard analysis and risk assessment shall be maintained for the life of the equipment, updated as necessary based on revised operations and modifications, and communicated to all operating personnel. \[45:11.3.1.2\]](#)

(C)

Apparatus shall be installed in compliance with applicable requirements of NFPA standards, including *NFPA 70*, as well as [manufacturer's recommendations and generally accepted good engineering practices](#). [45:11.3.1.3]

(D)

[Apparatus shall be operated and maintained according to the manufacturer's instructions, the design limitations of the equipment, and applicable codes and regulations. \[45:11.3.1.4\]](#)

(E)

Operating controls shall be accessible under normal and emergency conditions. [45:11.3.1.5]

### 16.3.2.2.2 Heating Equipment and Heating Operations.

(A)

All heating of [Class I liquids \[flash point < 100°F \(37.8°C\)\]](#), [Class II and III liquids \[flash point ≥ 100°F \(37.8°C\)\]](#), or flammable ~~liquids, combustible liquids, or flammable~~ gases shall be conducted so as to minimize fire hazards. [45:11.3.3.1]

(B)

Provisions shall be made to contain liquid that might be accidentally released from glass apparatus containing more than 8.45 oz (.25 L) of [Class I liquid \[flash point < 100°F \(37.8°C\)\]](#) or [Class II and III liquid \[flash point ≥ 100°F \(37.8°C\)\]](#) ~~flammable liquid or combustible liquid~~ heated to its flash point. [45:11.3.3.2]

(C)

Supplementary fire-extinguishing equipment shall be provided, if necessary. [45:11.3.3.3]

(D)

All heating operations whether attended or unattended shall be provided with an [independent](#) high-temperature alarm and an automatic shutdown with manual reset to prevent system failure that can result in fire or explosion. [45:11.3.3.4]

(E)

Strong oxidizing materials, such as perchloric acid, shall not be heated by gas flames or oil baths. [45:11.3.3.5]

(F)

Heating equipment with circulation fans or water cooling shall be equipped with an interlock arranged to disconnect current to the heating elements if the fan fails or the water supply is interrupted. [45:11.3.3.6]

(G)

**Commented [HD23]:** This has been added by the NFPA 45 committee.

Combining sections 11.2.2 and 11.3.3 reduces redundancy, increases consistency and makes it easier for the user to find all the information on heating in one place. All heating operations should have an independent overtemperature shut down.

**Commented [HD24R23]:** Left off here

## NFPA 45, 2024 Extracts

The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

Burners, induction heaters, ovens, furnaces, and other heat-producing equipment shall be located a safe distance from areas where temperature-sensitive and flammable materials and ~~[GH<sub>2</sub>]~~ compressed gases are handled. [45:11.3.3.7]

(H)

Oven and furnace installations shall comply with ~~NFPA 86~~: one of the following:

- (i) ~~Comply with NFPA 86~~
- (ii) ~~Be listed~~
- (iii) ~~Be reviewed and approved by a qualified person for safe operation for the use or purpose~~

[45:11.3.3.8]

### ~~A.16.3.2.2.2(H)~~

Ovens under 150,000 Btu would not be under the scope of NFPA 86. [45:A.11.3.3.8]

#### 16.3.2.2.3 Pressure Equipment.

(A)

~~Glass apparatus containing gas or vapors under vacuum or above ambient pressure shall be shielded, wrapped with tape, or otherwise protected from shattering (such as engineering controls or by apparatus design) during use. [45:11.3.5.1]~~

Commented [HD25]: This is moved from 16.3.2.2.1.2.(C).

(A~~B~~)\*

Commented [RP26R25]: OK

Equipment used at pressures above ~~15-5~~ psi (~~103-34~~ kPa gauge) shall ~~be designed and constructed by qualified individuals for use at the expected temperature, pressure, and other operating conditions affecting safety~~; meet the following:

- (1) ~~Be designed and constructed by qualified individuals for use at the expected temperature, pressure, and other operating conditions affecting safety.~~
- (2) ~~Be fitted with a pressure relief device, such as a rupture disc or a relief valve, that vents to a safe location.~~
- (3)\* ~~Be inspected on a regular basis to ensure the equipment is in good condition (e.g., no corrosion, cracks, distortion, scale formation, general chemical attack, any weakening of the closure, or any inability of the equipment to maintain pressure).~~

### ~~A.16.3.2.2.3(B)(3)~~

~~The organization should have processes to address the results of the inspection, including removal from service, derating, or disposal of the apparatus and to document and communicate any change of status as needed. [45:A.11.3.5.2(3)]~~

[45:~~11.3.5.1~~11.3.5.2]

### ~~A.16.3.2.2.3(A)~~A.16.3.2.2.3(B)

~~Equipment used with the potential for pressure require that the designer be cognitive of the stored energy, potential failure modes, and design principles for each type of equipment that may be part of the system. Normally this is performed by the manufacturer of the apparatus but for in-house fabricated apparatus or systems, the designer should have their proposal reviewed and approved by a qualified individual before use.~~

Pressure vessels, in particular, require specialized design beyond the scope of normal workshop practice. For design of pressure vessels, see Section VIII, "Rules for Construction of Pressure Vessels," Division 1, ASME Boiler and Pressure Vessel Code. [45:~~A.11.3.5.1~~A.11.3.5.2]

# **NFPA 45, 2024 Extracts**

The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

~~(B)–~~

~~Pressure equipment shall be fitted with a pressure relief device, such as a rupture disc or a relief valve. The pressure relief device shall be vented to a safe location. [45:11.3.5.2]~~

~~(C)–~~

~~Equipment operated at pressures above 15 psi (103 kPa gauge), such as autoclaves, steam sterilizers, reactors, and calorimeters, shall be operated and maintained according to manufacturers' instructions, the design limitations of the equipment, and applicable codes and regulations. [45:11.3.5.3]~~

- ~~(1)– Such equipment shall be inspected on a regular basis. [45:11.3.5.3.1]~~
- ~~(2)– Any significant change in the condition of the equipment, such as corrosion, cracks, distortion, scale formation, or general chemical attack, or any weakening of the closure, or any inability of the equipment to maintain pressure, shall be documented and removed from service immediately and shall not be returned to service until approved by a qualified person. [45:11.3.5.3.2]~~

~~(D)–~~

~~Any pressure equipment that has been found to be degraded shall be derated or discarded, whichever is appropriate. [45:11.3.5.4]~~

## **16.3.2.2.4\* Analytical Instruments.**

**(A)**

Analytical instruments, such as infrared, ultraviolet, atomic absorption, x-ray, mass spectrometers, chromatographs, and thermal analyzers, shall be installed in accordance with the manufacturers' instructions and applicable standards and codes. [45:11.3.6.1]

### **A.16.3.2.2.4**

[Refer to Part III of NFPA 30, Supplement 5, Electrostatics, for guidance regarding electrostatic safety issues. This guidance should be reviewed in laboratories in which the use of high-density polyethylene \(HDPE\) for the collection of spent laboratory Class I liquid \[flash point < 100°F \(37.8°C\)\] wastes from a high-performance liquid chromatograph \(HPLC\) or similar apparatus occurs. \[45:A.11.3.6\]](#)

**(B)\***

Analytical instruments shall be operated in accordance with manufacturers' instructions or approved recommended operating procedures. [45:11.3.6.2]

### **A.16.3.2.2.4(B)**

Hazards to personnel from high voltage, vapors or fumes, radiation, flames, flashbacks, and explosions should be minimized. [45:A.11.3.6.2]

## **16.3.2.3 Hazard Identification.**

This ~~chapter-subsection~~ shall apply to new and existing laboratories. [45:13.1]

### **16.3.2.3.X Identification of Entrances. [45:13.2]**

#### **16.3.2.3.X.1\***

[Entrances to laboratory units, laboratory work areas, storage areas, and associated facilities shall be identified by signs to warn emergency response personnel of unusual or severe hazards that are not directly related to the fire hazard of contents. \[45:13.2.1\]](#)

### **A.16.3.2.3.X.1**

[Examples of severe or unusual hazards that might require posting of signs include the following:](#)

- [\(1\) Unstable chemicals](#)

## NFPA 45, 2024 Extracts

The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

- [\(2\) Radioactive chemicals](#)
- [\(3\) Carcinogens, mutagens, and teratogens](#)
- [\(4\) Pathogens](#)
- [\(5\) High-pressure reactions](#)
- [\(6\) High-powered lasers](#)
- [\(7\) Water-reactive materials](#)
- [\(8\) Cryogenics](#)

Also, the names and home telephone numbers of one or more persons working in each laboratory work area should be posted at the entrance to that work area. Such information should be kept current. [\[45:A.13.2.1\]](#)

It is important to recognize that an extremely toxic substance need not be identified as a proportionately hazardous substance. The quantity of the substance, the ease of penetration of its container or risk of its release by fire, and the probability of harming emergency response personnel are the true measures of the hazard level. This standard does not exclusively endorse any particular convention for communicating unusual hazards to emergency response personnel, recognizing that professional judgments need to be made on a facility-by-facility basis. These judgments should recognize several existing conventions. [\[45:A.13.2.1\]](#)

Use of the system presented in NFPA 704, which might be suitable for Class I liquid [flash point < 100°F (37.8°C)] storage cabinets or those laboratories containing a nearly constant chemical inventory, is not recommended for multichemical laboratories where the chemicals can change frequently. Such laboratories can include any of the following:

- [\(1\) Analytical, biological \(public health, genetic engineering, bacteriological\)](#)
- [\(2\) Physical and chemical \(organic, inorganic, physical, research, crystallographic, forensic\)](#)
- [\(3\) Instructional \(college and high school chemistry and physics laboratories\)](#)
- [\(4\) Metallurgical](#)
- [\(5\) Mineralogical](#)
- [\(6\) Fine art restoration and identification](#)
- [\(7\) Dental](#)

Even where storage within a laboratory involves unusually high amounts of flammable or toxic or reactive materials (and hence calls for hazard identification), a lettered sign is generally more easily understood than a numerical designation. Hence, the NFPA 704 system is not recommended for laboratories in general. [\[45:A.13.2.1\]](#)

### **[16.3.2.3.X.2](#)**

The hazards shall be communicated in the plans for firefighting. [\[45:13.2.2\]](#)

#### **16.3.2.3.1\* Exhaust Systems.**

Exhaust systems used for the removal of hazardous materials shall be identified to warn personnel of the possible hazards. [\[45:13.3\]](#)

##### **A.16.3.2.3.1**

The exhaust system should be identified "WARNING — Chemical Laboratory Exhaust" (or "Chemical Fume Hood Exhaust" or other appropriate wording). Exhaust system discharge stacks and discharge vents and

## NFPA 45, 2024 Extracts

The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

exhaust system fans should be marked to identify the laboratories or work areas being served.  
[45:A.13.3]

### 16.3.2.3.2 Identification Systems.

Graphic systems used to identify hazards shall comply with ANSI Z535.1, *Safety Colors*; ANSI Z535.2, *Environmental and Facility Safety Signs*; ANSI Z535.3, *Criteria for Safety Symbols*; and ANSI Z535.4, *Product Safety Signs and Labels*; or other approved graphic systems. [45:13.5]

#### 16.4.1.1.2.2

Cylinders in the laboratory shall be equipped with a pressure regulator designed for the specific gas and marked for its maximum cylinder pressure. [45:10.1.5.2]

##### (A)

The regulator system shall be equipped with two gauges, either on the regulator or remote from the regulator, installed so as to show both the cylinder pressure and the outlet pressure. [45:10.1.5.2.1]

##### (B)

Where the source cylinder is outside of the laboratory work area, a station regulator and inlet pressure gauge shall be installed at the point of use. [45:10.1.5.2.2]

##### (C)

Cylinders shall have a manual shutoff valve. A quick connect shall not be used in place of a shutoff valve. [45:10.1.5.3]

#### 16.4.1.2.2\*

Each point of use shall have an accessible manual shutoff valve. [45:10.2.3]

##### A.16.4.1.2.2

Additional shutoff valves, located in accessible locations outside of the areas in which the gases are used, are acceptable. [45:A.10.2.3]

#### 16.4.1.2.2.1

The manual shutoff valve at the point of use shall be located away from the potential hazards and be located within 6 ft (1.8 m) of the point of use. [45:10.2.3.1]

#### 16.4.1.2.2.2

Where the cylinder valve is located within 6 ft (1.8 m), a separate point-of-use shutoff valve shall not be required. [45:10.2.3.2]

#### 16.4.1.2.2.3

Line regulators that have their source away from the point of use shall have a manual shutoff valve on the high-pressure side of the regulator. [45:10.2.3.3]

#### 16.4.1.2.2.4

Educational and instructional laboratory work areas that have flammable gas piped in from an external source shall have an emergency gas shutoff device in an accessible location near one of the egress doors from the laboratory work area in addition to valves required elsewhere. [45:10.2.3.4]

#### 16.4.1.2.3\*

Every portion of a piping system shall be rated for a pressure equal to or greater than the maximum system pressure that can develop or shall have uninterrupted and adequately sized pressure relief. [45:10.2.4.1]

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The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

### A.16.4.1.2.3

Pressure relief should only be provided by devices designed and approved for this purpose. Providing pressure relief by use of a loosely attached plastic laboratory tubing, by leaving glass stoppers in a flask to pop off, or by other similar methods do not meet the requirements of this section. Failure of any device cannot be considered as pressure relief. [Relying on proper operation of a control device such as a regulator setting is not satisfactory for downstream pressure protection.](#) [45:A.10.2.4.1]

#### 16.4.1.2.3.1\*

A pressure relief system shall be designed to provide a discharge rate sufficient to avoid further pressure increase and shall vent to a safe location. [45:10.2.4.2]

##### A.16.4.1.2.3.1

Typically, relief devices are sized to provide the full flow rate at no more than 10 percent overpressure per ASME guidelines.

A safe location per 16.4.1.2.3.1 is into an exhaust duct, into the plenum of a laboratory hood, or into a vent that exits outside the building. [45:A.10.2.4.2]

#### 16.4.1.2.4\*

Permanent piping shall be identified at the supply point and at each discharge point with the name of the material being transported. [45:10.2.5]

##### A.16.4.1.2.4

It is recommended that each intermediate regulator and valve also be identified. The identification should conform to ANSI/ASME A13.1, *Scheme for the Identification of Piping Systems*. [45:A.10.2.5]

#### 16.4.1.2.5\*

Piping systems, including regulators, shall not be used for gases other than those for which they are designed and identified unless a thorough review of the design specifications, materials of construction, and service compatibility is made by a qualified person and any appropriate modifications have been made. [45:10.2.6]

##### A.16.4.1.2.5

Great care should be taken when converting a piping system from one gas to another. In addition to the requirements of 16.4.1.2.5, thorough cleaning to remove residues might be essential. For example, inert oil-pumped nitrogen will leave a combustible organic residue that is incompatible with oxygen and other oxidizing agents. Similar incompatibilities can occur with other materials. [45:A.10.2.6]

#### 16.4.1.3 LH<sub>2</sub>.

##### 16.4.1.3.1

All system components used for cryogenic fluids shall be selected and designed for such service. [45:10.4.1]

###### 16.4.1.3.1.1

Design pressure for vessels and piping shall be not less than 150 percent of maximum pressure relief. [45:10.4.1.1]

###### 16.4.1.3.1.2\*

Systems or apparatus handling a cryogenic fluid that can cause freezing or liquefaction of the surrounding atmosphere shall be designed to prevent contact of the condensed air with organic materials. [45:10.4.1.2]

###### A.16.4.1.3.1.2

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The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

Air can be condensed when it contacts containers or piping containing cryogenic fluids. When this occurs, the concentration of oxygen in the condensed air increases, thereby increasing the likelihood of ignition of organic material. [45:A.10.4.1.2]

### 16.4.1.3.2

Pressure relief of vessels and piping handling cryogenic fluids shall comply with the applicable requirements of 16.4.1.2. [45:10.4.2]

### 16.4.1.3.3

The space in which cryogenic systems are located shall be ventilated commensurate with the properties of ~~[LH<sub>2</sub>]~~the specific cryogenic fluid in use. [45:10.4.3]

### 16.4.2 Indoor Storage.

~~Cylinders that are not necessary for current laboratory requirements shall be stored outside the laboratory unit in accordance with Chapters 7 and 9.~~

~~[Cylinders except cylinders containing less than 10 scf (0.3 scm) [ - ] that are not "in use" per 10.1.6 necessary for current laboratory requirements shall be stored outside the laboratory unit in accordance with Chapters 7 and 9 NFPA 55. [45:10.1.2]]~~

### 16.4.3 Outdoor Storage.

#### 16.4.3.1

~~[GH<sub>2</sub>]Compressed gas cylinders installed or stored outside of laboratory buildings shall be installed and operated in accordance with Chapters 1 through 7 the requirements in NFPA 55. [45:10.3.1]~~

GH<sub>2</sub> cylinders installed or stored outside of laboratory buildings shall be installed and operated in accordance with Chapters 1 through 7.16.4.3.2

#### 16.4.3.2

Compressed gas delivery systems shall be designed in accordance with Chapters 1 through 7.

~~[Compressed gas delivery systems shall be designed in accordance with Chapters 1 through 7 NFPA 55. [45:10.3.2]]~~

### A.16.1.2(2)

The hazards of pilot plants are primarily based on the process, the chemistry, and the equipment, not the laboratory environment. Laboratories that have pilot plants within the laboratory unit should apply NFPA 45 to the laboratory portion. NFPA 45 should not be used to justify applying laboratory requirements, such as a general-purpose-area electrical classification, to the pilot plant itself. [45:A.1.1.3(2)]

### A.16.2.5.3

An emergency response plan should be prepared and updated. The plan should be available for inspection by the AHJ, upon reasonable notice. The following information should be included in the emergency plan:

- (1) The type of emergency equipment available and its location
- (2) A brief description of any testing or maintenance programs for the available emergency equipment
- (3) An indication that hazard identification marking is provided for each storage area
- (4) Location of posted emergency response procedures
- (5) Safety Data Sheets (SDSs) for all hazardous materials stored on site
- (6) A list of responsible personnel who are designated and trained to be liaison personnel for the fire department; these individuals should be knowledgeable in the site emergency response procedures and should aid the emergency responders with the following functions:

**Commented [RP27]:** The TG agreed to retain the current NFPA 2 language and not extract from NFPA 45.

**Commented [HD28]:** This requirement should not be extracted since the next edition of NFPA 55 no longer covers hydrogen.

**Commented [RP29R28]:** The TG agreed to retain the current NFPA 2 language and not extract from NFPA 45.

**Commented [DH30]:** This requirement should not be extracted since the next edition of NFPA 55 no longer covers hydrogen.

**Commented [RP31R30]:** The TG agreed to retain the current NFPA 2 language and not extract from NFPA 45.

**Commented [RP32]:** The TG agreed to retain the current NFPA 2 language and not extract from NFPA 45.

**Commented [HD33]:** This requirement should not be extracted since the next edition of NFPA 55 no longer covers hydrogen. This is also very similar to the above requirement.

**Commented [RP34R33]:** The TG Agreed.

## NFPA 45, 2024 Extracts

The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

- (a) Pre-emergency planning
  - (b) Identifying where flammable, pyrophoric, oxidizing, and toxic gases are located
  - (c) Accessing ~~MSDSs~~[SDSs](#)
- (7) A list of the types and quantities of compressed and liquefied gases normally at the facility

[45:A.6.5.3]

### A.16.4.1.2.1

For additional information, see the following:

- (1) CGA Pamphlet P-1, ~~Standard for~~ Safe Handling of Compressed Gases in Containers
- (2) ASME B31.1, *Power Piping* (including addendum)
- (3) ASME B31.3, *Process Piping*
- (4) National Safety Council Data Sheet 1-688-86, *Cryogenic Fluids in the Laboratory*

[45:A.10.2.1]

### H.1 Scope.

This annex is intended to provide laboratory management with information to assist in understanding the potential consequences of an explosion in a laboratory and the need for adequately designed protection. It is not intended to be a design manual. [45:C.1]

### H.2 General. [45:C.2]

#### H.2.1

Where a laboratory work area or a laboratory unit is considered to contain an explosion hazard great enough to cause property damage outside that laboratory work area or injury outside that laboratory area requiring medical treatment beyond first aid, appropriate protection should be provided for the occupants of the laboratory work area, the laboratory unit, adjoining laboratory units, and non-laboratory areas. [45:C.2]

#### H.2.2

Protection should be provided by one or more of the following [45:C.2.2]:

- (1) Limiting amounts of flammable or reactive chemicals or chemicals with unknown characteristics used in or exposed by experiments
- (2) Special preventive or protective measures for the reactions, equipment, or materials themselves (e.g., high-speed fire detection with deluge sprinklers, explosion-resistant equipment or enclosures, explosion suppression, and explosion venting directed to a safe location)
- (3) Explosion-resistant walls or barricades around the laboratory work area containing the explosion hazard
- (4) Remote control of equipment to minimize personnel exposure
- (5) Sufficient deflagration venting in outside walls and/or roofs to maintain the integrity of the walls separating the hazardous laboratory work area or laboratory unit from adjoining areas
- (6) Conducting experiments in a detached or isolated building or outdoors

#### H.2.3 Explosion-Resistant Construction. [45:C.2.3]

Where explosion-resistant construction is used, adequately designed explosion resistance should be achieved by the use of one of the following methods:

- (1) Reinforced concrete walls

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The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

- (2) Reinforced and fully grouted concrete block walls
- (3) Steel walls
- (4) Steel plate walls with energy-absorbing linings
- (5) Barricades, such as those used for explosives operations, constructed of reinforced concrete, sand-filled/wood-sandwich walls, wood-lined steel plate, or earthen or rock berms
- (6) Specifically engineered construction assemblies

### H.2.4 Explosion Venting. [45:C.2.4]

Where explosion venting is used, it should be designed to ensure the following:

- (1) Fragments will not strike other occupied buildings or emergency response staging areas.
- (2) Fragments will not strike critical equipment (e.g., production, storage, utility services, and fire protection).
- (3) Fragments will be intercepted by blast mats, energy-absorbing barrier walls, or earthen berms.

### H.2.5 Unauthorized Access. [45:C.2.5]

Properly posted doors, gates, fences, or other barriers should be provided to prevent unauthorized access to the following:

- (1) Laboratory work areas containing an explosion hazard
- (2) Laboratory units containing an explosion hazard
- (3) The space between explosion vents and fragment barriers

### H.2.6 Inspection and Maintenance. [45:C.2.6]

#### H.2.6.1

Inspection of all protective construction devices and systems should be conducted at least annually.

#### H.2.6.2

[Required maintenance should be done to ensure integrity and operability.](#)

#### H.2.6.3

[Explosion shields and special explosion-containing hoods should be inspected prior to each use for deterioration, especially transparent shields and sight panels in special explosion-containing hoods.](#)

### H.3 Explosion.

An explosion is the bursting or rupture of an enclosure or a container due to the development of internal pressure from a deflagration. [69, 2019] Reactive explosions are further categorized as deflagrations, detonations, and thermal explosions. [45:C.3]

#### H.3.1 Container Failure.

When a container is pressurized beyond its burst strength, it can violently tear asunder (explode). A container failure can produce subsonic, sonic, or supersonic shock waves, depending on the cause of the internal pressure. [45:C.3.1]

##### H.3.1.1

The energy released by failure of a vessel containing a gas or liquid is the sum of the energy of pressurization of the fluid and the strain energy in the vessel walls due to pressure-induced deformation. [45:C.3.1.1]

##### H.3.1.2

## NFPA 45, 2024 Extracts

The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

In pressurized gas systems, the energy in the compressed gas represents a large proportion of the total energy released in a vessel rupture, whereas in pressurized liquid systems, the strain energy in the container walls represents the more significant portion of the total explosion energy available, especially in high-pressure systems. [45:C.3.1.2]

### H.3.1.3

Small-volume liquid systems pressurized to over 34,500 kPa (5000 psi), large-volume systems at low pressures, or systems contained by vessels made of materials that exhibit high elasticity should be evaluated for energy release potential under accident conditions. This does not imply that nonelastic materials of construction are preferred. Materials with predictable failure modes are preferred. [45:C.3.1.3]

### H.3.1.4

Liquid systems containing entrained air or gas store more potential energy and are, therefore, more hazardous than totally liquid systems because the gas becomes the driving force behind the liquid. [45:C.3.1.4]

### H.3.1.5

For gas-pressurized liquid systems, such as nitrogen over oil, an evaluation of the explosion energy should be made for both the lowest and highest possible liquid levels. [45:C.3.1.5]

### H.3.1.6

For two-phase systems, such as carbon dioxide, an energy evaluation should be made for the entire system in the gas phase, and the expansion of the maximum available liquid to the gas phase should then be considered. [45:C.3.1.6]

### H.3.2.1

The reaction rate is proportional to the increasing pressure of the reaction. A deflagration can, under some conditions, accelerate and build into a detonation. [45:C.3.2.1]

### H.3.2.2

The deflagration-to-detonation transition (D-D-T) is influenced by confinement containment that allows compression waves to advance and create higher pressures that continue to increase the deflagration rates. This is commonly called *pressure piling*. [45:C.3.2.2]

### H.3.3.2

A detonation causes a high-pressure shock wave to propagate outwardly, through the surrounding environment, at velocities above the speed of sound. [45:C.3.3.2]

### H.3.4 Thermal Explosion.

A thermal explosion is a self-accelerating exothermic decomposition that occurs throughout the entire mass, with no separate, distinct reaction zone. [45:C.3.4]

### H.3.4.1

A thermal explosion can accelerate into a detonation. [45:C.3.4.1]

### H.3.4.2

The peak pressure and rate of pressure rise in a thermal explosion are directly proportional to the amount of material undergoing reaction per unit volume of the container. This is quite unlike gas or vapor explosions, where the loading density is normally fixed by the combustible mixture at one atmosphere. Frank-Kamenetskii's "Calculation of Thermal Explosion Limits" is useful in evaluating the critical mass in the thermal explosion of solids. [45:C.3.4.2]

### H.4 Effects of Explosions.

## NFPA 45, 2024 Extracts

The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

### H.4.1 Personnel Exposure.

Personnel exposed to the effects of an explosion are susceptible to injury from the following:

- (1) Missiles and explosion-dispersed materials
- (2) Thermal and corrosive burns
- (3) Inhalation of explosion products
- (4) Overpressure, including incident, reflection-reinforced incident, and sustained overpressure
- (5) Body blowdown and whole-body displacement

Injuries from missiles and explosion-dispersed materials, burns, and inhalation of toxic gases account for the majority of injuries related to small explosions. Approximation of physiological damage due to explosions is given in Table H.4.1(a) and Table H.4.1(b).  
[45:C.4.1]

**Table H.4.1(a) Blast Effects from Detonations**

| Blast Effect                   | Range (ft) for Indicated Explosive Yield (TNT Equivalent) |       |      |       | Criteria         |                                  |
|--------------------------------|-----------------------------------------------------------|-------|------|-------|------------------|----------------------------------|
|                                | 0.1 g                                                     | 1.0 g | 10 g | 100 g |                  |                                  |
| 1% eardrum rupture             | 1.1                                                       | 2.4   | 5.2  | 11    | 23.5 kPa         | ( $P_i = 3.4$ psi)               |
| 50% eardrum rupture            | 0.47                                                      | 1.0   | 2.2  | 4.7   | 110 kPa          | ( $P_i = 16$ psi)                |
| No blowdown                    | 0.31                                                      | 1.3   | 6.9  | ~30   | 57 kPa · msec    | ( $I_i + I_q = 1.25$ psi · msec) |
|                                |                                                           |       |      |       | 0.9 m/sec        | ( $V_{max} = 0.3$ ft/sec)        |
| 50% blowdown                   | <0.1                                                      | 0.29  | 1.1  | 4.1   | 57 kPa · msec    | ( $I_i + I_q = 8.3$ psi · msec)  |
|                                |                                                           |       |      |       | 0.6 m/sec        | $V_{max} = 2.0$ ft/sec           |
| 1% serious displacement injury | <0.1                                                      | <0.2  | <0.5 | ~1.1  | 373 kPa · msec   | ( $I_i + I_q = 54$ psi · msec)   |
|                                |                                                           |       |      |       | $V_{max} 4$ msec | ( $V_{max} = 13$ ft/sec)         |
| Threshold lung hemorrhage      | <0.1                                                      | <0.2  | 0.5  | 1.8   | 180 kPa · msec   | ( $I_i + I_q = 26$ psi · msec)   |
| Severe lung hemorrhage         | <0.1                                                      | <0.2  | <0.5 | ~1.1  | 360 kPa · msec   | ( $I_i + I_q = 52$ psi · msec)   |
| 1% mortality                   | <0.1                                                      | <0.2  | <0.5 | <1    | 590 kPa · msec   | ( $I_i + I_q = 85$ psi · msec)   |

**NFPA 45, 2024 Extracts**

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| Blast Effect                                                                                                    | Range (ft) for Indicated Explosive Yield (TNT Equivalent) |       |      |       | Criteria                                       |
|-----------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|-------|------|-------|------------------------------------------------|
|                                                                                                                 | 0.1 g                                                     | 1.0 g | 10 g | 100 g |                                                |
| 50% mortality                                                                                                   | <0.1                                                      | <0.2  | <0.5 | <1    | 900 kPa · msec ( $I_i + I_q = 130$ psi · msec) |
| 50% large 1.5 m <sup>2</sup> to 2.3 m <sup>2</sup> (16 ft <sup>2</sup> to 25 ft <sup>2</sup> ) windows broken   | 0.26                                                      | 1.1   | 5.7  | ~30   | 21 kPa · msec ( $I_r = 3$ psi · msec)          |
| 50% small 0.12 m <sup>2</sup> to 0.56 m <sup>2</sup> (1.3 ft <sup>2</sup> to 6 ft <sup>2</sup> ) windows broken | 0.17                                                      | 0.40  | 1.9  | 9.9   | 55 kPa · msec ( $I_r = 8$ psi · msec)          |

For U.S. Customary units, 1 g = 0.04 oz; 1 m = 3.3 ft.

$P_i$  = peak incident overpressure kPa (psi)

$V_{max}$  = maximum translational velocity for an initially standing man m/sec (ft/sec)

$I_i$  = impulse in the incident wave kPa · msec (psi · msec)

$I_q$  = dynamic pressure impulse in the incident wave kPa · msec (psi · msec)

$I_r$  = impulse in the incident wave upon reflection against a surface perpendicular to its path of travel kPa · msec (psi · msec)

Note: The overpressure-distance curves of thermal explosions and deflagrations do not match those of TNT detonations. Nondetonation explosions have lower overpressures in close for comparable energy releases but carry higher overpressures to greater distances. The critical factor is impulse. Impulse is the maximum incident overpressure (psi) multiplied by the pulse duration (msec).

[45:Table C.4.1(a)]

**Table H.4.1(b) Criteria for Estimating Missile Injuries**

| Kind of Missile                 | Critical Organ or Event | Related Impact Velocity |        |
|---------------------------------|-------------------------|-------------------------|--------|
|                                 |                         | m/sec                   | ft/sec |
| Nonpenetrating                  | Cerebral concussion:    |                         |        |
| 4.5 kg (10 lb) object           | Threshold               | 4.6                     | 15     |
|                                 | Skull fracture:         |                         |        |
|                                 | Threshold               | 4.6                     | 15     |
|                                 | Near 100%               | 7.0                     | 23     |
| Penetrating*                    | Skin laceration:        |                         |        |
| 10 gm (0.35 oz) glass fragments | Threshold               | 15                      | 50     |
|                                 | Serious wounds:         |                         |        |

**NFPA 45, 2024 Extracts**

The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

| Kind of Missile | Critical Organ or Event | Related Impact Velocity |        |
|-----------------|-------------------------|-------------------------|--------|
|                 |                         | m/sec                   | ft/sec |
|                 | Threshold               | 30                      | 100    |
|                 | 50%                     | 55                      | 180    |
|                 | 100%                    | 91                      | 300    |

\*Eye damage, lethality, or paralysis can result from penetrating missiles at relatively low velocities striking eyes, major blood vessels, major nerve centers, or vital organs.

[45:Table C.4.1(b)]

**H.4.2 Damage to Structural Elements.**

The potential for damage to high-value buildings and equipment also warrants special consideration. Failure of building components should not be overlooked as a source of injury to personnel. [45:C.4.2]

**H.4.2.1**

Where the incident impulse is reinforced by reflection, as will be the case in large explosions within or near structures, the incident peak pressures for given damage are substantially lowered. The reflected pressure might be from 2 to 19 times greater than the incident pressure, depending on the magnitude of the incident pressure and the distance from reflecting surfaces. However, when a small explosion located more than a few inches from a reflecting surface has a TNT equivalence of less than 100 g<sub>m</sub> (3.5 oz), the reinforcement phenomenon is negligible because of the rapid decay of both the incident pressure wave and the reflected pressure wave with distance. [45:C.4.2.1]

**H.4.2.2**

Thermal explosions and deflagrations having impulses with rates of pressure rise greater than 20 milliseconds require peak pressures approximately three times those of detonations in order to produce similar damage. [45:C.4.2.2]

**H.4.2.3**

A sustained overpressure will result when a large explosion occurs in a building with few openings or inadequate explosion venting. This sustained overpressure is more damaging than a short duration explosion of equivalent rate of pressure rise and peak pressure. Explosions with TNT equivalencies of less than 100 g<sub>m</sub> (3.5 oz) would not be expected to create significant sustained overpressures, except in small enclosures. (In small explosions, burns, inhalation of toxic gases, and missile injuries usually exceed blast wave injuries.) [45:C.4.2.3]

**H.5 Hazard Analysis.**

**H.5.1**

The determination of the degree of hazard presented by a specific operation is a matter of judgment. An explosion hazard should be evaluated in terms of likelihood, severity, and the consequences of an explosion, as well as the protection required to substantially reduce the hazard. A review of the explosion hazard analysis by an appropriate level of management is recommended. [45:C.5.1]

**H.5.2**

The severity of an explosion is measured in terms of the rate of pressure rise, peak explosion pressure, impulse, duration of the overpressure, dynamic pressure, velocity of the propagating pressure wave, and residual overpressures. The effects of an explosion within an enclosure, such as a laboratory hood, laboratory work area, or laboratory unit can be far more severe than the effects of a similar explosion in an open space. Of primary importance is the missile hazard. Some explosions, such as in overpressurized lightweight glassware, can generate

## NFPA 45, 2024 Extracts

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pressure waves that, in themselves, do not endanger personnel, but the resulting fragments can blind, otherwise injure, or kill the experimenter. An explosion that develops pressures sufficient to endanger personnel in a laboratory work area usually will present a serious missile hazard. Consideration of missile hazards should include primary missiles from the vessel in which the explosion originates, secondary missiles accelerated by the expanding blast wave, and the mass, shape, and velocity of the missiles. It should be noted that an improperly anchored or inadequately designed shield also can become a missile. The possibility of flames and dispersion of hot, corrosive, or toxic materials likewise should be considered. [45:C.5.2]

### H.5.3

The likelihood of an explosion is estimated by considering such factors as the properties of the reactants; history of the reaction based on literature search, and so forth; possible intermediates and reaction products; pressure, volume, stored energy, design integrity, and safety factors of reaction vessels; pressure relief provisions, in the case of pressure vessels; and explosive limits, quantities, oxygen enrichment, and so forth, of flammable gases or vapors. The term *likelihood*, rather than *probability*, is used to describe an estimated event frequency based on experience, knowledge, or intuitive reasoning, rather than on statistical data. In general, there will be insufficient data to develop mathematical probabilities. [45:C.5.3]

### H.5.4

The consequences of an explosion can be estimated by considering the interactions of the explosion with personnel, equipment, and building components at varying distances from the center of the explosion. This analysis should include the following:

- (1) Numbers and locations of personnel
- (2) Injury and fatality potentials
- (3) Repair or replacement cost of equipment
- (4) Ability of the building or room or equipment to withstand the explosion and the cost to restore the facility and equipment
- (5) Adverse impact on research and development and business interruption costs as a result of loss of use of the facility

[45:C.5.4]

### H.5.5

Items H.5.5.1 through H.5.5.4 contain recommendations for protecting against explosion hazards of reactions conducted above atmospheric pressures. [45:C.5.5]

#### H.5.5.1

High-pressure experimental reactions should be conducted behind a substantial fixed barricade that is capable of withstanding the expected lateral forces. The barricade should be firmly supported at top and bottom to take these forces. At least one wall should be provided with explosion venting directed to a safe location. (See NFPA 68.) [45:C.5.5.1]

#### H.5.5.2

Reaction vessels should be built of suitable materials of construction and should have an adequate safety factor. [45:C.5.5.2]

#### H.5.5.3

All reaction vessels should be provided with a pressure relief valve or a rupture disc. [45:C.5.5.3]

#### H.5.5.4

Low-pressure reactions should be conducted in or behind portable barricades. [45:C.5.5.4]

## H.6 Explosion Hazard Protection.

## NFPA 45, 2024 Extracts

The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

### H.6.1

It is important to remember that a conventional laboratory hood is not designed to provide explosion protection.  
[45:C.6.1]

### H.6.2

The design of explosion hazard protection measures should be based on the following considerations:

- (1) Blast effects, as follows:
  - (a) Impulse
  - (b) Rate and duration of pressure rise
  - (c) Peak pressure
  - (d) Duration of overpressure
  - (e) Velocity of the propagating pressure wave
  - (f) Residual overpressure and underpressure
- (2) Missiles, as follows:
  - (a) Physical properties of the material
  - (b) Mass
  - (c) Shape
  - (d) Velocity

[45:C.6.2]

### H.6.3

Protection can be provided by one or more of the following methods:

- (1) Providing special preventive or protective measures (such as explosion suppression, high-speed fire detection with deluge sprinklers, explosion venting directed to a safe location, or explosion-resistant enclosures) for reactions, equipment, or the reactants themselves
- (2) Using remote control to minimize personnel exposure
- (3) Conducting experiments in a detached or isolated building, or outdoors
- (4) Providing explosion-resistant walls or barricades around the laboratory
- (5) Limiting the quantities of flammable or reactive chemicals used in or exposed by the experiments
- (6) Limiting the quantities of reactants of unknown characteristics to fractional gram amounts until the properties of intermediate and final products are well established
- (7) Providing sufficient explosion venting in outside walls to maintain the integrity of the walls separating the hazardous laboratory work area from adjacent areas (Inside walls should be of explosion-resistant construction.)
- (8) Disallowing the use of explosion hazard areas for other nonexplosion hazard uses
- (9) Locating offices, conference rooms, lunchrooms, and so forth, remote from the explosion hazard area

[45:C.6.3]

### H.6.4 Explosion-Resistant Hoods and Shields.

## NFPA 45, 2024 Extracts

The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

Laboratory personnel can be protected by specially designed explosion-resistant hoods or shields for TNT equivalencies up to 1.0 g (0.04 oz). For slightly greater TNT equivalencies, specially designed hoods provided with explosion venting are required. For TNT equivalencies greater than 2.0 g (0.07 oz), explosion-resistant construction, isolation, or other protective methods should be used. [45:C.6.4]

### H.6.4.1

Conventional laboratory hoods are not designed to provide explosion protection. [45:C.6.4.1]

### H.6.4.2

When explosion-resistant hoods or shields are used, they should be designed, located, supported, and anchored so as to do the following:

- (1) Withstand the effects of the explosion
- (2) Vent overpressures, injurious substances, flames, and heat to a safe location
- (3) Contain missiles and fragments
- (4) Prevent the formation of secondary missiles caused by failure of hood or shield components

[45:C.6.4.2]

### H.6.4.3

Commercially available explosion shields should be evaluated against the criteria of H.6.4.2 for the specific hazard. [45:C.6.4.3]

### H.6.4.4

Mild steel plate offers several advantages for hood and shield construction. It is economical, easy to fabricate, and tends to fail, at least initially, by bending and tearing, rather than by spalling, shattering, or splintering. [45:C.6.4.4]

The use of mirrors or closed-circuit television to view the experiments allows the use of nontransparent shields without hampering the experimenter. [45:C.6.4.4]

### H.6.4.5

When transparent shields are necessary for viewing purposes, the most common materials used are safety glass, wire-reinforced glass, and acrylic or polycarbonate plastic. Each of these materials, although providing some missile penetration resistance, has a distinct failure mode. [45:C.6.4.5]

Glass shields tend to fragment into shards and to spall on the side away from the explosion. Plastics tend to fail by cracking and breaking into distinct pieces. Also, plastics can lose strength with age, exposure to reactants, or mechanical action. Polycarbonates exhibit superior toughness compared to acrylics. [45:C.6.4.5]

Glass panels and plastic composite panels (safety glass backed with polycarbonate, with the safety glass toward the explosion hazard) have been suggested as an improved shield design. The glass blunts sharp missiles, and the polycarbonate contains any glass shards and provides additional resistance to the impulse load. [45:C.6.4.5]

## H.6.5 Explosion-Resistant Construction.

As explained in H.6.4, explosion-resistant construction can be required for TNT equivalencies greater than 2.0 g (0.07 oz). Explosion-resistant construction should be designed based on the anticipated blast wave, defined in terms of peak impulse pressure and pulse duration, and the worst-case expected missile hazard, in terms of material, mass, shape, and velocity. Missile velocities of 305 m/sec to 1220 m/sec (1000 ft/sec to 4000 ft/sec) normally can be expected. [45:C.6.5]

### H.6.5.1

The response of a wall to an explosive shock is a function of the pressure applied and of the time period over which the pressure is applied. The pressure-time product is known as impulse. [45:C.6.5.1]

## NFPA 45, 2024 Extracts

The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

Detonations of small quantities of explosive materials usually involve very short periods of time (tenths of milliseconds) and high average pressure. [45:C.6.5.1]

Gaseous deflagrations usually involve longer time periods and low average pressures. [45:C.6.5.1]

### H.6.5.2

Information on design of explosion-resistant walls and barricades can be obtained from references in Annex I. [45:C.6.5.2]

### H.6.6 Explosion Venting.

Peak pressure and impulse loadings resulting from deflagrations (not detonations) can be significantly reduced by adequate explosion venting. (See NFPA 68 for information on calculating required vent areas.) [45:C.6.6]

#### H.6.6.1

Explosion vents should be designed and located so that fragments will not strike occupied buildings or areas where personnel could be located. Blast mats, energy-absorbing barriers, or earthen berms can be used to interrupt the flight of fragments. [45:C.6.6.1]

#### H.6.6.2

An air blast, unlike a missile, is not interrupted by an obstacle in its line of travel. Instead, the blast wave will diffract around the obstacle and, except for slight energy losses, is essentially fully reconstituted within five to six obstacle dimensions beyond the obstacle. However, in the case of a small [TNT equivalence of 100 g (3.5 oz) or less] explosion, the wave decay with distance can more than offset the reinforcement phenomena. [45:C.6.6.2]

### I.1 General Hazards.

Thoroughly know the hazards of the gas you are using. All compressed gases have the pressure hazard, but a gas can also have more hazards; gases can be toxic, corrosive, flammable, asphyxiating, oxidizing, pyrophoric, and/or reactive. All these factors can impact the design of the system and how the gases are utilized. [45:F.1]

### I.2 Eye Protection.

Always wear eye protection when working on or near compressed gas systems. Make it your job not to let anyone without eye protection into any area where compressed gases are used or stored. [45:F.2]

### I.3 Train Users.

Never let anyone use or connect a cylinder to any system unless that person is trained and knowledgeable in the dangers of pressure, the chemical properties of the compressed gas, and the proper Compressed Gas Association (CGA) compressed gas fittings and connections. [45:F.3]

### I.4 Cylinder Identification.

Do not use a compressed gas cylinder unless the cylinder is clearly marked or labeled with the cylinder's contents. Reject any cylinder that is unmarked or has conflicting markings or labels. Never rely on the color of the cylinder to identify the contents. If there is any conflict or doubt concerning the contents, do not use the cylinder. Return it to your vendor. [45:F.4]

### I.5 Cylinder Content.

Be certain that the content of the cylinder is the correct product for use in the system to which you are connecting it. [45:F.5]

### I.6 Regulator Use.

Never use a compressed gas cylinder without a pressure-reducing regulator or device that will safely reduce the cylinder pressure to the pressure of your system. Only use regulators that have both a high-pressure gauge and a low-pressure gauge. This allows you to monitor both the pressure in the compressed gas cylinder and the pressure in the system. [45:F.6]

## NFPA 45, 2024 Extracts

The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

### I.7 Pressure Gauge Use.

As per [ASME B40.1](#) ~~ANSI B 40.1~~, *Pressure Gauges and Gauge Attachments*, never use a gauge above 75 percent of its maximum face reading. For example, a 20,700 kPa (3,000 psi) system should use at least 27,600 kPa (4,000 psi) gauges. If your system can achieve a maximum pressure of 517 kPa (75 psi), the gauge monitoring the system should be at least 690 (100 psi). (Immediately replace any gauge whose pointer does not go back to its zero point when pressure is removed.) [45:F.7]

### I.8 Valves.

Be sure the valve on the compressed gas cylinder and the pressure-reducing regulator you are using have the proper CGA connections for the pure gas (CGA V-1) or gas mixture (CGA V-7) you are using. NEVER USE AN ADAPTOR BETWEEN A CYLINDER AND A PRESSURE-REDUCING REGULATOR. [45:F.8]

### I.9 Proper Connection.

Be certain the CGA connection(s) on the cylinder and the pressure-reducing regulator fit together properly without being too loose or too tight. Proper connections will go together smoothly. Never use excessive force to connect a CGA connection. NEVER USE AN AID, such as pipe dope or Teflon® tape, TO CONNECT A REGULATOR TO A CYLINDER. [45:F.9]

### I.10 Connections.

Be certain that the pressure-reducing regulator you are using is compatible with the gas, and be certain that it is rated and marked for the maximum pressure rating of the CGA connection on the compressed gas cylinder valve you are attaching it to. All compressed gas cylinder connections can be found listed with their recommended gases and the maximum allowed pressures in CGA/ANSI V-1, *Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections*. [45:F.10]

### I.11 Regulator Compatibility.

Never replace the CGA connection that the regulator manufacturer has put on a regulator with one for a different gas service. Only the regulator manufacturer or a trained service representative knows the gas compatibility of the regulator's internal design and can properly reclean the regulator. [45:F.11]

### I.12 Procedures.

After attaching a pressure-reducing regulator to a compressed gas cylinder, do the following:

- (1) Turn the regulator's adjustment screw out (counterclockwise) until it feels loose.
- (2) Stand behind the cylinder with the valve outlet facing away from you.
- (3) Observe the high-pressure gauge on the regulator from an angle; do not pressurize a gauge while looking directly at the glass or plastic faceplate.
- (4) Open the valve handle on the compressed gas cylinder S-L-O-W-L-Y, until you hear the space between the cylinder valve gently fill the gas. (You can also watch the pressure rise on the high-pressure gauge. If you turned the regulator's adjustment screw back properly, there should be no gas flow out of the regulator or pressure rise on the low-pressure gauge.)
- (5) If you are using a nontoxic, nonflammable gas, you can ensure purity by shutting off the cylinder valve and gently cracking the CGA connection at the cylinder valve. (Generally, three pressurizations with venting will ensure the interior of the connection has a clean, representative sample of the gas in the compressed gas cylinder. For toxic or flammable gases, you can purchase special venting regulators that can be safely vented to a fume hood or vented gas cabinet.)
- (6) When you are ready to use the compressed gas cylinder, fully open the cylinder valve until you feel it stop. Then, close it one-quarter turn. (A fully open valve that has no play in it can confuse a person who is checking to see if it is open. Many accidents have been recorded by people trying to open a previously fully opened valve by using a large wrench.)

## NFPA 45, 2024 Extracts

The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

- (7) Use the following practices on acetylene cylinders to allow quick closing of the valve in the event of an emergency:
  - (a) Open acetylene cylinder valves no more than one and one-half turns.
  - (b) Leave the wrench on the valve spindle when the cylinder is being used, if the acetylene cylinder has a T-wrench instead of a hand-wheel valve.

[45:F.12]

### I.13 Pressure Relief.

Make sure any system you are pressurizing (piping, manifolds, containers, etc.) that can be isolated or closed off has its own pressure-relief device. It is the user's responsibility to see that the system has proper pressure-relief device(s) built into it. Do not rely on the relief device on the compressed gas cylinder's regulator; it is not designed to protect downstream systems. This is very critical when cryogenic liquids are used. Pressure-relief discharge points should be vented to safe locations (not directed ~~toward~~[towards](#) people or routed to safe locations for hazardous gases). [45:F.13]

### I.14 Cylinders Not in Use.

Shut off cylinders that are not in use. Always have a cylinder cap on any cylinder that is being stored or is not in use. [45:F.14]

### I.15 Backflow Precautions.

Use backflow check valves where flammable and oxidizing gases are connected to a common piece of equipment or where low- and high-pressure gases are connected to a common set of piping. Do not rely on a closed valve to prevent backflow. [45:F.15]

### I.16 Pressure Relief.

The relief device on a cylinder of liquefied flammable gas (generally found on the cylinder valve) always should be in direct contact (communication) with the vapor space of the cylinder in both use and storage. Never lay a cylinder of liquefied flammable gas on its side unless it is so designed (and so marked) to allow that positioning, as in the case of propane cylinders for forklift trucks. [45:F.16]

### I.17 Protection of Cylinders in Use.

Cylinders in use should be secured by a holder or device specifically designed to secure a cylinder. Never stand a single cylinder in an open area unsecured. Always protect cylinders from dangers of overhead hazards, high temperatures, and other sources of damage, such as vehicle traffic. [45:F.17]

### I.18 Moving Cylinders.

Always use a cylinder cart to move large cylinders or specially designed cylinder holders to carry small cylinders. Never pick up a cylinder by its cap. [45:F.18]

### I.19 Refilling.

Never refill a cylinder or use a cylinder for storing any material. If gas is accidentally forced back or sucked back into a cylinder, mark the cylinder well and inform your gas supplier. (Almost all recent deaths involving compressed gas cylinders occurred as users were putting gas back into cylinders and fillers at the compressed gas plants.) [45:F.19]

### I.20 Asphyxiation.

Possibly the greatest hazard to a user of compressed gases — and especially users of cryogenic fluids — is asphyxiation. Remember; that, except for oxygen and for air with at least 19.5 percent oxygen, ALL GAS IS AN ASPHYXIAN. Vent gas only into safe and properly ventilated locations outside ~~of~~ the building or fume hood. EXPOSURE TO AN ATMOSPHERE THAT HAS 12 PERCENT OR LESS OXYGEN WILL BRING ABOUT UNCONSCIOUSNESS WITHOUT WARNING AND SO QUICKLY THAT THE INDIVIDUALS CANNOT HELP OR PROTECT THEMSELVES. [45:F.20]

## NFPA 45, 2024 Extracts

The task group has decided to make the extracts into NFPA 2 from NFPA 45, 2024 match exactly per the NFPA MOS.

### I.21 Cryogenic Gases.

If you are transferring cryogenic gases inside or have equipment using cryogenic gases that vents anything more than a few cubic centimeters of gas per minute inside (i.e., not to a hood), you should have adequate 24-hour ventilation and install continuous oxygen meter(s)/monitor(s) with a "low oxygen" alarm. [45:F.21]

Remember, all compressed gases are hazardous; understand those hazards completely and design your system accordingly. The major compressed gas vendors have the technical expertise available to support users. NEVER BECOME COMPLACENT WHEN USING A COMPRESSED GAS. Always respect the hazards and treat them accordingly. [45:F.21]