Hydrogen Refueling Code Gap Assessment

Final Report

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FOREWORD

As part of its goal to support the development of codes and standards for hydrogen technology, the National Renewable Energy Laboratory requested that the Foundation conduct a study to identify gaps and conflicts in current codes and standards addressing the construction permitting of refueling stations for fuel cell electric vehicles (FCEVs) as well as other hydrogen facilities. Once these conflicts and gaps are recognized, proposed resolutions for the relevant codes and standards are provided. In general, the requirements within relevant codes and standards should be harmonized in order to simplify the planning, design and construction requirements for gaseous hydrogen refueling stations from jurisdiction to jurisdiction. This harmonization has already been accomplished to a large degree due to the continued efforts of the responsible Technical Committees (TCs). This report offers a fresh look at the current requirements and offers suggestions for the continued improvement of hydrogen codes and standards.

The content, opinions and conclusions contained in this report are solely those of the authors.

Hydrogen Refueling Code Gap Assessment

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Executive Summary

The goal of this project is to identify gaps and conflicts in current codes and standards addressing the construction permitting of refueling stations for fuel cell electric vehicles (FCEVs) as well as other hydrogen facilities. Once these conflicts and gaps are recognized, proposed resolutions for the relevant codes and standards are provided. In general, the requirements within relevant codes and standards should be harmonized in order to simplify the planning, design and construction requirements for gaseous hydrogen refueling stations from jurisdiction to jurisdiction. This harmonization has already been accomplished to a large degree due to the continued efforts of the responsible Technical Committees (TCs). This report offers a fresh look at the current requirements and offers suggestions for the continued improvement of hydrogen codes and standards.

Introduction

The goal of this project is to identify gaps and conflicts in current codes and standards addressing the construction permitting of refueling stations and other hydrogen facilities. A code gap is considered to be a subject that one might expect to find information on within the document of interest, yet no information is present. This is especially common with new products and technologies. As the hazards associated with new products and technologies become better understood, codes / standards are revised to better address those hazards. A conflict exists when hazards are addressed in multiple codes / standards but the prescribed hazard mitigation varies among these codes and standards. For example, one code may prescribe a separation distance (e.g. - setback to property line, separation between hazards, separation between hazard and exposure, etc.) of 10 feet while another code or standard requires a separation distance of 30 feet. Code harmony is desired so that construction requirements are similar regardless of which codes / standards are utilized from jurisdiction to jurisdiction.

Plan review for a proposed construction project can frequently identify areas where codes have shortcomings, conflicts or gaps. A mock plan review was conducted of two (2) installations for which complete plans currently exist. The plan review was a tool used to assist in the identification of code issues and not the focus of the effort. Specific results of the plan review effort are not discussed further but were used along with side by side comparison of existing requirements to produce the issues discussed in this report. Relevant codes and standards used in the assessment included the following:

- International Building Code (IBC), 2012 Edition
- International Fire Code (IFC), 2009 and 2012 Editions
- NFPA 1, *Fire Code*, 2009 Edition (via extract text primarily)
- NFPA 2, *Hydrogen Technologies Code*, 2011 Edition
- NFPA 52, *Vehicular Gaseous Fuel Systems Code*, 2010 Edition
- NFPA 55, *Compressed Gases and Cryogenic Fluids Code*, 2013 Edition

This project was partially funded by the FPRF with the balance funded by FP2FIRE. This project was greatly aided by both Air Products and Proton Energy who provided construction plans and documents for recent refueling stations.

Procedure

The goal of the assessment was to review provisions relevant to unattended consumer refueling facilities intended to dispense gaseous hydrogen (GH2) only for FCEVs. The project did not encompass other hydrogen delivery systems such as liquid delivery, liquid hydrogen converted to gas, distilled water electrolyzer systems, or hydrogen generators. Similarly, hydrogen enriched fuels or mixed fuel stations are not in the scope.

The Technical Panel recognized that significant efforts relative to deployment of FCEVs is occurring in California and encouraged a focus on systems such as those that have been or will be deployed in California within the next 2-4 years with the anticipated refueling rates for those time frames (i.e. - 50-200 cars per day). Specifically, the panel encouraged the review of plans for two types of refueling stations that are gaining prevalence:

- A station with a 10,000 psi system with on site gaseous compression and storage, and
- A high pressure gas tube trailer installation with routine tube trailer delivery.

The initial intent was to review two sets of plans for refueling stations which were provided by Air Products and Proton Energy and to use the plan review process to identify code gaps, conflicts and/or issues. This plan review was performed in detail and did help to identify some code issues for consideration of the panel; however the number of issues identified with this method was not large. This is a reflection of the high quality of the plans submitted and reviewed. In order to identify potential code issues, the scope of the project was expanded to also include a side by side comparative analysis of the primary source codes. Utilizing these two processes, a significant list of code issues was developed. These issues were assimilated into a table to ease comparison and distributed to the Panelists for consideration. A meeting with panelists was conducted on November 5, 2012 at NREL in Golden, CO to discuss these issues and develop recommendations.

Assessment Results

A table of various topics, code gaps and code conflicts, resulting from the mock plan reviews and comparative analysis is included as Table A.1 in Appendix A. NFPA 2 is intended to be a one source document for all issues pertaining to hydrogen. The inaugural edition of NFPA 2 is primarily an extract document containing numerous requirements from NFPA 52 and NFPA 55. Therefore, NFPA 2 is identified in the first code / standard column, followed by NFPA 52, NFPA 55 and finally other codes/standards. It is important to note that future editions of NFPA 52 (i.e. - 2013 Edition and beyond) will not include requirements relevant to hydrogen which have now been extracted into NFPA 2. Also, as of early December 2012, the 2013 Edition of NFPA 52 and NFPA 55 were not yet available to the public so the 2010 Editions were utilized for the initial assessment and the in-person panel meeting. The NFPA 55 information was updated in January 2013 with the requirements from the 2013 Edition of NFPA 55 after the document became available but 2013 NFPA 52 is still not available to the public as of early January 2013. The comments in the document relevant to conflicts and gaps related to NFPA 52 are also included (because different jurisdictions are working with different editions of the standards due to varying code adoption cycles) but it is important to clarify that no additional

action is needed to resolve gaps in future editions of NFPA 52. If the issue was extracted into NFPA 2, additional action may be required in NFPA 2 to achieve code harmony.

Table 1 below is a summary of the proposed resolutions to resolve the code gaps and code conflicts identified. Once again, action items are primarily focused for the Technical Committees of NFPA 2 and the IFC.

Table 1 Proposed Resolutions to Resolve Code Gaps and Code Conflicts Identified

Item	Topic	Proposed Resolution
1	Canopies used to Support Gaseous Hydrogen Systems	**Code Gap**: NFPA 2 should include text similar to IBC for installations involving canopies used to support gaseous hydrogen systems. If the construction requirements are to be eliminated, then the ability to locate hydrogen on top of canopies should be prohibited. Action needed: Forward to NFPA 2 TC for consideration.
2	Weather Protection	**Code Conflict**: The 2013 Edition of NFPA 55 is now coordinated with the 2012 IBC. The code conflict in NFPA 2 will be resolved at the next code cycle when the extract text from NFPA 55 is extracted into NFPA 2. Action needed: None.
3	Vehicle Impact Protection	**Code Conflict**: NFPA 1, *Fire Code*, and NFPA 400, *Hazardous Materials Code*, are the source documents from which NFPA 2/52/55 extract this text. NFPA 1 and NFPA 400 should be coordinated with the IFC. IFC Technical Committee should consider revising requirement to 5 feet. If rejected by IFC, then the reasoning should be forwarded to NFPA 1 / 400 Technical Committees to consider revising the 5 feet to 3 feet in their documents. If 5 feet is required for access purposes, then a separate clear space requirement should be considered for NFPA 2 since equipment access for routine inspection, testing and maintenance is a separate issue from vehicle impact protection. Action needed: Forward to NFPA 1 and 400 TCs as well as the ICC for consideration.

Table 1 Proposed Resolutions to Resolve Code Gaps and Code Conflicts Identified

Item	Topic	Proposed Resolution
4	IFC Scope Statements in Chapters 53 and 58	**Code Gap**: The IFC Technical Committee should reference NFPA 2 in several locations, particularly in Chapter 23 (Motor Fuel-Dispensing Facilities and Repair Garages) and the Scope statements in Sections 5301.1 and 5801.1. Action needed: Forward to ICC for consideration.
5	Indoor Explosion Control	**Code Clarification**: IFC requirement for explosion control in the case of hydrogen dispensing indoors is a little vague and contained in a footnote to Table 911.1. This footnote text is subjective and does not automatically trigger explosion control for indoor dispensing as it does in NFPA 2 / 52. IFC Committee should include a reference to NFPA 2 in Table 911.1 and/or Section 2309. Action needed: Forward to ICC for consideration.
6	Deflagration Venting	**Code Conflict**: IFC should reference NFPA 2 to direct users to use NFPA 2 in addition to IFC. Action needed: Forward to ICC for consideration.
7	Vehicle Fueling Pad	**Code Gap**: NFPA 2 and IFC should address code gap regarding vehicle fueling pads where the pads are not feasible or available (e.g. - off-road fueling applications). Action needed: Forward to ICC and NFPA 2 for consideration. **Code Gap**: The IFC should also address the code gap regarding the vehicle being grounded by other means, such as the use of a grounding cable, as an alternative. Action needed: Forward to ICC for consideration.
8	Certification	**Code Gap**: IFC should address this code gap and include similar text. At a minimum, the IFC should reference NFPA 2. Action needed: Forward to ICC for consideration.
9	Hazard Analysis	**Code Gap**: The IFC Technical Committee should require a hazard analysis either directly in Section 2309

Table 1 Proposed Resolutions to Resolve Code Gaps and Code Conflicts Identified

Item	Topic	Proposed Resolution
		or thru a reference to IFC 104.7.2 and/or NFPA 2. Action needed: Forward to ICC for consideration.
10	Standby or Emergency Power	No action proposed. NFPA 1 / 400 also deal with this topic if jurisdiction is non-IFC.
11	Electronic Supervision	No action proposed. NFPA 1 / 400 also deal with this topic if jurisdiction is non-IFC.
12	Alarm System	No action proposed.
13	Leak Detection	**Code Gap**: IFC should reference NFPA 2 in regard to gas detectors, leak detection and flame detectors at dispensing equipment. Action needed: Forward to ICC for consideration.
14	Emergency Shutdown Device (ESD)	**Code Gap**: IFC should reference NFPA 2 to resolve code gap regarding one ESD vs. two. Action needed: Forward to ICC for consideration. **Code Conflict**: Reference to NFPA 2 in IFC would also resolve code conflict regarding ESD location from dispensing operation (e.g. - 20-100 ft. vs. 25-75 ft.). Action needed: Forward to ICC for consideration.
15	Separation Distances	**Code Conflict**: NFPA 2 extract text will be updated with new text from NFPA 55 (2013 Ed.). Action needed: None. **Code Conflict**: The IFC should reference NFPA 2 in regard to bulk hydrogen separation distance. Action needed: Forward to ICC for consideration.
16	Separation Distance Discrepancies - Storage	**Code Conflict**: IFC should reference the more specific application of outdoor bulk hydrogen compressed gas systems in NFPA 55 to resolve this code conflict. Action needed: Forward to ICC for consideration. **Code Conflict**: NFPA 2 currently conflicts with NFPA 55 but this will be corrected in the next code cycle when the extract text from NFPA 55 is updated in NFPA 2.

Table 1 Proposed Resolutions to Resolve Code Gaps and Code Conflicts Identified

Item	Topic	Proposed Resolution
		Action needed: None.
17	Separation Distance Discrepancies - Dispensing	**Code Conflict**: IFC should reference the more specific application of outdoor bulk hydrogen compressed gas systems in NFPA 2 to resolve this code conflict. However, NFPA 2 should be updated to differentiate between storage and use (e.g. - dispensing) areas separation distances to combustibles. Action needed: Forward to ICC and NFPA 2 for consideration. **Code Conflict**: NFPA 2 currently conflicts with NFPA 55 because it uses NFPA 52 language specific to dispensing. This will be corrected in the next code cycle when the extract text from NFPA 55 is also included in NFPA 2. Action needed: None.
18	Nozzles	**Code Gap**: IFC Technical Committee should incorporate similar language or at a minimum, make a general reference to NFPA 2. Action needed: Forward to ICC for consideration.
19	Breakaway	**Code Gap**: The IFC should resolve this code gap and consider adding this requirement into Sections 2307 (Liquefied Petroleum Gas Motor Fuel-Dispensing Facilities), 2308 (Compressed Natural Gas Motor Fuel-Dispensing Facilities) and 2309 (Hydrogen Motor Fuel-Dispensing and Generation Facilities), similar to the requirement in Section 2306.7.5.1 for flammable and combustible liquid motor fuel-dispensing facilities. The IFC should reference NFPA 2 in several locations regardless, particularly in Chapter 23 (Motor Fuel-Dispensing Facilities and Repair Garages) to resolve code gap. In addition, Section 5301.1 (Compressed Gases - Scope) of the 2012 IFC might include a third Exception, "Compressed hydrogen for use as a vehicular fuel shall comply with Chapter 23 and NFPA 2", similar to Exception 2 for compressed natural gas (CNG) used as vehicular fuel. Action needed: Forward to ICC for consideration.

Table 1 Proposed Resolutions to Resolve Code Gaps and Code Conflicts Identified

Item	Topic	Proposed Resolution
20	Venting	**Code Conflict**: NFPA 2 Technical Committee should update applicable sections with new text extracted from the 2013 Edition of NFPA 55. Action needed: None. **Code Gap**: The IFC Technical Committee should reference NFPA 2 in several locations, particularly in Chapter 23 (Motor Fuel-Dispensing Facilities and Repair Garages) to resolve code gap. In addition, Section 5301.1 (Compressed Gases - Scope) of the 2012 IFC might include a third Exception, "Compressed hydrogen for use as a vehicular fuel shall comply with Chapter 23 and NFPA 2", similar to Exception 2 for compressed natural gas (CNG) used as vehicular fuel. Action needed: Forward to ICC for consideration.
21	Vent Pipe Termination	**Code Conflict**: NFPA 2 Technical Committee should update applicable sections to new text extracted from the 2013 Edition of NFPA 55. Action needed: None. **Code Gap**: The IFC Technical Committee should reference NFPA 2 in several locations to resolve code gap, particularly in Chapter 23 (Motor Fuel-Dispensing Facilities and Repair Garages). In addition, Section 5301.1 (Compressed Gases - Scope) of the 2012 IFC might include a third Exception, "Compressed hydrogen for use as a vehicular fuel shall comply with Chapter 23 and NFPA 2", similar to Exception 2 for compressed natural gas (CNG) used as vehicular fuel. Action needed: Forward to ICC for consideration.

Table 1 Proposed Resolutions to Resolve Code Gaps and Code Conflicts Identified

Item	Topic	Proposed Resolution
22	Vent Pipe Construction Material	**Code Gap**: NFPA 2 should consider adding some Annex material regarding a design goal statement (e.g. - operation or PRD activation shall not cause a rupture of the vent pipe) as well as a discussion of CGA G-5.5, *Hydrogen Vent Systems*. The IFC should reference NFPA 2 in several locations, particularly in Chapter 23 (Motor Fuel-Dispensing Facilities and Repair Garages) to resolve code gap. In addition, Section 5301.1 (Compressed Gases - Scope) of the 2012 IFC might include a third Exception, "Compressed hydrogen for use as a vehicular fuel shall comply with Chapter 23 and NFPA 2", similar to Exception 2 for compressed natural gas (CNG) used as vehicular fuel. Action needed: Forward to ICC and NFPA 2 for consideration.
23	Projectile Protection	**Code Gap**: NFPA 2 Technical Committee should consider establishing a task group to study this topic further especially in light of composite tanks. Action needed: Forward to NFPA 2 for consideration.
24	Lightning Protection	**Code Gap**: NFPA 2 and possibly IFC should include references to NFPA 780, *Standard for the Installation of Lightning Protection Systems*. Action needed: Forward to ICC and NFPA 2 for consideration.
25	Sun Protection in Areas with Temperature Extremes	**Code Conflict**: NFPA 2 extract text will be updated with new text from NFPA 55 (2013 Ed.), Sections 7.1.11.5 and 7.1.11.5.1. Action needed: None.

Summary

The following action items should be considered:

- The NFPA 2 Technical Committee should consider taking action on applicable Items 1-25 in Table 1. Additional details provided in Table A.1.

- The appropriate IFC Technical Committees should consider taking action on applicable Items 1-25 in Table 1. Additional details provided in Table A.1.
- Develop a checklist of all code provisions that are relevant to the review of such a facility; i.e. include a list of those code provisions that are ok as is.

References

API RP 2003, *Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents*, 2008, American Petroleum Institute, Washington, D.C.

ASME Boiler and Pressure Vessel Code, 2010, American Society of Mechanical Engineers, Fairfield, New Jersey.

ASME B31.3, *Process Piping*, 2012, American Society of Mechanical Engineers, Fairfield, New Jersey.

BS EN 1081: *Resilient Floor Coverings. Determination of the Electrical Resistance*, 1998, British Standards Institution, London, United Kingdom.

CGA G-5.5, *Hydrogen Vent Systems*, 2007, Compressed Gas Association, Chantilly, Virginia.

CGA S-1.1, *Pressure Relief Device Standards – Part 1 – Cylinders for Compressed Gases*, 2011, Compressed Gas Association, Chantilly, Virginia.

CGA S-1.2, *Pressure Relief Device Standards – Part 2 – Cargo and Portable Tanks for Compressed Gases*, 1995, Compressed Gas Association, Chantilly, Virginia.

CGA S-1.3, *Pressure Relief Device Standards – Part 3 – Stationary Storage Containers for Compressed Gases*, 2008, Compressed Gas Association, Chantilly, Virginia.

International Building Code (IBC), 2012, International Code Council, Washington, D.C.

International Fire Code (IFC), 2009 and 2012 Editions, International Code Council, Washington, D.C.

NFPA 1, *Fire Code*, 2009 and 2012 Editions, National Fire Protection Association, Quincy, Massachusetts.

NFPA 2, *Hydrogen Technologies Code*, 2011, National Fire Protection Association, Quincy, Massachusetts.

NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*, 2012, National Fire Protection Association, Quincy, Massachusetts.

NFPA 52, *Vehicular Gaseous Fuel Systems Code*, 2010, National Fire Protection Association, Quincy, Massachusetts.

NFPA 55, *Compressed Gases and Cryogenic Fluids Code*, 2013, National Fire Protection Association, Quincy, Massachusetts.

NFPA 68, *Standard on Explosion Protection by Deflagration Venting*, 2007, National Fire Protection Association, Quincy, Massachusetts.

NFPA 69, *Standard on Explosion Prevention Systems*, 2008, National Fire Protection Association, Quincy, Massachusetts.

NFPA 70, *National Electrical Code*, 2011, National Fire Protection Association, Quincy, Massachusetts.

NFPA 400, *Hazardous Materials Code*, 2013, National Fire Protection Association, Quincy, Massachusetts.

NFPA 495, *Explosive Materials Code*, 2010, National Fire Protection Association, Quincy, Massachusetts.

NFPA 780, *Standard for the Installation of Lightning Protection Systems*, 2011, National Fire Protection Association, Quincy, Massachusetts.

SAE J2600, *Compressed Hydrogen Surface Vehicle Fueling Connection Devices*, 2012, SAE International, Warrendale, Pennsylvania.

Appendix A

Table A.1 Hydrogen Refueling Station Code Observations					
Item	**Topic / Gap / Conflict**	**NFPA 2 (2011 Ed.) Requirement**	**NFPA 52 (2010 Ed.) Requirement**	**NFPA 55 (2013 Ed.) Requirement**	**Other Code / Standard Requirement**
1	**Canopies used to Support Gaseous Hydrogen Systems** Construction Requirements for Canopies with GH2 above. The 2012 IBC contains construction requirements for canopies (with H2 above) but NFPA 2/52 do not. NFPA 2 Committee might consider similar Type I construction requirements or move to delete canopy content from IFC. **Panel Input:** NFPA 30A has some canopy requirements for hydrogen. Canopy requirements were requested by industry early on. Need to keep IBC/IFC content. NFPA 1 states won't get this content unless they are put into an NFPA document. Weather protection canopies over a dispenser may be different than storage of GH2 on top of the canopy. The IBC construction requirements are good text that should get into the NFPA system. Valid code concern. **Proposed Resolution:** NFPA 2 should include text similar to IBC for installations involving canopies used to support gaseous hydrogen systems. If the construction requirements are to be eliminated, then the ability to locate hydrogen on top of canopies should be prohibited.	No requirement for construction with GH2 above. One reference to LH2 dispensers below canopies: **11.3.1.17 Dispenser Installations Beneath Canopies.** Where [LH2] dispensers are installed beneath a canopy or enclosure, either the canopy or enclosure shall be designed to prevent accumulation or entrapment of ignitable vapors or all electrical equipment installed beneath the canopy or enclosure shall be suitable for Class I, Division 2 hazardous (classified) locations. [**30A:**12.4]	No requirement.	No requirement.	**IBC (2012) Chapter 4 Special Detailed Requirements Based on Use and Occupancy** **406 Motor-Vehicle-Related Occupancies** **406.7 Motor fuel-dispensing facilities.** **406.7.2 Canopies.** **406.7.2.1 Canopies used to support gaseous hydrogen systems.** *Canopies* that are used to shelter dispensing operations where flammable compressed gases are located on the roof of the *canopy* shall be in accordance with the following: 1. The *canopy* shall meet or exceed Type I construction requirements. 2. Operations located under *canopies* shall be limited to refueling only. 3. The *canopy* shall be constructed in a manner that prevents the accumulation of hydrogen gas.

Table A.1 Hydrogen Refueling Station Code Observations					
Item	**Topic / Gap / Conflict**	**NFPA 2 (2011 Ed.) Requirement**	**NFPA 52 (2010 Ed.) Requirement**	**NFPA 55 (2013 Ed.) Requirement**	**Other Code / Standard Requirement**
2	**Weather Protection** Weather protection requirements vary slightly between NFPA 2/52 and the IBC / NFPA 55. IBC and NFPA 55 require noncombustible construction and limits maximum size. Also, separation distance requirements may vary depending on applicable fire code. **Panel Input:** This will be addressed in 2013 NFPA 55. May need to make sure that the correct requirements from NFPA 55 Ch 7 gets into 2. 7.1.11.5.1 for sun exposure. Need to keep the 1500 ft^2 limit to limit the size. Cannot allow gas accumulation. **Proposed Resolution:** The 2013 Edition of NFPA 55 is now coordinated with the 2012 IBC. The code conflict in NFPA 2 should be resolved at the next code cycle when the extract text from NFPA 55 is updated.	**6.6 Weather Protection.** **6.6.1 Classification of Weather Protection as an Indoor Versus Outdoor Area.** **6.6.1.1** A weather protection structure shall be permitted to be used for sheltering hydrogen in outdoor storage or use areas, without requiring these areas to be classified as indoor storage. **6.6.1.2** For such storage or use areas to be regulated as outdoor storage or use, compliance with conditions in 6.6.1.4 and 6.6.2 shall be required. [**55:**6.5.2.2] **6.6.1.3** Where storage or use areas are provided with weather protection that does not comply with these conditions, the storage or use area shall be regulated as an indoor storage or use area. [**55:**6.5.2.3] **6.6.1.4** Supports and walls shall not obstruct more than one side or more than 25 percent of the perimeter of the storage or use area. [**55:**6.5.3] **6.6.2 Structure Separation Distances.** **6.6.2.1** The distance from the structure and the structural supports to buildings, lot lines, public ways or means of egress to a public way shall not be less than the distance required for an outside hazardous material storage or use area without weather protection. [**55:**6.5.4.1] **6.6.2.2** Where the weather protection structure is constructed of noncombustible materials, reductions	**Chapter 9 GH2 Compression, Gas Processing, Storage and Dispensing Systems** **9.3 System Siting.** **9.3.2 Outdoors.** **9.3.2.1.1* Weather Protection.** Where weather protection is provided for sheltering outside hazardous material storage or use areas, such storage or use areas shall be considered outside storage or use areas, provided that all of the following conditions are met: (1) Supports and walls shall not obstruct more than one side or more than 25 percent of the perimeter of the storage or use area. [**5000:**34.2.5(1)] (2) The distance from the structure and the structural supports to buildings, lot lines, public ways, or means of egress to a public way shall not be less than the distance required by NFPA 1 for an outside hazardous material storage or use area without weather protection. [**5000:**34.2.5(2)] (3) Weather-protection structures constructed in accordance with 9.3.2.1.1 shall not contain explosive or detonable materials. [**5000:**34.2.5(3)] **A.9.3.2.1.1** Hydrogen is not considered an "explosive or	**6.6 Weather Protection.** **6.6.1** For other than explosive materials and hazardous materials presenting a detonation hazard, a weather protection structure shall be permitted to be used for sheltering outdoor storage or use areas, without requiring such areas to be classified as indoor storage or use. **6.6.2** Weather protected areas constructed in accordance with 6.6.3 shall be regulated as outdoor storage or use. **6.6.2.1** Weather protected areas that are not constructed in accordance with 6.6.3 shall be regulated as indoor storage or use. **6.6.3** Buildings or structures used for weather protection shall be in accordance with the following: (1) The building or structure shall be constructed of noncombustible materials. (2) Walls shall not obstruct more than one side of the structure. (3) Walls shall be permitted to obstruct portions of multiple sides of the structure, provided that the obstructed area does not exceed 25 percent of the structure's perimeter area.	**IBC (2012) Chapter 4 Special Detailed Requirements Based on Use and Occupancy** **414 Hazardous Materials** **414.6 Outdoor storage, dispensing and use.** **414.6.1 Weather protection.** Where weather protection is provided for sheltering outdoor hazardous material storage or use areas, such areas shall be considered outdoor storage or use when the weather protection structure complies with Sections 414.6.1.1 through 414.6.1.3. **[F] 414.6.1.1 Walls.** Walls shall not obstruct more than one side of the structure. **Exception:** Walls shall be permitted to obstruct portions of multiple sides of the structure, provided that the obstructed area is not greater than 25 percent of the structure's perimeter. **[F] 414.6.1.2 Separation distance.** The distance from the structure to buildings, *lot lines*, *public ways* or *means of egress* to a *public way* shall be not less than the distance required for an outside hazardous material storage or use area without weather protection. **[F] 414.6.1.3 Noncombustible construction.** The overhead structure shall be of *approved*

Table A.1 Hydrogen Refueling Station Code Observations					
Item	**Topic / Gap / Conflict**	**NFPA 2 (2011 Ed.) Requirement**	**NFPA 52 (2010 Ed.) Requirement**	**NFPA 55 (2013 Ed.) Requirement**	**Other Code / Standard Requirement**
		in the separation distance shall be permitted based on the use of fire barrier walls where permitted for specific materials in accordance with the requirements of Chapters 7 and 8. [**55:**6.5.4.2]	detonable" material per se...	(4) The building or structure shall be limited to a maximum area of 1500 ft^2 (140 m^2), with increases in area allowed by the building code based on occupancy and type of construction. (5) The distance from the structure constructed as weather protection to buildings, lot lines, public ways, or means of egress to a public way shall not be less than the distance required for an outside hazardous material storage or use area without weather protection based on the hazard classification of the materials contained. (6) Reductions in separation distance shall be permitted based on the use of fire barrier walls where permitted for specific materials in accordance with the requirements of Chapters 7 through 11.	noncombustible construction with a maximum area of 1,500 square feet (140 m^2). **Exception:** The maximum area is permitted to be increased as provided by Section 506.

Table A.1 Hydrogen Refueling Station Code Observations					
Item	**Topic / Gap / Conflict**	**NFPA 2 (2011 Ed.) Requirement**	**NFPA 52 (2010 Ed.) Requirement**	**NFPA 55 (2013 Ed.) Requirement**	**Other Code / Standard Requirement**
3	**Vehicle Impact Protection:** Vehicle Impact Protection Requirements Vary Slightly between NFPA 2/52/55 and the IFC. IFC to consider increasing clearance to protected object to 5 feet for additional safety or NFPA 1/400 to reduce to 3 feet since minimum post height is 3 feet. (NFPA 1/2/52/55/400 more stringent than IFC) **Panel Input:** 3 feet is too small. Should have 5 feet for access purposes. Not really worth pursuing. Too hard to change the top level codes (NFPA 1, IFC). **Proposed Resolution:** NFPA 1, *Fire Code*, and NFPA 400, *Hazardous Materials Code*, are the source documents from which NFPA 2/52/55 extract this text. NFPA 1 and NFPA 400 should be coordinated with the IFC. IFC Technical Committee should consider revising requirement to 5 feet. If rejected by IFC, then the reasoning should be forwarded to NFPA 1 / 400 Technical Committees to consider revising the 5 feet to 3 feet in their documents. If 5 feet is required for access purposes, then a separate clear space requirement should be considered for NFPA 2 since equipment access for routine inspection, testing and maintenance is a separate issue from vehicle impact protection.	**4.14 Protection From Vehicular Damage.** **4.14.1** When required, guard posts or other approved means shall be provided to protect against physical damage in accordance with Section 4.1.5. **4.14.1.1** Guard posts or other approved means shall be provided to protect the following areas where subject to vehicular damage: [**1:**60.1.15.1] (1)*Storage tanks and connected piping, valves, and fittings [**1:**60.1.15.1(1)] (2) Dispensing areas [**1:**60.1.15.1(2)] (3) Use areas [**1:**60.1.15.1(3)] **4.14.1.2** Where guard posts are installed, the posts shall meet the following criteria: [**1:**60.1.15.2] (1) They shall be constructed of steel not less than 4 in. in diameter and concrete filled. [**1:**60.1.15.2(1)] (2) They shall be spaced not more than 4 ft (1.2 m) between posts on center. [**1:**60.1.15.2(2)] (3) They shall be set not less than 3 ft deep in a concrete footing of not less than a 15 in. diameter. [**1:**60.1.15.2(3)] (4) They shall be set with the top of the posts not less than 3 ft (0.9 m) above ground. [**1:**60.1.15.2(4)] (5) They shall be located not less than 5 ft from the tank. [**1:**60.1.15.2(5)]	**Chapter 9 GH2 Compression, Gas Processing, Storage and Dispensing Systems** **9.2 General System Requirements.** **9.2.5 Equipment Security and Vehicle Protection** **9.2.5.4** Where guard posts are installed, the posts shall meet the following criteria: (1) They shall be constructed of steel not less than 4 in. (10 cm) 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. (38 cm) 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 5 ft (1.5 m) from the tank. [**1:**60.1.15.2]	**Chapter 4 General Requirements** **4.11 Protection from Vehicular Damage.** **4.11.1.2** 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. (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 5 ft (1.5 m) from the tank. [**400:**6.1.9.2] **Chapter 7 Compressed Gases** **7.1 General.** **7.1.9 Security.** **7.1.9.3 Physical Protection.** **7.1.9.3.2** Guard posts or other means shall be provided to protect compressed gas cylinders, containers, tanks, and systems indoors and outdoors from vehicular damage in accordance with Section 4.11.	**IFC (2009 & 2012) Chapter 3 General Requirements** **312 Vehicle Impact Protection** **312.2 Posts.** Guard posts shall comply with all of the following requirements: 1. Constructed of steel not less than 4 inches (102 mm) in diameter and concrete filled. 2. Spaced not more than 4 feet (1219 mm) between posts on center. 3. Set not less than 3 feet (914 mm) deep in a concrete footing of not less than a 15-inch (381 mm) diameter. 4. Set with the top of the posts not less than 3 feet (914 mm) above ground. 5. Located not less than 3 feet (914 mm) from the protected object.

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4	**IFC Scope Statements in Chapters 53 and 58:** IFC 2012 Chapter 53 - Compressed Gases Scope statement contains an Exception for compressed natural gas (CNG) for use as a vehicular fuel but there is not a similar exception for refueling with compressed hydrogen. Similarly, the Flammable Gas chapter Scope statement references NFPA 55 and other IFC chapters, including IFC Chapter 23 (Motor Fuel-Dispensing Facilities and Repair Garages), but omits NFPA 2. **Do we need additional pointers to NFPA 2 for H2 refueling to comply with Chapter 23 and NFPA 2? IFC refers to NFPA 52 ONLY in Section 5301.1 in regard to CNG.** **Panel Input:** This is needed. CGA will submit proposal to reference NFPA 55 in IFC. NREL may also push for references to NFPA 2 and/or NFPA 55 in the IFC. **Proposed Resolution:** The IFC Technical Committee should reference NFPA 2 in several locations, particularly in Chapter 23 (Motor Fuel-Dispensing Facilities and Repair Garages) and the Scope statements in Sections 5301.1 and 5801.1.	Not Applicable	Not Applicable	Not Applicable	**IFC (2012) Chapter 53 Compressed Gases** **5301 General** **5301.1 Scope.** Storage, use and handling of compressed gases in compressed gas containers, cylinders, tanks and systems shall comply with this chapter, including those gases regulated elsewhere in this code.... **Exceptions:** 1. Gases used as refrigerants in refrigeration systems (see Section 606). 2. Compressed natural gas (CNG) for use as a vehicular fuel shall comply with Chapter 23, NFPA 52 and the International Fuel Gas Code. **IFC (2012) Chapter 58 Flammable Gases and Flammable Cryogenic Fluids** **5801 General** **5801.1 Scope.** The storage and use of flammable gases and flammable cryogenic fluids shall be in accordance with this chapter and NFPA 55. ... Hydrogen motor fuel-dispensing stations and repair garages and their associated above-ground hydrogen storage systems shall also be designed and constructed in accordance with Chapter 23.

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5	**Indoor Explosion Control** Explosion control not required per IFC unless quantity of flammable gas exceeds MAQ or where an explosion hazard exists, such as a dispensing operation. (Rooms containing dispensing and use of hazardous materials when an explosive environment can occur because of the characteristics or nature of the hazardous materials or as result of the dispensing or use process per Footnote d in IFC Table 911.1.) NFPA 52 requires explosion venting for rooms within buildings regardless of quantity. **Panel Input:** NFPA 2 is correlated with IFC for >MAQ, then venting is required. This should be OK with NFPA 2 except for fueling where the venting requirement is there. Indoor fast fill in 52 does require venting. This is also in NFPA 2. Should be worked into I codes. Indoor fueling differences should be addressed. Adding reference to NFPA 2 in the IFC (in addition to the existing IFC requirements) could really help here. **Proposed Resolution:** IFC requirement for explosion control in the case of hydrogen dispensing indoors is a little vague and contained in a footnote to Table 911.1. This footnote text is subjective and does not automatically trigger explosion control for indoor dispensing as it does in NFPA 2 / 52. IFC Committee should include a reference to NFPA 2 in Table 911.1 and/or Section 2309.	**Chapter 6 General Hydrogen Requirements** **6.9* Explosion Control.** **6.9.1** Explosion control shall be provided where the quantity of GH2 or LH2 in storage or use exceed the quantity thresholds requiring special provisions as listed in Table 6.4.1.1 or where otherwise required. **6.9.2** When explosion control is required, it shall be provided by one or both of the following methods: (1) Explosion prevention in accordance with 6.9.3 (2) Deflagration venting in accordance with 6.9.4 **6.9.3* Explosion Prevention.** When provided, explosion prevention shall be in accordance with one or more of the methods specified in NFPA 69, *Standard on Explosion Prevention Systems*. **6.9.4* Deflagration Venting.** When provided, explosion protection by the use of deflagration venting shall be in accordance with NFPA68, *Standard on Explosion Protection by Deflagration Venting*. **Chapter 7 Gaseous Hydrogen** **7.3 Bulk GH2 Systems.** **7.3.2 Bulk GH2 Systems Storage.** **7.3.2.2 Indoor Storage.** **7.3.2.2.2 Detached Buildings.** **7.3.2.2.2.3*** Explosion control shall be provided in accordance with the	**Chapter 9 GH2 Compression, Gas Processing, Storage and Dispensing Systems** **9.3 System Siting.** **9.3.3 Indoors.** **9.3.3 Indoors.** **9.3.3.1 General.** Compression, gas processing, dispensing equipment, and storage containers connected for use shall be permitted 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 Section 9.3. **9.3.3.3 Dispensing.** Fuel dispensing indoors shall be in accordance with 9.3.3.3. **9.3.3.3.1 Deflagration Venting.** When used, deflagration (explosion) venting shall be provided in exterior walls and roofs only. **9.3.3.3.2** Vents shall be permitted to consist of any one or any combination of the following: (1) Walls of light material (2) Lightly fastened hatch covers (3) Lightly fastened, outward opening doors in exterior walls (4) Lightly fastened walls or roofs (5) Other methods in accordance with NFPA 69, *Standard on Explosion Prevention Systems* **9.3.3.4 Rooms Within Buildings.** **9.3.3.4.3** At least one wall shall be an	**6.9 Explosion Control.** Explosion control shall be provided as required by Table 6.9 in accordance with NFPA68, *Standard on Explosion Protection by Deflagration Venting*, or NFPA 69, *Standard on Explosion Prevention Systems*, where amounts of compressed gases in storage or use exceed the quantity thresholds requiring special provisions. **Table 6.9 Explosion Control Requirements** requires explosion venting or prevention systems for non-liquefied or liquefied flammable gas. **Chapter 10 Bulk Hydrogen Compressed Gas Systems** **10.6 Indoor Bulk Hydrogen Compressed Gas Systems.** **10.6.3 Hydrogen Gas Rooms.** **10.6.3.3** Explosion control shall be provided in accordance with the requirements of Section 6.9.	**IFC (2012) Chapter 9 Fire Protection Systems** **911 Explosion Control** **911.1 General.** Explosion control shall be provided in the following locations: 1. Where a structure, room or space is occupied for purposes involving explosion hazards as identified in Table 911.1. 2. Where quantities of hazardous materials specified in Table 911.1 exceed the maximum allowable quantities in Table 5003.1.1(1). Such areas shall be provided with explosion (deflagration) venting, explosion (deflagration) prevention systems, or barricades in accordance with this section and NFPA 69, or NFPA 495 as applicable. Deflagration venting shall not be utilized as a means to protect buildings from detonation hazards. **Table 911.1, Explosion Control Requirements**, requires explosion control where explosion hazards exist. Per the Table footnote, "Rooms containing dispensing and use of hazardous materials when an explosive environment can

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		requirements of Section 6.9. [**55:**10.4.4.3] **Chapter 10 GH2 Vehicle Fueling Facilities** **10.3 Dispensing.** **10.3.2 Dispensing to The Public.** **10.3.2.2 Indoor Public Fueling.** **10.3.2.2.1 General.** **10.3.2.2.1.1 Dispensing.** Fuel dispensing indoors shall be in accordance with 10.3.2.2. [**52:**9.3.3.3] **10.3.2.2.1.2 Deflagration Venting.** When used, deflagration (explosion) venting shall be provided in exterior walls and roofs only. [**52:**9.3.3.3.1] **10.3.2.2.1.3** Vents shall be permitted to consist of any one or any combination of the following: [**52**:9.3.3.3.2] (1) Walls of light material [**52**:9.3.3.3.2(1)] (2) Lightly fastened hatch covers [**52**:9.3.3.3.2(2)] (3) Lightly fastened, outward opening doors in exterior walls [**52**:9.3.3.3.2(3)] (4) Lightly fastened walls or roofs [**52**:9.3.3.3.2(4)] (5) Other methods in accordance with NFPA 69, *Standard on Explosion Prevention Systems* [**52**:9.3.3.3.2(5)] **10.3.2.2.1.5 Rooms Within Buildings.** **(B)** At least one wall shall be an exterior wall. [**52:**9.3.3.4.3] **(C)** Explosion venting shall be provided in accordance with 10.3.2.2.1.2 and 10.3.2.2.1.3. [**52:**9.3.3.4.4]	exterior wall. **9.3.3.4.4** Explosion venting shall be provided in accordance with 9.3.3.3.1.		occur because of the characteristics or nature of the hazardous materials or as a result of the dispensing or use process."

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6	**Deflagration Venting**: IFC requirements for deflagration venting are more detailed and provide additional guidance on design. Should NFPA 2 provide additional guidance or specifically request an engineering analysis to justify design of deflagration venting. **Panel Input:** Similar approach. Add NFPA 2 reference in IFC to direct users to use NFPA 2 in addition to those in IFC. **Proposed Resolution:** IFC should reference NFPA 2 to direct users to use NFPA 2 in addition to IFC.	**10.3.2.2 Indoor Public Fueling.** **10.3.2.2.1 General.** **10.3.2.2.1.1 Dispensing.** Fuel dispensing indoors shall be in accordance with 10.3.2.2. [**52:**9.3.3.3] **10.3.2.2.1.2 Deflagration Venting.** When used, deflagration (explosion) venting shall be provided in exterior walls and roofs only. [**52:**9.3.3.3.1] **10.3.2.2.1.3** Vents shall be permitted to consist of any one or any combination of the following: [**52**:9.3.3.3.2] (1) Walls of light material [**52**:9.3.3.3.2(1)] (2) Lightly fastened hatch covers [**52**:9.3.3.3.2(2)] (3) Lightly fastened, outward opening doors in exterior walls [**52**:9.3.3.3.2(3)] (4) Lightly fastened walls or roofs [**52**:9.3.3.3.2(4)] (5) Other methods in accordance with NFPA 69, *Standard on Explosion Prevention Systems* [**52**:9.3.3.3.2(5)] **10.3.2.2.1.4** Where applicable, snow loads shall be included in the calculations of the building [venting system]. [**52:**9.3.3.3.3]	**Chapter 9 GH2 Compression, Gas Processing, Storage and Dispensing Systems** **9.3 System Siting.** **9.3.3 Indoors.** **9.3.3.3 Dispensing.** **9.3.3.3.1 Deflagration Venting.** When used, deflagration (explosion) venting shall be provided in exterior walls and roofs only. **9.3.3.3.2** Vents shall be permitted to consist of any one or any combination of the following: (1) Walls of light material (2) Lightly fastened hatch covers (3) Lightly fastened, outward opening doors in exterior walls (4) Lightly fastened walls or roofs (5) Other methods in accordance with NFPA 69, *Standard on Explosion Prevention Systems*		**IFC (2012) Chapter 9 Fire Protection Systems** **911 Explosion Control** **911.2 Required deflagration venting.** Areas that are required to be provided with deflagration venting shall comply with the following: 1. Walls, ceilings and roofs exposing surrounding areas shall be designed to resist a minimum internal pressure of 100 pounds per square foot (psf). The minimum internal design pressure shall not be less than five times the maximum internal relief pressure specified in Section 911.2, Item 5. 2. Deflagration venting shall be provided only in exterior walls and roofs. **Exception:** Where sufficient exterior wall and roof venting cannot be provided because of inadequate exterior wall or roof area, deflagration venting shall be allowed by specially designed shafts vented to the exterior of the building. 3. Deflagration venting shall be designed to prevent unacceptable structural damage. Where relieving a

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					deflagration, vent closures shall not produce projectiles of sufficient velocity and mass to cause life threatening injuries to the occupants or other persons on the property or adjacent public ways. 4. The aggregate clear area of vents and venting devices shall be governed by the pressure resistance of the construction assemblies specified in Item 1 of this section and the maximum internal pressure allowed by Item 5 of this section. 5. Vents shall be designed to withstand loads in accordance with the IBC. Vents shall consist of any one or any combination of the following to relieve at a maximum internal pressure of 20 pounds per square foot (958 Pa), but not less than the loads required by the IBC: 5.1 Exterior walls designed to release outward. 5.2 Hatch covers. 5.3 Outward swinging doors. 5.4 Roofs designed to uplift. 5.5 Venting devices listed for the purpose.

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					6. Vents designed to release from the exterior walls or roofs of the building when venting a deflagration shall discharge directly to the exterior of the building where an unoccupied space not less than 50 feet in width is provided between the exterior walls of the building and the lot line. **Exception:** Vents complying with Item 7 of this section. 7. Vents designed to remain attached to the building when venting a deflagration shall be so located that the discharge opening shall not be less than 10 feet vertically from window openings and exits in the building and 20 feet horizontally from exits in the building, from window openings and exits in adjacent building on the same lot, and from the lot line. 8. Discharge from vents shall not be into the interior of the building.

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7	**Vehicle Fueling Pad** Vehicle fueling pad must be concrete or other approved material. NFPA 2/52 refer to an approved method (later referring to EN 1081 in Annex) but IFC specifically requires methodology specified in EN 1081. **Panel Input:** NFPA 2 approach of putting the requirement(s) of the reference standards (i.e. - API RP 2003, BS EN 1081, etc.) in the Annex is the best approach. Some of the standards being referenced may not be appropriate for non-annex material. Other approved standards may need to be developed. IFC does not specifically allow the use of a grounding cable. Other types of vehicles and off-road fueling (i.e. - forklifts, ships, light towers, temporary fueling areas at events / demonstrations, etc.) are not addressed. There should be provisions to address vehicles that cannot be on a fueling pad. Mobile (fleet) fueling cannot do this for example. **Proposed Resolution:** NFPA 2 and IFC should address code gap regarding vehicle fueling pads where the pads are not feasible or available (e.g. - off-road fueling applications). The IFC should also address the code gap regarding the vehicle being grounded by other means, such as the use of a grounding cable, as an alternative.	**Chapter 10 GH2 Vehicle Fueling Facilities** **10.3 Dispensing.** **10.3.1 General.** **10.3.1.17 Stray or Impressed Currents and Bonding.** **10.3.1.17.3** A vehicle fueling pad shall be provided in the area where vehicles are to be refueled. [**52:**9.13.3] **10.3.1.17.3.1** The pad shall be constructed with a length and width to accommodate the types of vehicles to be fueled. [**52:**9.13.3.1] **10.3.1.17.4*** The vehicle fueling pad shall be of concrete or a material having a resistivity not exceeding 1 megohm as determined by an approved method [unless the vehicle is grounded by other means such as a grounding cable]. [**52:**9.13.3.2] **A.10.3.1.17.4** Motor vehicles can acquire an electrostatic charge while traveling. The resistance offered by the tires through an uncoated concrete surface is low enough that this charge dissipates to ground very quickly (seconds or less). However, under dry conditions, an asphalt surface can offer sufficient resistance that the charge will not dissipate in a timely manner. A small number of incidents have occurred in Europe where a nonabsorbent polymer having unusually high resistance was used at service stations to prevent soil	**Chapter 9 GH2 Compression, Gas Processing, Storage and Dispensing Systems** **9.13 Stray or Impressed Currents and Bonding.** **9.13.3.2*** The vehicle fueling pad shall be of concrete or a material having a resistivity not exceeding 1 megohm as determined by an approved method. **A.9.13.3.2** Motor vehicles can acquire an electrostatic charge while traveling... The 1 megohm criterion is cited from API RP 2003, *Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents*. Measurement of the resistivity of the vehicle fueling pad can be conducted using BS EN 1081: *Determination of Electrical Resistance—Resilient Floor Coverings*.	**No requirement.**	**IFC (2012) Chapter 23 Motor Fuel-Dispensing Facilities and Repair Garages** **2309 Hydrogen Motor Fuel-Dispensing and Generation Facilities** **2309.5 Safety Precautions.** **2309.5.1 Protection from Vehicles.** **2309.5.1.1 Vehicle fueling pad.** The vehicle shall be fueled on noncoated concrete or other approved paving material having a resistance not exceeding 1 megohm as determined by the methodology specified in EN 1081.

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		contamination from gasoline spills. Therefore, paved surfaces that result in a resistance greater than 1 megohm should not be used. Transfer surface materials meeting the criteria specified will provide for the dissipation of static charge built up on the vehicle before the driver opens the door to initiate refueling. The 1 megohm criterion is cited from the API RP 2003, *Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents.* Measurement of the resistivity of the vehicle fueling pad can be conducted using BS EN 1081: *Determination of Electrical Resistance — Resilient Floor Coverings.* [**52:** A.9.13.3.2]			

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8	**Certification** Certification of GH2 dispensing and storage facilities is required by NFPA 2/52 but not IFC. Is certification needed? Benefits? Is prescriptive content inadequate? Qualitative/Subjective **Panel Input:** Lack of a UL stamp makes this needed. Not a problem that IFC does not require. Most installations would want to do this anyway. **Proposed Resolution:** IFC should address this code gap and include similar text. At a minimum, the IFC should reference NFPA 2.	**Chapter 10 GH2 Vehicle Fueling Facilities** **10.2 General.** **10.2.1 System Approvals.** **10.2.1.1** Dispensing and storage facilities shall be certified as meeting the requirements of this code by qualified engineer(s) with expertise and competence in the design, fabrication, and construction of hydrogen containers, piping systems, site fire protection, gaseous detection, emergency shutdown provisions, isolation, drainage, site spacing, fire protection equipment, operating procedures, worker protection, and other components of the facility. [**52:**9.2.2]	**Chapter 9 GH2 Compression, Gas Processing, Storage and Dispensing Systems** **9.2 General System Requirements.** **9.2.2** Dispensing and storage facilities shall be certified as meeting the requirements of this code by qualified engineer(s) with expertise and competence in the design, fabrication, and construction of hydrogen containers, piping systems, site fire protection, gaseous detection, emergency shutdown provisions, isolation, drainage, site spacing, fire protection equipment, operating procedures, worker protection, and other components of the facility.	**No requirement.**	**No similar requirement in IFC 2009 or 2012.**

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9	**Hazard Analysis** Hazard Analysis (HA) is required by NFPA 2/52 but optional per IFC, only if mandated by the fire code official per Section 104.7.2. These hazard analyses may require safety provisions above and beyond current code requirements. **Panel Input:** Panel is Ok with these requirements. An HA will performed anyway so not a problem. **Proposed Resolution:** It is recommended that IFC Section 2309 be amended to REQUIRE a hazard analysis either directly or thru reference to IFC 104.7.2 or NFPA 2.	**Chapter 10 GH2 Vehicle Fueling Facilities** **10.2 General.** **10.2.1 System Approvals.** **10.2.1.2*** A hazard analysis shall be conducted on every hydrogen fueling system installation by a qualified engineer(s) with proven expertise in hydrogen fueling systems and installations. [**52:**9.2.3] **10.2.1.3** The hazard analysis shall include the following fire protection measures: fire protection and suppression systems, detection systems, and ventilation. [**52:**9.2.3.1] **10.2.1.4** The hazard analysis shall include consideration of potential failures in hoses, nozzles, dispensing equipment, as well as failures for maintenance and service. [**52:**9.2.3.2]	**Chapter 9 GH2 Compression, Gas Processing, Storage and Dispensing Systems** **9.2 General System Requirements.** **9.2.3*** A hazard analysis shall be conducted on every hydrogen fueling system installation by a qualified engineer(s) with proven expertise in hydrogen fueling systems and installations. **9.2.3.1** The hazard analysis shall include the following fire protection measures: fire protection and suppression systems, detection systems, and ventilation. **9.2.3.2** The hazard analysis shall include consideration of potential failures in hoses, nozzles, dispensing equipment, as well as failures for maintenance and service.	**No requirement.**	**IFC (2012) Chapter 1 Scope and Administration** **104 General Authority and Responsibilities** **104.7 Approved Materials and Equipment.** **104.7.2 Technical assistance.** To determine the acceptability of technologies, processes, products, facilities, materials and uses attending the design, operation or use of a building or premises subject to inspection by the fire code official, the fire code official is authorized to require the owner or agent to provide, without charge to the jurisdiction, a technical opinion and report. The opinion and report shall be prepared by a qualified engineer, specialist, laboratory or fire safety specialty organization acceptable to the fire code official and shall analyze the fire safety properties of the design, operation or use of the building or premises and the facilities and appurtenances situated thereon, to recommend necessary changes. The fire code official is authorized to require design submittals to be prepared by, and bear the stamp of, a registered design professional.

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10	**Standby or Emergency Power** Standby or emergency power is required for mechanical ventilation, treatment systems, temperature control, alarm, detection or other electrically operated systems in indoor Group H (hazardous) occupancies. **Panel Input:** Section 6.7.1 in NFPA 2 addresses this issue. Trigger is MAQ. IFC has exception that when power is shut off and system is fail safe backup power for these systems is not required (may not apply to fire detectors). Panel did not see a conflict here. Clarify approved fail safe exception to put provisions for the fail safe aspect to eliminate the need for backup power. This would need to go into the IFC as well. **Proposed Resolution:** No action proposed. NFPA 1 / 400 also deal with this topic if jurisdiction is non-IFC.	**Chapter 6 General Hydrogen Requirements** **6.7* Electrical Equipment.** **6.7.1 Standby Power.** **6.7.1.1** 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*, *(NEC)*: [**55:**6.6.1.1] (1) Mechanical ventilation [**55:**6.6.1.1(1)] (2) Treatment systems [**55:**6.6.1.1(2)] (3) Temperature controls [**55:**6.6.1.1(3)] (4) Alarms [**55:**6.6.1.1(4)] (5) Detection systems [**55:**6.6.1.1(5)] (6) Other electrically operated systems [**55:**6.6.1.1(6)] **6.7.1.2** The requirements of 6.7.1.1 shall not apply where emergency power is provided in accordance with *NFPA 70*, *National Electrical Code*. [**55:**6.6.1.2] **6.7.2 Emergency Power.** When emergency power is required, the system shall meet the requirements for a Protection Level 2 system in accordance with NFPA 110, *Standard for Emergency and Standby Power Systems*. [**55:**6.6.2]	**No requirement.**	**Chapter 6 Building-Related Controls** **6.7* Electrical Equipment.** **6.7.1 Standby Power.** **6.7.1.1** Where the following systems are required by this code for the storage or use of compressed gases or cryogenic fluids that exceed the quantity thresholds for gases requiring special provisions, such systems shall be connected to a standby power system in accordance with *NFPA 70*, *National Electrical Code*: (1) Mechanical ventilation (2) Treatment systems (3) Temperature controls (4) Alarms (5) Detection systems (6) Other electrically operated systems **6.7.1.2** The requirements of 6.7.1.1 shall not apply where emergency power is provided in accordance with 6.7.2 and *NFPA 70*, *National Electrical Code*. **6.7.2 Emergency Power.** When emergency power is required, the system shall meet the requirements for a Level 2 system in accordance with NFPA 110, *Standard for Emergency and Standby Power Systems*.	**IFC (2012) Chapter 50 Hazardous Materials - General Provisions** **5004 Storage (>MAQ)** **5004.7 Standby or emergency power.** Where mechanical ventilation, treatment systems, temperature control, alarm, detection or other electrically operated systems are required, such systems shall be provided with an emergency or standby power system in accordance with NFPA 70 and Section 604. **Exceptions:** ... 6. Standby power for mechanical ventilation, treatment systems and temperature control systems shall not be required where an approved fail-safe engineered system is installed.

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Item	**Topic / Gap / Conflict**	**NFPA 2 (2011 Ed.) Requirement**	**NFPA 52 (2010 Ed.) Requirement**	**NFPA 55 (2013 Ed.) Requirement**	**Other Code / Standard Requirement**
11	**Electronic Supervision** Supervision and monitoring is required for emergency alarm, detection and automatic fire-extinguishing systems in indoor Group H (hazardous) occupancies. **Panel Input:** Similar to #10. Dealt with by NFPA 1 and 400. Seems OK. **Proposed Resolution:** No action proposed. NFPA 1 / 400 also deal with this topic if jurisdiction is non-IFC.	**No requirement.**	**No requirement.**	**No requirement.**	**IFC (2012) Chapter 50 Hazardous Materials - General Provisions** **5004 Storage (>MAQ)** **5004.10 Supervision and monitoring.** Emergency alarm, detection and automatic fire-extinguishing systems required by Section 5004 shall be electrically supervised and monitored by an approved supervising station or, when approved, shall initiate an audible and visual signal at a constantly attended on-site location.

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Item	**Topic / Gap / Conflict**	**NFPA 2 (2011 Ed.) Requirement**	**NFPA 52 (2010 Ed.) Requirement**	**NFPA 55 (2013 Ed.) Requirement**	**Other Code / Standard Requirement**
12	**Alarm System** An emergency manual alarm system is required for indoor Group H (hazardous) occupancies. NFPA 2/52 system utilizes a local fire alarm system but IFC requires a separate emergency (hazardous material) alarm system (unless fire alarm system is approved by AHJ). **Panel Input:** None. No issue seen here. **Proposed Resolution:** No action proposed.	**Chapter 10 GH2 Vehicle Fueling Facilities** **10.3 Dispensing.** **10.3.3 Dispensing to Nonpublic Users.** **10.3.3.2 Indoor Nonpublic Fueling.** **10.3.3.2.2 Indoor Nonpublic Fast Fill Fueling.** **10.3.3.2.2.5 Fire Alarm System.** The dispensing area shall be equipped with a protected premises (local) fire alarm system in accordance with *NFPA 72*, *National Fire Alarm and Signaling Code*. [**52**:9.4.4.1] **(A) Manual Fire Alarm Boxes.** A manual fire alarm box shall be located not less than 20 ft (6.1 m) and not more than 100 ft (30.5 m) from the dispensing station. [**52**:9.4.4.2] (1) An additional manual fire alarm box shall be located at the nearest exit from the dispensing area. [**52**:9.4.4.2.1] (2) Activation of the fire alarm box shall sound a local fire alarm signal to alert building occupants of a fire in the dispensing area and shall shut down the dispenser, stop the flow of gas into the room, and start or continue to run the ventilation system. [**52**:9.4.4.2.2]	**Chapter 9 GH2 Compression, Gas Processing, Storage and Dispensing Systems** **9.4 Indoor Fast-Fill Fueling, Outdoor Storage, and Compression.** Fast-fill fueling indoors shall be permitted where storage, gas processing, and compression equipment is located outdoors complying with 9.3.2.1 through 9.3.2.3. **9.4.4 Fire Alarm System.** **9.4.4.1** The dispensing area shall be equipped with a protected premises (local) fire alarm system in accordance with *NFPA 72*, *National Fire Alarm and Signaling Code*. **9.4.4.2 Manual Fire Alarm Boxes.** A manual fire alarm box shall be located not less than 20 ft (6.1 m) and not more than 100 ft (30.5 m) from the dispensing station. **9.4.4.2.1** An additional manual fire alarm box shall be located at the nearest exit from the dispensing area. **9.4.4.2.2** Activation of the fire alarm box shall sound a local fire alarm signal to alert building occupants of a fire in the dispensing area and shall shut down the dispenser, stop the flow of gas into the room, and start or continue to run the ventilation system.	**No requirement.**	**IFC (2012) Chapter 50 Hazardous Materials - General Provisions** **5004 Storage (>MAQ)** **5004.9 Emergency alarm.** An approved manual emergency alarm system shall be provided in buildings, rooms or areas used for storage of hazardous materials. Emergency alarm-initiating devices shall be installed outside of each interior exit or exit access door of storage buildings, rooms or areas. Activation of an emergency alarm-initiating device shall sound a local alarm to alert occupants of an emergency situation involving hazardous materials.

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Item	**Topic / Gap / Conflict**	**NFPA 2 (2011 Ed.) Requirement**	**NFPA 52 (2010 Ed.) Requirement**	**NFPA 55 (2013 Ed.) Requirement**	**Other Code / Standard Requirement**
13	**Leak Detection** Leak detection, gas detectors and flame detectors are required at dispensing equipment in NFPA 2/52 but not IFC. NFPA 2/55 and IFC also contain requirements for excess flow control; one approved method of excess flow control is leak detection and emergency shutoff. How is excess flow control typically provided throughout piping system? Options available for hydrogen? Is fugitive gas detection the only approved means for hydrogen? Can missing gas be detected? Gas that is not where it is expected to me. Loss of mass or pressure?? **Panel Input:** None. No verbal input received at meeting. Software control systems on hydrogen dispensing / compression equipment can be used to support low / high pressure alarms, in turn, acting as a leak detector. For example, some fueling stations will not fuel if the pressure in the fill line is less than 300-400 psi. Some manufacturers use this as a means to protect the integrity of the dispensing system. **Proposed Resolution:** IFC should reference NFPA 2 in regard to gas detectors, leak detection and flame detectors at dispensing equipment.	**Chapter 10 GH2 Vehicle Fueling Facilities** **10.3 Dispensing.** **10.3.1 General.** **10.3.1.19* Fire Protection.** **10.3.1.19.1** Dispensing equipment shall be provided with gas detectors, leak detection, and flame detectors such that fire and gas can be detected at any point on the equipment. **[52:**9.2.14**]** **10.3.1.19.1.1** These detectors shall be maintained and calibrated in accordance with the manufacturer's instructions on at least an annual basis or earlier if required by the manufacturer. [**52:**9.2.14.1] **10.3.1.19.1.2** The station owner or operator shall maintain a record of detector maintenance and calibration in good condition and accessible to the inspector. [**52:**9.2.14.2] **10.3.1.19.1.3** A sticker at least 6 in.^{2} (39 cm^2) shall be affixed on the dispenser indicating the date of the next scheduled maintenance and calibration. [**52:**9.2.14.3] **Chapter 7 Gaseous Hydrogen** **7.1 General.** **7.1.22 Excess Flow Control.** **7.1.22.1** Where [GH2] is carried in pressurized piping above a gauge pressure of 15 psi (103 kPa), an approved means of leak detection and emergency shutoff or excess flow control shall be provided.	**Chapter 9 GH2 Compression, Gas Processing, Storage and Dispensing Systems** **9.2 General System Requirements.** **9.2.14** Dispensing equipment shall be provided with gas detectors, leak detection, and flame detectors such that fire and gas can be detected at any point on the equipment. **9.2.14.1** These detectors shall be maintained and calibrated in accordance with the manufacturer's instructions on at least an annual basis or earlier if required by the manufacturer. **9.2.14.2** The station owner or operator shall maintain a record of detector maintenance and calibration in good condition and accessible to the inspector. **9.2.14.3** A sticker at least 6 in.^{2} (39 cm^2) shall be affixed on the dispenser indicating the date of the next scheduled maintenance and calibration. **9.4 Indoor Fast-Fill Fueling, Outdoor Storage, and Compression.** **9.4.7 Dispensing Equipment.** Gas dispensing equipment shall be listed or approved for indoor use. **9.4.7.4 Gas Detection System.** The dispenser enclosure or housing shall be equipped with a gas detection system, which shall actuate when a maximum of 25 percent of the lower	**Chapter 7 Compressed Gases** **7.3 Use and Handling.** **7.3.1 General.** **7.3.1.12 Excess Flow Control.** **7.3.1.12.1*** Where compressed gases having a hazard ranking in one or more of the following hazard classes in accordance with NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response*, are carried in pressurized piping above a gauge pressure of 15 psi (103 kPa), an approved means of either leak detection with emergency shutoff or excess flow control shall be provided: (1) Health hazard Class 3 or Class 4 (2) Flammability Class 4 (3) Instability Class 3 or Class 4	**IFC (2012) Chapter 50 Hazardous Materials - General Provisions** **5003 General Requirements** **5003.2 Systems, equipment and processes.** **5003.2.2 Piping, tubing, valves and fittings.** **5003.2.2.1 Design and construction.** Piping, tubing, fittings and related components used for hazardous materials shall be in accordance with the following:... 6. Where gases or liquids having a hazard ranking of: Health Class 3 or 4 Flammability Class 4 Instability Class 3 or 4 in accordance with NFPA 704 are carried in pressurized piping above 15 psi gauge (103 kPa), an approved means of leak detection and emergency shutoff or excess flow control shall be provided. Where the piping originates from within a hazardous material storage room or area, the excess flow control shall be located within the storage room or area. Where the piping originates from a bulk source, the excess flow control shall be located as

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		[**55:**7.3.1.12.1] **Chapter 10 GH2 Vehicle Fueling Facilities** **10.3 Dispensing.** **10.3.3 Dispensing to Nonpublic Users.** **10.3.3.2 Indoor Nonpublic Fueling.** **10.3.3.2.2 Indoor Nonpublic Fast Fill Fueling.** **10.3.3.2.2.7 Dispensing Equipment.** Gas dispensing equipment shall be listed or approved for indoor use. [**52**:9.4.7] **(E) Gas Detection System.** The dispenser enclosure or housing shall be equipped with a gas detection system, which shall actuate when a maximum of 25 percent of the lower flammable limit (LFL) is detected (1 percent H2 in air). [**52**:9.4.7.4] (1) Actuation of the gas detection system shall shut down the dispenser, stop the flow of gas into the room, and start or continue to run the ventilation system [when mechanical ventilation systems are required]. [**52**:9.4.7.4.1] (2) Actuation of the gas detection system shall sound a local alarm and provide visual indication when a maximum of 25 percent of the lower flammable limit (LFL) is detected (1 percent H2 in air). [**52**:9.4.7.4.2] (3) The gas detection system shall function during maintenance operations on the ventilation system. [**52**:9.4.7.4.3]	flammable limit (LFL) is detected (1 percent H2 in air). **9.4.7.4.1** Actuation of the gas detection system shall shut down the dispenser, stop the flow of gas into the room, and start or continue to run the ventilation system. **9.4.7.4.2** Actuation of the gas detection system shall sound a local alarm and provide visual indication when a maximum of 25 percent of the lower flammable limit (LFL) is detected (1 percent H2 in air). **9.4.7.4.3** The gas detection system shall function during maintenance operations on the ventilation system.		close to the bulk source as practical. **Exceptions:** 1. Piping for inlet connections designed to prevent backflow. 2. Piping for pressure relief devices.

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14	**Emergency Shutdown Device** Emergency shutdown controls vary slightly. Both IFC and NFPA 2/52 require manual emergency shutoff valve at hydrogen supply. IFC requires a minimum of one emergency shutdown control between 25-75 feet of dispensers. NFPA 52 requires a minimum of two emergency shutdown devices - one at the dispensing area and one remote from the dispensing area 20-100 feet away. IFC and NFPA 2/52 require that power to hydrogen storage, compression and dispensing equipment be shut off automatically and valves to hydrogen generator, between main supply and compressor, and between storage containers and dispensing equipment are closed automatically. **Panel Input:** Not a problem but different concepts here. ESD is different from the main shutdown valve. 9.11.5 may need clarification related to what is an emergency manual shutdown device (e.g. - valve, button, actuator). Terminology needs improvement on the NFPA side. Need two valves one at point of use and one at source – both that shut down. Add a valve on IFC. **Proposed Resolution:** IFC should reference NFPA 2 to resolve code gap regarding one ESD vs. two. Reference to NFPA 2 would also resolve code conflict regarding ESD location from dispensing operation (e.g. - 20-100 ft. vs.	**Chapter 10 GH2 Vehicle Fueling Facilities** **10.3 Dispensing.** **10.3.1 General.** **10.3.1.18 Installation of Emergency Shutdown Equipment.** **10.3.1.18.1 Manually Operated Container Valve.** **10.3.1.18.1.1** Each group of storage vessels up to a maximum combined capacity of 10,000 scf (283 m^3) shall be provided with a manually operated shutoff valve. [**52:**9.11.1.1] **10.3.1.18.1.2** A manually operated shutoff valve shall be installed in a manifold as close to a container or group of containers as practical. [**52:**9.11.1.2] **10.3.1.18.1.3** The valve in 10.3.1.18.1.2 shall be located downstream of the backflow check valve specified in 10.3.1.18.2. [**52:**9.11.1.3] **10.3.1.18.2** The compressor discharge line supplying the storage container shall be equipped with a backflow check valve near the container to prevent discharge of hydrogen from the container in case of the rupture of the line, hose, or fittings. [**52:**9.11.2] **10.3.1.18.3** Where excess-flow check valves are used, the closing flow shall be greater than the design flow maximum system design flow rate and less than the flow rating of the piping system that results from a complete	**Chapter 9 GH2 Compression, Gas Processing, Storage and Dispensing Systems** **9.4.6 Emergency Shutdown Device (ESD).** A manual emergency shutdown device (ESD) shall be located in the dispensing area not less than 20 ft (6.1 m) and not more than 100 ft (30.5 m) in the path of egress from the dispensing area. **9.4.6.1** An additional shutdown shall be installed on the dispenser. **9.4.6.2** Actuation of the ESD shall shut down the dispenser, stop the flow of gas into the room, and start or continue to run the ventilation system. **9.4.7 Dispensing Equipment.** Gas dispensing equipment shall be listed or approved for indoor use. **9.4.7.1 Automatic Shut-off Valve.** Hydrogen gas piping used to transport GH2 between the bulk hydrogen compressed gas storage system and a dispenser at a fast-fill station shall have a valve that closes when one of the following occurs: (1) The power supply to the dispenser is shut off. (2) Any ESD at the refueling station is activated. **9.4.7.2 Manual Shut-off Valve.** A fast-closing, “quarter turn” manual shutoff valve shall be provided at a fast-fill station upstream of the	**No requirement.**	**IFC (2012) Chapter 23 Motor Fuel-Dispensing Facilities and Repair Garages** **2309 Hydrogen Motor Fuel-Dispensing and Generation Facilities** **2309.5 Safety Precautions.** **2309.5.3 Emergency shutdown controls.** In addition to the manual emergency shutoff valve required by Section 2309.5.2, a remotely located, manually activated emergency shutdown control shall be provided. An emergency shutdown control shall be located within 75 feet of, but not less than 25 feet from, dispensers and hydrogen generators. **IFC (2012) 2309.5.3.1 System requirements.** Activation of the emergency shutdown control shall automatically shut off the power supply to all hydrogen storage, compression and dispensing equipment; shut off natural gas or other fuel supply to the hydrogen generator; and close valves between the main supply and the compressor and between the storage containers and dispensing equipment. **IFC (2012) 2309.5.2 Emergency shutoff valves.** A manual emergency shutoff valve shall be

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	25-75 ft.).	line failure between the excess-flow valve and the equipment downstream of the excess-flow check valve. [**52:**9.11.3] **10.3.1.18.4** Gas piping from an outdoor compressor or storage system into a building shall be provided with [an automatic emergency] shutoff [valve] located outside the building.[**52:**9.11.4] **10.3.1.18.5** An emergency manual shutdown device shall be provided at the dispensing area and also at a location remote from the dispensing area. [**52:**9.11.5] **10.3.1.18.5.1** This device, when activated, shall shut off the power supply and gas supply [from the hydrogen source to] the dispenser. [**52:**9.11.5.1] **10.3.1.18.5.2** When GH2 is being produced from the conversion of LH2, the emergency shutdown system also shall shut off the liquid supply and power to the LH2 transfer equipment necessary for the conversion process. [**52:**9.11.5.2] **10.3.1.18.5.3** Emergency shutdown devices shall be distinctly marked for easy recognition with a permanently affixed legible sign. [**52:**9.11.5.3] **10.3.1.18.7** Control circuits shall be arranged so that, when an emergency shutdown device is activated or electric power is cut off, systems that shut down shall remain down until manually	breakaway device specified in 9.11.6, where it is readily accessible to the person dispensing hydrogen, unless one of the following occurs: (1) The self-closing valve referred to in 9.4.7.1 is located immediately upstream of the dispenser. (2) The dispenser is equipped with a self-closing valve that closes each time the control arm is turned to the OFF position or when the ESD is activated. **9.4.7.3 Shutdown.** **9.4.7.3.1** 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: (1) Gas detection system (2) Fire alarm system (3) Fire detection system (4) Emergency shutdown system (ESD) (5) Sensors or controls used to prevent overtemperature or overpressurization of the on-board fuel container (6) Required ventilation systems (7) Dispenser leak monitoring system **9.4.7.3.2** Reactivation of the dispenser and gas flow into the room after system shutdown required by 9.4.7.1 or 9.4.7.3 shall be by manual		provided to shut down the flow of gas from the hydrogen supply to the piping system. **IFC (2012) Chapter 58 Flammable Gases and Flammable Cryogenic Fluids** **5803 General Requirements** **5803.1 Quantities not exceeding the MAQ per CA.** **5803.1.3 Emergency shutoff.** Compressed gas systems conveying flammable gases shall be provided with approved manual or automatic emergency shutoff valves that can be activated at each point of use and at each source. **5803.1.3.1 Shutoff at source.** A manual or automatic fail-safe emergency shutoff valve shall be installed on supply piping at the cylinder or bulk source. Manual or automatic cylinder valves are allowed to be used as the required emergency shutoff valve when the source of supply is limited to unmanifolded cylinder sources. **5803.1.3.2 Shutoff at point of use.** A manual or automatic emergency shutoff valve shall be installed on the supply piping at the point of use or at a point where the equipment using the gas is connected to the supply system.

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		activated or reset after a safe condition is restored. [**52:**9.11.7] **10.3.3.2.2.6 Emergency Shutdown Device (ESD).** A manual emergency shutdown device (ESD) shall be located in the dispensing area not less than 20 ft (6.1 m) and not more than 100 ft (30.5 m) in the path of egress from the dispensing area. [**52**:9.4.6] **(A)** An additional shutdown shall be installed on the dispenser. [**52**:9.4.6.1] **(B)** Actuation of the ESD shall shut down the dispenser, stop the flow of gas into the room, and start or continue to run the ventilation system. [**52**:9.4.6.2] **10.3.3.2.2.7 Dispensing Equipment.** Gas dispensing equipment shall be listed or approved for indoor use. [**52**:9.4.7] **(A) Automatic Shutoff Valve.** Hydrogen gas piping used to transport GH2 between the bulk hydrogen compressed gas storage system and a dispenser at a fast-fill station shall have a valve that closes when one of the following occurs: [**52**:9.4.7.1] (1) The power supply to the dispenser is shut off. [**52**:9.4.7.1(1)] (2) Any emergency shutdown device at the refueling station is activated. [**52**:9.4.7.1(2)] **(B) Manual Shutoff Valve.** A fast-closing, “quarter turn” manual shutoff	restart and shall be conducted by trained personnel. **9.11 Installation of Emergency Shutdown Equipment.** **9.11.1 Manually Operated Container Valve.** **9.11.1.1** Each group of storage vessels up to a maximum combined capacity of 10,000 scf (283 m^3) shall be provided with a manually operated shutoff valve. **9.11.1.2** A manually operated shutoff valve shall be installed in a manifold as close to a container or group of containers as practical. **9.11.1.3** The valve in 9.11.1.2 shall be located downstream of the backflow check valve specified in 9.11.2. **9.11.2** The compressor discharge line supplying the storage container shall be equipped with a backflow check valve near the container to prevent discharge of hydrogen from the container in case of the rupture of the line, hose, or fittings. **9.11.3** Where excess-flow check valves are used, the closing flow shall be greater than the design flow maximum system design flow rate and less than the flow rating of the piping system that results from a complete line failure between the excess-flow valve and the equipment downstream of the excess-flow check valve.		

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		valve shall be provided at a fast-fill station upstream of the breakaway device specified in 10.3.1.18.6, where it is readily accessible to the person dispensing hydrogen, unless one of the following occurs: [**52**:9.4.7.2] (1) The self-closing valve referred to in 10.3.3.2.2.7(A) is located immediately upstream of the dispenser. [**52**:9.4.7.2(1)] (2) The dispenser is equipped with a self-closing valve that closes each time the control arm is turned to the OFF position or when the ESD is activated. [**52**:9.4.7.2(2)] **(C) Shutdown.** 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 [when mechanical ventilation systems are required]: [**52:**9.4.7.3.1] (1) Gas detection system [**52**:9.4.7.3.1(1)] (2) Fire alarm system [**52**:9.4.7.3.1(2)] (3) Fire detection system [**52**:9.4.7.3.1(3)] (4) Emergency shutdown system (ESD) [**52**:9.4.7.3.1(4)] (5) Sensors or controls used to prevent overtemperature or overpressurization of the on-board fuel container [**52**:9.4.7.3.1(5)] (6) Required ventilation systems	**9.11.4** Gas piping from an outdoor compressor or storage system into a building shall be provided with shut-off valves located outside the building. **9.11.5** An emergency manual shut-down device shall be provided at the dispensing area and also at a location remote from the dispensing area. **9.11.5.1** This device, when activated, shall shut off the power supply and gas supply to the compressor and the dispenser. **9.11.5.2** When GH2 is being produced from the conversion of LH2, the emergency shutdown system also shall shut off the liquid supply and power to the LH2 transfer equipment necessary for the conversion process. **9.11.5.3** ESDs shall be distinctly marked for easy recognition with a permanently affixed legible sign. **9.11.7** Control circuits shall be ar-ranged so that, when an emergency shutdown device is activated or electric power is cut off, systems that shut down shall remain down until manually activated or reset after a safe condition is restored. **9.11.8 Fast-Fill Station.** **9.11.8.1** Each line between a gas storage facility and a dispenser at a fast-fill station shall have a valve that closes when one of the following		

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		[**52**:9.4.7.3.1(6)] (7) Dispenser leak monitoring system [**52**:9.4.7.3.1(7)] **(D) Reactivation.** Reactivation of the dispenser and gas flow into the room after system shutdown required by 10.3.3.2.2.7(A) or 10.3.3.2.2.7(C) shall be by manual restart and shall be conducted by trained personnel. [**52**:9.4.7.3.2]	occurs: (1) The power supply to the dispenser is cut off. (2) Any emergency shutdown device at the refueling station is activated. **9.11.8.2** A fast-closing, "quarter turn" manual shut-off valve shall be provided at a fast-fill station upstream of the breakaway device specified in 9.11.6, where it is readily accessible to the person dispensing hydrogen, unless one of the following occurs: (1) The self-closing valve referred to in 9.11.8.1 is located immediately upstream of the dispenser. (2) The dispenser is equipped with a self-closing valve that closes each time the control arm is turned to the OFF position or when an emergency device is activated. **9.11.9** A self-closing valve shall be provided on the inlet of the compressor that shuts off the gas supply to the compressor when one of the following occurs: (1) An emergency shutdown device is activated. (2) A power failure occurs. (3) The power to the compressor is switched to the OFF position.		

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Item	**Topic / Gap / Conflict**	**NFPA 2 (2011 Ed.) Requirement**	**NFPA 52 (2010 Ed.) Requirement**	**NFPA 55 (2013 Ed.) Requirement**	**Other Code / Standard Requirement**
15	**Separation Distances** Separation distance discrepancies, particularly at lot lines. NFPA 2/52/55 are more conservative than the IFC. **Panel Input:** Much of this issue is addressed in the 2013 Edition of NFPA 55. Line of sight issue is clarified in 2013 Edition for example. Use alternative provisions for other installations such as next to a high rise based on the exposure being considered—air intake, wall openings, etc. **Proposed Resolution:** NFPA 2 extract text should be updated with new text from NFPA 55 (2013 Ed.). The IFC should reference NFPA 2 in regard to bulk hydrogen separation distance.	**Chapter 7 Gaseous Hydrogen** **7.3 Bulk GH2 Systems.** **7.3.2 Bulk GH2 Systems Storage.** **7.3.2.3 Outdoor Storage.** **7.3.2.3.1 Aboveground Locations.** **7.3.2.3.1.1 Minimum Distance for Aboveground Locations.** **(A)*** The minimum distance from a [GH2] system [of indicated capacity] located outdoors to specified exposures shall be in accordance with Table 7.3.2.3.1.2(a) or Table 7.3.2.3.1.2(b). (*See also Annex I.*) [**55:**10.3.2.2.1] 30-45 feet required to lot lines per Table 7.3.2.3.1.2(a).	**Chapter 9 GH2 Compression, Gas Processing, Storage and Dispensing Systems** **9.3 System Siting.** **9.3.1 General.** **9.3.1.3** The minimum distance from a bulk hydrogen compressed gas system located outdoors to specified exposure shall be in accordance with Table 9.3.1.3(a) or Table 9.3.1.3(b). *(See also Annex D.)* [**55:**10.3.2.2.1] 30-45 feet required to lot lines per Table 9.3.1.3(a) yet West Coast Facility houses a tube trailer on the property line, separated only by the concrete block wall.	**Chapter 10 Bulk Hydrogen Compressed Gas Systems** **10.3 Outdoor Bulk Hydrogen Compressed Gas Systems.** **10.3.2 Location.** **10.3.2.1* Minimum Distance.** The minimum distance from a bulk hydrogen compressed gas system located outdoors to specified exposures shall be in accordance with Table 10.3.2.1(a), Table 10.3.2.1(b), or Table 10.3.2.1(c). *(See also Annex G.)* **10.3.2.4* Reduction of Distance by Mitigation Means.** **10.3.2.4.1* Passive Means.** Except for distances to air intakes, the distances to Group 1 and 2 exposures shown in Table 10.3.2.1(a), Table 10.3.2.1(b), and Table 10.3.2.1(c) shall be permitted to be reduced by one-half and shall not apply to Group 3 exposures where fire barrier walls are located between the system and the exposure and constructed in accordance with the following: (1) Fire barrier walls shall have a minimum fire resistance rating of not less than 2 hours. (2) The fire barrier wall shall interrupt the line of sight between the bulk hydrogen	**IFC (2012) Chapter 50 Hazardous Materials - General Provisions** **5003 General Requirements** **5003.12 Outdoor control areas.** Outdoor control areas for hazardous materials in amounts not exceeding the MAQ per outdoor control area shall be in accordance with the following: 1. Outdoor control areas shall be kept free from weeds, debris and common combustible materials not necessary to the storage. The area surrounding an outdoor control area shall be kept clear of such materials for a minimum of 15 feet. 2. Outdoor control areas shall be located not closer than 20 feet from a lot line that can be built upon, public street, public alley or public way. **Exception:** ... 2. For compressed gas hazardous materials, unless otherwise specified, the minimum required distances shall not apply when fire barriers without openings or penetrations having a minimum fire-resistance rating of 2 hours interrupt the line of sight between the storage and

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				compressed gas system and the exposure. (3) .... ~29-46 feet required to lot lines by Table 10.3.2.1(a).	the exposure. The configuration of the fire barrier shall be designed to allow natural ventilation to prevent the accumulation of hazardous gas concentrations. ...

Table A.1 Hydrogen Refueling Station Code Observations					
Item	**Topic / Gap / Conflict**	**NFPA 2 (2011 Ed.) Requirement**	**NFPA 52 (2010 Ed.) Requirement**	**NFPA 55 (2013 Ed.) Requirement**	**Other Code / Standard Requirement**
16	**Separation Distance Discrepancies - Storage** Separation distance discrepancies, particularly in regard to clearances between outdoor storage areas and combustibles. In general, IFC is more strict than NFPA 2/52/55. IFC requires 15 feet ≤MAQ and 25 feet >MAQ yet NFPA 2/52/55 range is 10-20 feet. **Panel Input:** Addressed in 2013 NFPA 55. **Proposed Resolution:** IFC should reference the more specific application of outdoor bulk hydrogen compressed gas systems in NFPA 55 to resolve this code conflict. NFPA 2 currently conflicts with NFPA 55 but this should be corrected in the next code cycle when the extract text from NFPA 55 is updated in NFPA 2.	**Chapter 7 Gaseous Hydrogen** **7.3 Bulk GH2 Systems.** **7.3.2 Bulk GH2 Systems Storage.** **7.3.2.3 Outdoor Storage.** **7.3.2.3.1 Aboveground Locations.** **7.3.2.3.1.1 Minimum Distance for Aboveground Locations.** **(A)*** The minimum distance from a [GH2] system [of indicated capacity] located outdoors to specified exposures shall be in accordance with Table 7.3.2.3.1.2(a) or Table 7.3.2.3.1.2(b). (*See also Annex I.*) [**55:**10.3.2.2.1] 10-20 feet required to ordinary combustibles, including fast-burning solids such as ordinary lumber, excelsior, paper and combustible waste and vegetation other than that found in maintained landscaped areas per Table 7.3.2.3.1.2(a).	**Chapter 9 GH2 Compression, Gas Processing, Storage and Dispensing Systems** **9.3 System Siting.** **9.3.1 General.** **9.3.1.3** The minimum distance from a bulk hydrogen compressed gas system located outdoors to specified exposure shall be in accordance with Table 9.3.1.3(a) or Table 9.3.1.3(b). *(See also Annex D.)* [**55:**10.3.2.2.1] 10-20 feet separation required for ordinary combustibles, including fast-burning solids such as ordinary lumber, excelsior, paper, and combustible waste and vegetation other than that found in maintained landscaped areas per Table 9.3.1.3(a).	**Chapter 10 Bulk Hydrogen Compressed Gas Systems** **10.3 Outdoor Bulk Hydrogen Compressed Gas Systems.** **10.3.2 Location.** **10.3.2.1* Minimum Distance.** The minimum distance from a bulk hydrogen compressed gas system located outdoors to specified exposures shall be in accordance with Table 10.3.2.1(a), Table 10.3.2.1(b), or Table 10.3.2.1(c). *(See also Annex G.)* **10.3.2.4* Reduction of Distance by Mitigation Means.** **10.3.2.4.1* Passive Means.** Except for distances to air intakes, the distances to Group 1 and 2 exposures shown in Table 10.3.2.1(a), Table 10.3.2.1(b), and Table 10.3.2.1(c) shall be permitted to be reduced by one-half and shall not apply to Group 3 exposures where fire barrier walls are located between the system and the exposure and constructed in accordance with the following: (1) Fire barrier walls shall have a minimum fire resistance rating of not less than 2 hours. (2) The fire barrier wall shall interrupt the line of sight between the bulk hydrogen	**IFC (2012) Chapter 50 Hazardous Materials - General Provisions** **5003 General Requirements** **5003.12 Outdoor control areas [≤3,000 cu. ft.].** Outdoor control areas for hazardous materials in amounts not exceeding the MAQ per outdoor control area shall be in accordance with the following: 1. Outdoor control areas shall be kept free from weeds, debris and common combustible materials not necessary to the storage. The area surrounding an outdoor control area shall be kept clear of such materials for a minimum of 15 feet. **IFC (2012) 5804.2 Outdoor storage [>3,000 cu. ft.].** Outdoor storage of flammable gases in amounts exceeding the MAQ per control area indicated in Table 5003.1.1(3) [e.g. - 3,000 cu. ft. of flammable gas in an outdoor control area] shall be in accordance with Sections 5001, 5003 and 5004, and this chapter. **5004.11 Clearance from combustibles.** The area surrounding an outdoor storage area or tank shall be kept clear of combustible materials and vegetation for a minimum distance of 25 feet.

Table A.1 Hydrogen Refueling Station Code Observations					
Item	**Topic / Gap / Conflict**	**NFPA 2 (2011 Ed.) Requirement**	**NFPA 52 (2010 Ed.) Requirement**	**NFPA 55 (2013 Ed.) Requirement**	**Other Code / Standard Requirement**
				compressed gas system and the exposure. (3) .... ~12-19 feet required to 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 by Table 10.3.2.1(a).	

Table A.1 Hydrogen Refueling Station Code Observations					
Item	**Topic / Gap / Conflict**	**NFPA 2 (2011 Ed.) Requirement**	**NFPA 52 (2010 Ed.) Requirement**	**NFPA 55 (2013 Ed.) Requirement**	**Other Code / Standard Requirement**
17	**Separation Distance Discrepancies - Dispensing** Separation distance discrepancies, particularly in regard to clearances between outdoor dispensing and use areas and combustibles. IFC is much more strict than NFPA 2/52/55. IFC requires 15 feet ≤MAQ and 30 feet >MAQ yet NFPA 2/52/55 range is 10-20 feet. **Panel Input:** Addressed in 2013 NFPA 55. **Proposed Resolution:** IFC should reference the more specific application of outdoor bulk hydrogen compressed gas systems in NFPA 55 to resolve this code conflict. However, NFPA 2 should be updated to differentiate between storage area separation distances to combustibles and use (e.g. - dispensing) areas separation distances to combustibles. NFPA 2 currently conflicts with NFPA 55 because it uses NFPA 52 language specific to dispensing. This should be corrected in the next code cycle when the extract text from NFPA 55 is also included in NFPA 2.	**Chapter 10 GH2 Vehicle Fueling Facilities** **10.3 Dispensing.** **10.3.2 Dispensing to The Public.** **10.3.2.3 Outdoor Public Fueling.** **10.3.2.3.1 General.** **10.3.2.3.1.3** The outdoor installation of hydrogen dispensers shall meet the separation distances shown in Table 10.3.2.3.1.3. [**52**:9.3.1.4] Clearance from combustibles is not specifically mentioned in Table 10.3.2.3.1.3 but the required separation is 10 feet for most exposures such as buildings, public ways, etc. **10.3.2.3.1.4** The point of transfer shall be permitted to be located at a lesser distance from buildings or walls constructed of concrete or masonry materials or of other material having a fire resistance rating of at least 2 hours, but at least 10 ft (3.0 m) from any building openings. [**52:**9.3.2.3] **10.3.2.3.1.5** Dispensing points shall be permitted to be located at a lesser distance from buildings or walls constructed of materials having a fire resistance rating of not less than 2 hours, but at least 10 ft (3.0 m) from building openings. [**52:**9.3.2.3.1]	**Chapter 9 GH2 Compression, Gas Processing, Storage and Dispensing Systems** **9.3 System Siting.** **9.3.1 General.** **9.3.1.4** The outdoor installation of hydrogen dispensers shall meet the separation distances shown in Table 9.3.1.4. Clearance from combustibles is not specifically mentioned in Table 9.3.1.4 but the required separation is 10 feet for most exposures such as buildings, public ways, etc.	**Chapter 10 Bulk Hydrogen Compressed Gas Systems** **10.3 Outdoor Bulk Hydrogen Compressed Gas Systems.** **10.3.2 Location.** **10.3.2.1* Minimum Distance.** The minimum distance from a bulk hydrogen compressed gas system located outdoors to specified exposures shall be in accordance with Table 10.3.2.1(a), Table 10.3.2.1(b), or Table 10.3.2.1(c). *(See also Annex G.)* **10.3.2.4* Reduction of Distance by Mitigation Means.** **10.3.2.4.1* Passive Means.** Except for distances to air intakes, the distances to Group 1 and 2 exposures shown in Table 10.3.2.1(a), Table 10.3.2.1(b), and Table 10.3.2.1(c) shall be permitted to be reduced by one-half and shall not apply to Group 3 exposures where fire barrier walls are located between the system and the exposure and constructed in accordance with the following: (1) Fire barrier walls shall have a minimum fire resistance rating of not less than 2 hours. (2) The fire barrier wall shall interrupt the line of sight between the bulk hydrogen	**IFC (2012) Chapter 50 Hazardous Materials - General Provisions** **5003 General Requirements** **5003.12 Outdoor control areas [≤3,000 cu. ft.].** Outdoor control areas for hazardous materials in amounts not exceeding the MAQ per outdoor control area shall be in accordance with the following: 1. Outdoor control areas shall be kept free from weeds, debris and common combustible materials not necessary to the storage. The area surrounding an outdoor control area shall be kept clear of such materials for a minimum of 15 feet. **5005 Use, Dispensing and Handling (>MAQ)** **5005.3 Outdoor dispensing and use.** **5005.3.1 Quantities exceeding the MAQ per control area [>1,500 cu. ft.].** Outdoor dispensing or use of hazardous materials, in either closed or open containers or systems, in amounts exceeding the MAQ per control area indicated in Tables 5003.1.1(3) and 5003.1.1(4) shall be in accordance with Sections 5001, 5003, 5005.1 and 5005.3. **IFC (2012) 5005.3.8 Clearance**

Table A.1 Hydrogen Refueling Station Code Observations					
Item	**Topic / Gap / Conflict**	**NFPA 2 (2011 Ed.) Requirement**	**NFPA 52 (2010 Ed.) Requirement**	**NFPA 55 (2013 Ed.) Requirement**	**Other Code / Standard Requirement**
				compressed gas system and the exposure. (3) .... ~12-19 feet required to 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 by Table 10.3.2.1(a).	**from combustibles.** The area surrounding an outdoor dispensing or use area shall be kept clear of combustible materials and vegetation for a minimum distance of 30 feet.

Table A.1 Hydrogen Refueling Station Code Observations					
Item	**Topic / Gap / Conflict**	**NFPA 2 (2011 Ed.) Requirement**	**NFPA 52 (2010 Ed.) Requirement**	**NFPA 55 (2013 Ed.) Requirement**	**Other Code / Standard Requirement**
18	**Nozzles** NFPA 2 provides better description of listing requirement for fueling nozzles. **Panel Input:** Make a general reference to NFPA 2 in the IFC. **Proposed Resolution:** IFC Technical Committee should incorporate similar language or at a minimum, make a general reference to NFPA 2.	**Chapter 10 GH2 Vehicle Fueling Facilities** **10.3 Dispensing.** **10.3.1 General.** **10.3.1.15 Vehicle Fueling Connection.** **10.3.1.15.1** Fueling nozzles for GH2 service shall be listed or approved in accordance with SAE J2600, *Compressed Hydrogen Surface Refueling Connection Devices*. [**52:**5.11.1] **10.3.1.15.2** The use of adapters shall be prohibited. [**52:**5.11.2] **10.3.1.15.3** The fueling connection shall prevent the escape of gas where the connector is not properly engaged or becomes separated. [**52:**9.2.9]	**Chapter 5 General GH_2 Requirements and Equipment Qualifications** **5.11 Vehicle Fueling Connection.** **5.11.1** Fueling nozzles for GH2 service shall be listed or approved in accordance with SAE J2600, *Compressed Hydrogen Surface Refueling Connection Devices*. **5.11.2** The use of adapters shall be prohibited.	No requirement.	**IFC (2012) Chapter 23 Motor Fuel-Dispensing Facilities and Repair Garages** **2309 Hydrogen Motor Fuel-Dispensing and Generation Facilities** **2309.2 Equipment.** **2309.2.2 Listed or approved equipment.** Hoses, hose connections, compressors, hydrogen generators, dispensers, detection systems and electrical equipment used for hydrogen shall be listed or approved for use with hydrogen. Hydrogen motor-fueling connections shall be listed and labeled or approved for use with hydrogen.

Table A.1 Hydrogen Refueling Station Code Observations					
Item	**Topic / Gap / Conflict**	**NFPA 2 (2011 Ed.) Requirement**	**NFPA 52 (2010 Ed.) Requirement**	**NFPA 55 (2013 Ed.) Requirement**	**Other Code / Standard Requirement**
19	**Breakaway** Breakaway device between the connection of the hose to the dispenser and the filling nozzle is required per NFPA 2/52 but not the IFC. Suggest adding text to IFC. **Panel Input:** This is a needed requirement. Need to add a reference to NFPA 2 to the IFC or add this requirement in to the IFC. **Proposed Resolution:** The IFC should resolve this code gap and consider adding this requirement into Sections 2307 (Liquefied Petroleum Gas Motor Fuel-Dispensing Facilities), 2308 (Compressed Natural Gas Motor Fuel-Dispensing Facilities) and 2309 (Hydrogen Motor Fuel-Dispensing and Generation Facilities), similar to the requirement in Section 2306.7.5.1 for flammable and combustible liquid motor fuel-dispensing facilities. The IFC should reference NFPA 2 in several locations regardless, particularly in Chapter 23 (Motor Fuel-Dispensing Facilities and Repair Garages) to resolve code gap. In addition, Section 5301.1 (Compressed Gases - Scope) of the 2012 IFC might include a third Exception, "Compressed hydrogen for use as a vehicular fuel shall comply with Chapter 23 and NFPA 2", similar to Exception 2 for compressed natural gas (CNG) used as vehicular fuel.	**Chapter 10 GH2 Vehicle Fueling Facilities** **10.3 Dispensing.** **10.3.1 General.** **10.3.1.18 Installation of Emergency Shutdown Equipment.** **10.3.1.18.6** A breakaway device that causes hydrogen gas flow to stop shall be installed between the connection of the hose to the dispenser and the filling nozzle. [**52:**9.11.6] **10.3.1.18.6.1** Such a device shall be arranged to separate using a force not greater than 150 lb (68 kg) when applied in any direction that the vehicle would move. [**52:**9.11.6.1] **10.3.1.18.6.2** Breakaway devices shall be compatible with ANSI/IAS NGV 4.4, *Breakaway Devices for Dispensing Systems*. [**52:**9.11.6.2]	**Chapter 9 GH2 Compression, Gas Processing, Storage and Dispensing Systems** **9.11 Installation of Emergency Shutdown Equipment.** **9.11.6** A breakaway device that causes hydrogen gas flow to stop shall be installed between the connection of the hose to the dispenser and the filling nozzle. **9.11.6.1** Such a device shall be arranged to separate using a force not greater than 150 lb (68 kg) when applied in any direction that the vehicle would move. **9.11.6.2** Breakaway devices shall be compatible with ANSI/ IAS NGV 4.4, *Breakaway Devices for Dispensing Systems*.	No requirement.	**No similar requirement in IFC. Breakaway devices are required for flammable and combustible liquid motor fuel-dispensing facilities (2306.7.5.1) but not for hydrogen motor fuel-dispensing and generation facilities.**

Table A.1 Hydrogen Refueling Station Code Observations					
Item	**Topic / Gap / Conflict**	**NFPA 2 (2011 Ed.) Requirement**	**NFPA 52 (2010 Ed.) Requirement**	**NFPA 55 (2013 Ed.) Requirement**	**Other Code / Standard Requirement**
20	**Venting** Venting of H2 systems required by NFPA 2/52/55 but no longer in IFC. **Panel Input:** Need a pointer to NFPA 2. Need to get to CGA G5.5. More relief valves may not be better. Hard to get these eliminated from designs but safety may not be improved by more relief valves. Material was likely dropped from IFC because reference to 55 was added and this was thought to be OK. PRD v PRV. This may have been inadvertent. **Proposed Resolution:** NFPA 2 Technical Committee should update applicable sections with new text extracted from the 2013 Edition of NFPA 55. The IFC Technical Committee should reference NFPA 2 in several locations, particularly in Chapter 23 (Motor Fuel-Dispensing Facilities and Repair Garages) to resolve code gap. In addition, Section 5301.1 (Compressed Gases - Scope) of the 2012 IFC might include a third Exception, "Compressed hydrogen for use as a vehicular fuel shall comply with Chapter 23 and NFPA 2", similar to Exception 2 for compressed natural gas (CNG) used as vehicular fuel.	**Chapter 6 General Hydrogen Requirements** **6.16* Vent Pipe Termination.** Hydrogen venting systems discharging to the atmosphere shall be in accordance with CGA G-5.5, *Hydrogen Vent Systems*. [**55:**10.2.2] **7.3 Bulk GH2 Systems.** **7.3.1* Bulk GH2 Systems — General.** **7.3.1.2 Design of GH2 Systems.** **7.3.1.2.1*** Piping, tubing, valves, and fittings shall be designed and installed in accordance 7.1.15.1 and Sections 704.1.2.3, 704.1.2.4, and 704.1.2.5 of the ICC *International Fuel Gas Code (IFGC)*. Cast-iron pipe, valves, and fittings shall not be used. [**55:**10.2.1] **7.3.1.2.2 Pressure Relief Devices.** Hydrogen-venting systems discharging to the atmosphere shall be in accordance with CGA G-5.5, *Hydrogen Vent Systems*. [**55:**10.2.2] **7.3.2 Bulk GH2 Systems Storage.** **7.3.2.4 Underground Systems.** [GH2] systems installed underground where [GH2] containers are to be buried in contact with earth or fill shall be in accordance with 7.3.2.4. [**55:**10.4.2] **7.3.2.4.9 Venting of Underground GH2 Containers.** Vent pipes for under-ground [GH2] containers shall be in accordance with 7.3.1.2.1. [**55:**10.4.2.9] **8.3 Bulk LH2 Systems.** **8.3.1 Bulk LH2 Systems — General.** **8.3.1.2 Design of LH2 Systems.**	**Chapter 9 GH2 Compression, Gas Processing, Storage and Dispensing Systems** **9.9 Installation of Piping and Hoses.** **9.9.2*** Hydrogen shall be vented in accordance with Section 5.4. **Chapter 5 General GH_2 Requirements and Equipment Qualifications** **5.4* Pressure Relief Devices.** When required by 5.4.1, pressure relief devices shall be provided to protect containers and systems containing compressed gases from rupture in the event of overpressure from thermal exposure. [**55:**7.1.5.5.1] **5.4.1** Pressure relief devices to protect containers shall be designed and provided in accordance with CGA S-1.1, *Pressure Relief Device Standards – Part 1 – Cylinders for Compressed Gases,* for cylinders; CGA S-1.2, *Pressure Relief Device Standards – Part 2 – Cargo and Portable Tanks for Compressed Gases*, for portable tanks; and CGA S-1.3, *Pressure Relief Device Standards – Part 3 – Stationary Storage Containers for Compressed Gases*, or ASME *Boiler and Pressure Vessel Code*, Section VIII, for stationary tanks or applicable equivalent requirements in the country of use. [**55:**7.1.5.5.2] **5.4.2** Pressure relief devices shall be	**Chapter 10 Bulk Hydrogen Compressed Gas Systems** **10.2 General.** **10.2.2* Piping Systems.** Piping, tubing, valves, and fittings shall be designed and installed in accordance with ASME B31.12, *Hydrogen Piping and Pipelines*, 7.3.1.3, and Sections 704.1.2.3, 704.1.2.4, and 704.1.2.5 of the ICC *International Fuel Gas Code (IFGC)*. Cast-iron pipe, valves, and fittings shall not be used. **10.2.3 Hydrogen-Venting Systems.** Hydrogen-venting systems serving pressure relief devices discharging hydrogen to the atmosphere shall be in accordance with CGA G-5.5, *Hydrogen Vent Systems*. **10.4 Underground Bulk Hydrogen Compressed Gas Systems.** **10.4.1 Underground Systems.** Bulk hydrogen compressed gas systems installed underground where compressed gas containers are to be buried in contact with earth or fill shall be in accordance with 10.4.1. **10.4.1.10 Venting of Underground Compressed Gas Containers.** Vent pipes for underground compressed gas containers shall be in accordance with 10.2.2.	IFC (2009 Ed. -> **Removed from 2012 Ed**.) Furthermore, **IFC refers to NFPA 52 ONLY in Section 5301.1 in regard to CNG.** **IFC (2009) Chapter 22 Motor Fuel-Dispensing Facilities and Repair Garages** **2209 Hydrogen Motor Fuel-Dispensing and Generation Facilities** **2209.5 Safety Precautions** **2209.5.4 Venting of hydrogen systems.** Hydrogen systems shall be equipped with pressure relief devices that will relieve excessive internal pressure in accordance with Sections 2209.5.4.1 through 2209.5.4.3.6. **2209.5.4.2 Pressure relief devices.** Portions of the system subject to overpressure shall be protected by pressure relief devices designed and installed in accordance with the requirements of CGA S-1.1, S-1.2, S-1.3 or the ASME Boiler and Pressure Vessel Code , as applicable. Containers used for the storage of liquefied hydrogen shall be provided with pressure relief devices in accordance with Section 3203.2. **2209.5.4.2.1 Minimum rate of discharge.**

Table A.1 Hydrogen Refueling Station Code Observations					
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		8.3.1.2.2 Pressure Relief Devices. Stationary and portable containers and tanks shall be provided with pressure relief devices in accordance with the requirements of 8.1.4 and 8.3.1.2.2.1 through 8.3.1.2.2.3. [**55:**11.2.2] **8.3.1.2.2.2** Hydrogen venting systems discharging to the atmosphere shall be in accordance with CGA G-5.5, *Hydrogen Vent Systems*. [**55:**11.2.2.2] **8.3.2.5.5 Venting of Underground Tanks.** Vent pipes for underground storage tanks shall be in accordance with 8.3.1.2.2.2. [**55:**11.4.3.5]	sized in accordance with the specifications to which the container was fabricated. [**55:**7.1.5.5.3] **5.4.3** The pressure relief device shall have the capacity to prevent the maximum design pressure of the container or system from being exceeded. [**55:**7.1.5.5.4] **5.4.4** Pressure relief devices shall be arranged to discharge unobstructed to the open air in such a manner as to prevent any impingement of escaping gas upon the container, adjacent structures, or personnel. This requirement shall not apply to DOT specification containers having an internal volume of 2.0 ft3 (0.057 m3) or less. [**55:**7.1.5.5.5] **5.4.5** Pressure relief devices or vent piping shall be designed or located so that moisture cannot collect and freeze in a manner that would interfere with operation of the device. [**55:**7.1.5.5.6] **5.4.6** Pressure relief valves for GH2 service shall not be fitted with lifting devices. **5.4.6.1** The adjustment, if external, shall be provided with a means for sealing the adjustment to prevent tampering. **5.4.6.2** If at any time it is necessary to break such a seal, the valve shall be removed from service until it has	**Chapter 11 Bulk Liquefied Hydrogen Systems** **11.2 Design of Bulk Liquefied Hydrogen Systems.** **11.2.2 Pressure Relief Devices.** Stationary and portable containers and tanks shall be provided with pressure relief devices in accordance with the requirements of 8.2.4 and 11.2.2.1 through 11.2.2.3. **11.2.2.2** Hydrogen venting systems discharging to the atmosphere shall be in accordance with CGA G-5.5, *Hydrogen Vent Systems*. **11.4.3.5 Venting of Underground Tanks.** Vent pipes for underground storage tanks shall be in accordance with 11.2.2.2.	The minimum flow capacity of pressure relief devices on hydrogen storage containers shall be at least the capacity required by Section 2209.5.4.2 or the capacity required to accommodate a hydrogen compressor that fails to shut down or unload, whichever is greater.

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Item	**Topic / Gap / Conflict**	**NFPA 2 (2011 Ed.) Requirement**	**NFPA 52 (2010 Ed.) Requirement**	**NFPA 55 (2013 Ed.) Requirement**	**Other Code / Standard Requirement**
			been reset and sealed. **5.4.6.3** 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. **5.4.6.4** The organization making such adjustment shall attach a permanent tag with the setting, capacity, and date. **5.4.7** Pressure relief valves protecting ASME pressure vessels shall be repaired, adjusted, and tested in accordance with the ASME *Boiler and Pressure Vessel Code*.		

Table A.1 Hydrogen Refueling Station Code Observations					
Item	**Topic / Gap / Conflict**	**NFPA 2 (2011 Ed.) Requirement**	**NFPA 52 (2010 Ed.) Requirement**	**NFPA 55 (2013 Ed.) Requirement**	**Other Code / Standard Requirement**
21	**Vent Pipe Termination** Vent pipe termination requirements contained in NFPA2/52/55 but no longer in IFC. **Panel Input:** Need a reference in IFC to point to NFPA 55 or 2 or both. Why did this get deleted from IFC? **Proposed Resolutions:** NFPA 2 Technical Committee should update applicable sections to new text extracted from the 2013 Edition of NFPA 55. The IFC Technical Committee should reference NFPA 2 in several locations, particularly in Chapter 23 (Motor Fuel-Dispensing Facilities and Repair Garages) to resolve code gap. In addition, Section 5301.1 (Compressed Gases - Scope) of the 2012 IFC might include a third Exception, "Compressed hydrogen for use as a vehicular fuel shall comply with Chapter 23 and NFPA 2", similar to Exception 2 for compressed natural gas (CNG) used as vehicular fuel.	**Chapter 6 General Hydrogen Requirements** **6.16* Vent Pipe Termination.** Hydrogen venting systems discharging to the atmosphere shall be in accordance with CGA G-5.5, *Hydrogen Vent Systems*. [**55:**10.2.2] **Chapter 7 Gaseous Hydrogen** **7.1 General.** **7.1.17 Vent Pipe Termination.** **7.1.17.1** Venting of [GH2] shall be directed to an approved location. [**55:**7.3.1.5.1] **7.1.17.2** The termination point for piped vent systems serving cylinders, containers, tanks, and gas systems used for the purpose of operational or emergency venting shall be in accordance with Section 6.16. [**55:**7.3.1.5.2]	**Chapter 5 General GH_2 Requirements and Equipment Qualifications** **5.5 Vent Pipe Termination.** **5.5.1** Hydrogen venting systems discharging to the atmosphere shall be in accordance with CGA G-5.5, *Hydrogen Vent Systems*. [**55:**10.2.2] **5.5.2** Venting of gas through PRDs shall be to an approved location. **5.5.2.1** The termination point for piped vent systems serving cylinders, containers, tanks, and gas systems used for the purpose of operational or emergency venting shall be located to prevent impingement exposure on the system served and to minimize the effects of high temperature thermal radiation or the effects of contact with the gas from the escaping plume to the supply system, personnel, adjacent structures, and ignition sources. [**55:**6.14]	**Chapter 6 Building-Related Controls** **6.1 General.** **6.15 Vent Pipe Termination.** The termination point for piped vent systems serving cylinders, containers, tanks, and gas systems used for the purpose of operational or emergency venting shall be located to prevent impingement exposure on the system served and to minimize the effects of high temperature thermal radiation or the effects of contact with the gas from the escaping plume to the supply system, personnel, adjacent structures, and ignition sources. **Chapter 7 Compressed Gases** **7.3 Use and Handling.** **7.3.1 General.** **7.3.1.5 Vent Pipe Termination.** **7.3.1.5.1** Venting of gases shall be directed to an approved location. **7.3.1.5.2** The termination point for piped vent systems serving cylinders, containers, tanks, and gas systems used for the purpose of operational or emergency venting shall be in accordance with Section 6.15. **Chapter 10 Bulk Hydrogen Compressed Gas Systems** **10.2 General.** **10.2.3 Hydrogen-Venting**	**IFC (2009 Ed. -> Removed from 2012 Ed**.) Furthermore, **IFC refers to NFPA 52 ONLY in Section 5301.1 in regard to CNG.** **IFC (2009) Chapter 22 Motor Fuel-Dispensing Facilities and Repair Garages** **2209 Hydrogen Motor Fuel-Dispensing and Generation Facilities** **2209.5 Safety Precautions** **2209.5.4 Venting of hydrogen systems.** **2209.5.4.1 Location of discharge.** Hydrogen vented from vent pipe systems serving pressure relief devices or purging systems shall not be discharged inside buildings or under canopies used for weather protection. **2209.5.4.3 Vent pipe.** Stationary containers and tanks shall be provided with a vent pipe system that will divert gas discharged from pressure relief devices to the atmosphere. Vent pipe systems serving pressure relief devices and purging systems used for operational control shall be designed and constructed in accordance with Sections 2209.5.4.3.1 through 2209.5.4.3.6. **2209.5.4.3.1 Materials of construction.** The vent pipe

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				Systems. Hydrogen-venting systems serving pressure relief devices discharging hydrogen to the atmosphere shall be in accordance with CGA G-5.5, *Hydrogen Vent Systems*.	system shall be constructed of materials approved for hydrogen service in accordance with ASME B31.3 for the rated pressure, volume and temperature of gas to be transported. The vent piping shall be designed for the maximum backpressure within the pipe, but not less than 335 pounds per square inch gauge (psig) (2310 kPa). **2209.5.4.3.2 Structural support.** The vent pipe system shall be supported to prevent structural collapse and shall be provided with a rain cap or other feature that would not limit or obstruct the gas flow from venting vertically upward. **2209.5.4.3.3 Obstructions.** A means shall be provided to prevent water, ice and other debris from accumulating inside the vent pipe or obstructing the vent pipe. **2209.5.4.3.4 Height of vent and separation.** The height (H) and separation distance (D) of the vent pipe shall meet the criteria set forth in Table 2209.5.4.3.4 for the combinations of maximum hydrogen flow rates and vent stack opening diameters listed . Alternative venting systems shall be allowed when in accordance

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					with Section 2209.5.4.3.6. **2209.5.4.3.5 Maximum flow rate.** The vent pipe system shall be sized based on the maximum flow rate for the system served and be specified on the construction documents . The maximum flow rate shall be determined in accordance with the requirements of CGA S-1.3 using the aggregate gas flow rate from all connected vent, purge and relief devices that operate simultaneously during a venting operation, purging operation or emergency relief event. **2209.5.4.3.6 Alternative venting systems.** Where alternative venting systems are used in lieu of the requirements of Section 2209.5.4.3.5, an analysis of radiant heat exposures and hydrogen concentrations shall be provided. The analysis of exposure to radiant heat shall assume a wind speed of 30 feet/second (9.14 m/sec) and provide a design that limits radiant heat exposure to the maximum values shown in Table 2209.5.4.3.6(1). The analysis of exposure to hydrogen concentra-tion shall provide a design that limits the maximum hydrogen concentration to the values shown in Table 2209.5.4.3.6(2).

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22	**Vent Pipe Construction Material** Vent pipes are intended to route a release from a pressure relief device (PRD) operation to a "safe place". There are no requirements for construction material (pressure rating) for this material. Construction using soft materials (copper) that may be rated for a few hundred psi are tempting for a pipe that vents to atmospheric pressure but can rupture at or near PRD when exposed to several thousand psi. Does this need to be codified? Is this covered in CGA G-5.5, *Hydrogen Vent Systems?* **Panel Input:** Need to have vent pipe built per CGA G5.5. Need a statement of the design goal (operation or PRD shall not cause a rupture of the vent pipe) combined with a good annex statement. **Proposed Resolution:** NFPA 2 should consider adding some Annex material regarding a design goal statement (e.g. - operation or PRD activation shall not cause a rupture of the vent pipe) as well as a discussion of CGA G-5.5, *Hydrogen Vent Systems*. The IFC should reference NFPA 2 in several locations, particularly in Chapter 23 (Motor Fuel-Dispensing Facilities and Repair Garages) to resolve code gap. In addition, Section 5301.1 (Compressed Gases - Scope) of the 2012 IFC might include a third Exception, "Compressed hydrogen for use as a vehicular fuel shall comply with Chapter 23 and NFPA 2", similar to Exception 2 for compressed natural gas (CNG) used as vehicular fuel.	**Chapter 6 General Hydrogen Requirements** **6.16* Vent Pipe Termination.** Hydrogen venting systems discharging to the atmosphere shall be in accordance with CGA G-5.5, *Hydrogen Vent Systems*. [**55:**10.2.2]	**Chapter 5 General GH_2 Requirements and Equipment Qualifications** **5.5 Vent Pipe Termination.** **5.5.1** Hydrogen venting systems discharging to the atmosphere shall be in accordance with CGA G-5.5, *Hydrogen Vent Systems*. [**55:**10.2.2]	**Chapter 10 Bulk Hydrogen Compressed Gas Systems** **10.2 General.** **10.2.3 Hydrogen-Venting Systems.** Hydrogen-venting systems serving pressure relief devices discharging hydrogen to the atmosphere shall be in accordance with CGA G-5.5, *Hydrogen Vent Systems*.	**IFC (2009 Ed. -> Removed from 2012 Ed.)** **IFC (2009) Chapter 22 Motor Fuel-Dispensing Facilities and Repair Garages** **2209 Hydrogen Motor Fuel-Dispensing and Generation Facilities** **2209.5 Safety Precautions** **2209.5.4 Venting of hydrogen systems.** Stationary containers and tanks shall be provided with a vent pipe system that will divert gas discharged from pressure relief devices to the atmosphere. Vent pipe systems serving pressure relief devices and purging systems used for operational control shall be designed and constructed in accordance with Sections 2209.5.4.3.1 through 2209.5.4.3.6. **2209.5.4.3 Vent pipe.** **2209.5.4.3.1 Materials of construction.** The vent pipe system shall be constructed of materials approved for hydrogen service in accordance with ASME B31.3 for the rated pressure, volume and temperature of gas to be transported. The vent piping shall be designed for the maximum backpressure within the pipe, but not less than 335 pounds per sq. inch gauge (psig) (2310 kPa).

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23	**Projectile Protection** **Panel Input:** Are requirements needed? This comes up during plan reviews. Need 50 cal rifle to penetrate tanks. Tank design is robust. DOT/ASME approval may result in the pressure vessel design being sufficient to address. Steel tanks usually not an issue. Piping could be a problem. But the hole size would be similar to a bullet hole in a tank. LH2 could be a concern due to not being a pressure vessel. There could be an issue with composite tanks. **Proposed Resolution:** NFPA 2 Technical Committee should consider establishing a task group to study this topic further.	No requirement.	No requirement.	No requirement.	No requirement in NFPA 400 (2013 Ed.), *Hazardous Materials Code*, or 2012 IFC.

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24	**Lightning Protection** The annex material to NFPA 2 Section 10.3.1.17.1 includes an API reference to lightning protection yet lightning protection is not specifically mentioned in Chapter 10 (GH2 Vehicle Fueling Facilities) and NFPA 780 is not referenced anywhere in NFPA 2, including Chapter 13 (Hydrogen Generation Systems) despite a requirement to protect against lightning. **Panel Input:** Refer to NEC. Reference via a Fire Protection Note to NFPA 780, *Standard for the Installation of Lightning Protection Systems*. **Proposed Resolution:** NFPA 2 and possibly IFC should include references to NFPA 780.	**Chapter 10 GH2 Vehicle Fueling Facilities** **10.3 Dispensing.** **10.3.1 General.** **10.3.1.17 Stray or Impressed Currents and Bonding.** **10.3.1.17.1*** Where stray or impressed currents are used or can be present on dispensing systems, such as cathodic protection, protective measures to prevent ignition shall be taken. [**52:**9.13.1] **A.10.3.1.17.1** See API RP 2003, *Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents*. [**52:** A.9.13.1] **13.2.4 Siting.** Hydrogen generation system(s) shall be installed in accordance with Chapters 1 through 8 [as well as the following criteria]: [**55**:12.3.2.4] (2) The system shall be anchored, located, and protected so that the system and equipment will not be adversely affected by rain, snow, ice, freezing temperatures, wind, seismic events, and lightning. [**55**:12.3.2.4(2)]	**Chapter 9 GH2 Compression, Gas Processing, Storage, and Dispensing Systems** **9.13 Stray or Impressed Currents and Bonding.** **9.13.1*** Where stray or impressed currents are used or can be present on dispensing systems, such as cathodic protection, protective measures to prevent ignition shall be taken. **A.9.13.1** See API RP 2003, *Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents*.	**Chapter 12 Gas Generation Systems** **12.3 Flammable Gases — Gaseous.** **12.3.2 Hydrogen Generation Systems.** **12.3.2.4 General Siting Requirements.** Hydrogen generation system(s) shall be installed in accordance with Chapters 1 through 7 and Chapter 10 of this code, and the system(s) shall be installed as follows: (2) The system shall be anchored, located, and protected so that the system and equipment will not be adversely affected by rain, snow, ice, freezing temperatures, wind, seismic events, and lightning.	No requirement in IFC.

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25	**Sun Protection** NFPA 2 extract text is outdated (i.e. - 2010 Ed. of NFPA 55). **Panel Input:** Meet weather protection requirements. **Proposed Resolution:** NFPA 2 extract text should be updated with new text from NFPA 55 (2013 Ed.), Sections 7.1.11.5 and 7.1.11.5.1.	**7.1.9.1.3* Temperature Extremes.** [GH2] containers, cylinders, and tanks, whether full or partially full, shall not be exposed to temperatures exceeding 125°F (52°C) or sub-ambient (low) temperatures unless designed for use under such exposure. [**55:**7.1.10.5]		**7.1.11.5 Temperature Extremes.** Compressed gas cylinders, containers, and tanks, whether full or partially full, shall not be exposed to temperatures exceeding 125°F (52°C) or sub-ambient (low) temperatures unless designed for use under such exposure. **7.1.11.5.1** Compressed gas cylinders, containers, and tanks that have not been designed for use under elevated temperature conditions shall not be exposed to direct sunlight outdoors where ambient temperatures exceed 125°F (52°C). The use of a weather protected structure or shaded environment for storage or use shall be permitted as a means to protect against direct exposure to sunlight.	**IFC (2012 Ed.) 5303.14 Overhead cover.** Compressed gas containers, cylinders and tanks are allowed to be stored or used in the sun except in locations where extreme temperatures prevail. When extreme temperatures prevail, overhead covers shall be provided.