Plan Review Checklist

Outdoor Hydrogen Fueling Station Employing Delivered Hydrogen, Bulk Liquid and Gaseous Storage, and High Pressure Gaseous Hydrogen Dispensing

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This Plan Review Checklist consists of the following sections to help Authorities Having Jurisdiction (AHJ)s and applicants better understand NFPA 2 – Hydrogen Technologies Code and specifically the Outdoor Hydrogen Fueling Station application and the relevant key code requirements for compliance to the NFPA 2 Hydrogen Technologies Code 2016 edition (the Code).

Section 1. Scope

The Hydrogen Fueling Station Plan Review Checklist (the Checklist) will assist in demonstrating compliance with the Code. The Checklist will simplify both the project development and safety review processes.

The Checklist is constructed, as the name implies, in check list format to demonstrate compliance with key code requirements for outdoor hydrogen fueling stations employing delivered hydrogen, bulk Liquified hydrogen (LH2) and Gaseous Hydrogen (GH2) storage, and high pressure GH2 dispensing. These 'key code requirements' are those which have a material impact on the equipment design or site engineering and construction. As such**, this check list does not include all of the requirements in the Code**. The Checklist has the additional following design exclusions. The Hydrogen Fueling Station Plan Review Checklist **does not** address requirements for the following items:

Design Exclusions:

-Exhausted Enclosures
-Gas Cabinets
-Gas Rooms
-Metal Hydride Storage Systems
-Non-bulk Hydrogen Storage Systems
-Vehicle Fueling Appliances (VFAs)
-Residential Fueling
-Indoor Fueling
-Outdoor Fueling from Transport Vehicles
-On-site Hydrogen Production
-Stationary Fuel Cells
-Co-location of Hydrogen Dispenser under existing gasoline dispenser canopy

The Checklist addresses the following chapters of NFPA 2:

Chapter 4: General Fire Safety Requirements
Chapter 6: General Hydrogen Requirements
Chapter 7: Gaseous Hydrogen
Chapter 8: Liquefied Hydrogen
Chapter 10: Vehicle Fueling Facilities

Example of Plan Review Checklist Required Documents

1 Emergency Response Plan
2 Site Drawings
3 Equipment Listing* As Needed
4 Insurance Information
5 Training Documents
6 Equipment Leak Testing Plans
7 Engineering Certification Report
8 Quantitative Risk Assessment (QRA) As Needed
9 Scheduled Maintenance Plan
10 Chemical Inventory
11 Equipment Testing Protocol

*The definition of listed equipment can be found under 3.2.5 of the Code. Additional information on listed equipment can be found under the Annex of the Code, under A.3.2.5

Active Means and Design Means of Mitigation as Safety Equivalency to Separation Distances for Bulk Gaseous and Liquefied Hydrogen Storage Systems.

This following items are potential enhanced safety measures that could help in reducing set-back distances. Other potential enhanced safety measures might be available to achieve the same objective of safety equivalency in accordance with Section 1.5.

Enhanced safety measures can be provided as part of this Plan Review Checklist by a project developer as a proposal to an AHJ as part of his/her petition for a variance under Chapter 1, Paragraph 1.5 “Equivalency”. The implementation of all or some of these measures does not necessitate a reduction of safety setback distances by any specific amount. Decisions made on the allowable reduction in the setback distances based on these measures would be determined by the AHJ based on review of the permit application. The inclusion of this information in this Plan Review Checklist does not necessarily mean that these measures will achieve equivalency nor absolve the AHJ from conducting a rigorous review of the applicant’s equivalency demonstration.

Risk Assessment

Section 1.5 of The Code allows for systems, methods, or devices of equivalent or superior safety to be used in place of those prescribed in the Code. A Fire Risk Assessment (FRA) should be performed to assess the effectiveness of alternative means or methods. Of the various types of FRAs, a Quantitative Risk Assessment (QRA) is particularly well-suited for evaluating separation distance reductions due to alternative safety measures.

A QRA uses information such as pressure, line size, and component specifications to assess potential hazards using computational models of physical behavior. This mathematic rigor allows different strategies and equipment to be easily compared on a scientific basis.

Sandia National Laboratory developed the Hydrogen Risk Assessment Model (HyRAM) specifically to be used in hydrogen station QRAs. HyRAM accounts for the physics and probability of accidental hydrogen releases and evaluates the resulting harm criteria. These results can be used to directly and quantitatively compare alternative means to the prescriptive requirements of the Code.

Active Enhanced Safety Measures

Reference Annex A.7.3.2.3.1.2(B) of the NFPA 2 code for examples of Active Enhanced Safety Measures.

Section 2. Checklist Instructions

Plan Review Instructions. The Checklist contains a summary of the key code requirements of the NFPA 2 Hydrogen Technologies Code 2016 edition (the Code) in a Checklist format. The applicant should show compliance with all requirements identified in the Checklist either through compliance with the prescriptive requirements presented in the Code or through the equivalency clause, as described in Chapter 1, Paragraph 1.5 of the Code which states that nothing in the Code is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this code.

The intent of the Checklist is to aid both project developers and safety officials in more rapidly demonstrating compliance with the Code and resolving any areas where prescriptive requirements are not met, and the equivalency clause is invoked. This Checklist **is not** intended to capture all applicable requirements for a project but should indicate that the majority of the safety requirements within the Code are met. There may be additional requirements dictated by the local Fire Code, Building Code, local zoning regulations, or in documents that are incorporated by reference in the Code. The applicant should check with the local municipality for other approvals required for a hydrogen fueling station such as environmental, land use, public health, building, and zoning.

The Checklist is intended to demonstrate basic site-specific compliance. The local AHJ may choose to include requirements specific to the jurisdiction in which the project would be located.

The Checklist is structured in a check sheet format that identifies key code requirements. The applicant or the Authority Having Jurisdiction (AHJ) should either (1) write “Yes” or “No” on compliance with the applicable section, or (2) provide an explanation for how they have achieved equivalency to the requirement or (3) explain why the requirement is not applicable, on a separate document in the case of (2) and (3).

Section 3. NFPA 2 Hydrogen Technologies Code (2016 Edition) Compliance Checklist

Section 3. NFPA 2 Hydrogen Technologies Code 2016 Edition Compliance Checklist

Compliance Checklist for Outdoor Public Hydrogen Fueling Station Employing Delivered Hydrogen, Bulk Liquid and Gaseous Storage, and High Pressure Gaseous Hydrogen Dispensing

Legend:

NFPA2 Edition: 2016	Topic	Comments	Y/N
Chapter 4	**General Fire Safety Requirements**		
4.2.3.1.2	Safety-from-Fire Objectives		
4.2.3.1.2.2	Building Access for Rescue		
4.2.4	Property Protection		
4.2.4.2	Property Protection Objectives		
4.2.4.2.1	Prevention of Ignition		
4.2.4.2.2	Fire Spread and Explosions		
4.2.4.2.3	Structural Integrity		
4.2.4.2.4	Hydrogen Hazards		
4.6	Emergency Plan		
4.6.1	Emergency Plan		
4.9	Management Plan and Hazardous Materials Documentation		
4.9.1	When required, a Hazardous Materials Management Plan shall be completed and submitted		
4.9.2	When required, a Hazardous Materials Inventory Statement shall be completed and submitted		
4.11	Personnel Training		
4.11.3	Emergency Response Liaison		
4.11.4	Emergency Responders		
4.11.4.3	Onsite Emergency Response Team shall be Trained		
4.11.4.5	Documentation of Training		
4.13	Signs		
4.13.1.1	Design and Construction of Signs		
4.13.1.2	English as Primary Language on Signs		
4.13.1.3	Maintenance of Signs		
4.13.2	Hazard Identification Signs		
4.13.2.1	Placement of visible hazard identification signs in accordance with NFPA 704		
4.14	Protection from Vehicular Damage		
4.14.1	Installation of Guard Posts		
4.14.1.2	Definition of Guard Posts		
Chapter 6	**General Hydrogen Requirements**		
6.6	Weather Protection		
6.6.1.1	Use of weather protection to shelter outdoor storage or use areas		
6.6.1.4	Design requirements for buildings or structures used for weather protection for outdoor storage or use		
6.7	Electrical Equipment shall be in accordance with NFPA 70		

6.7.1	Standby Power		
6.7.1.1	H2 System's connection to a standby power system shall be in accordance to NFPA 70		
6.7.2	Emergency Power shall meet requirements of Level 2 system per NFPA 110		
6.8	Employee alarm system may be required		
6.9	Explosion Control		
6.9.1	Explosion control shall be provided when H2 storage quantity exceeds Table 6.4.1.1		
6.9.3	Explosion prevention when provided shall comply with NFPA 69		
6.9.4	Deflagration prevention when provided shall comply with NFPA 68		
6.10	Fire Protection		
6.11	Fire Alarm Systems		
6.11.1	Manual fire alarm shall be provided		
6.11.2	Fire alarm system must comply with NFPA 72		
6.12	Gas Detection		
6.12.1	Listing for Gas Detection Equipment		
6.12.2	Requirements for Installation, Maintenance, Testing and Calibration of GH2 detection systems		
6.13	Lighting for Storage and Use Areas		
6.16	Vent Pipe Termination shall comply with CGA G-5.5: Hydrogen Vent Systems		
6.17	Ventilation		
6.20	Source Valve shall be Provided for Bulk Gas Systems		
6.20.1	Marking for Source Valve		
6.21	Cleaning and Purging of Piping Systems		
6.21.1.1	Cleaning and Purging requirements for new systems, change in service, repairs to piping systems		
6.21.1.3	Requirements for Cleaning and Purging Documentation		
6.21.1.4	Management of Change (MOC) Requirements		
6.21.1.5	Design review, Inspection and Test Requirements for Hydrogen Piping Systems		
Chapter 7	**Gaseous Hydrogen**		
7.1.2.1	GH_2 System Design		
7.1.2.2	Installation		
7.1.2.3.1	Materials Control		
7.1.2.3.2	Fail Safe		
7.1.3	Listed or Approved Equipment		
7.1.4	Metal Hydrides	Scope Exclusion	
7.1.5.1	Cylinders, Containers, and Tanks Design and Construction		
7.1.5.3	Supports		
7.1.5.5.2	Pressure Relief Devices		
7.1.5.5.3	PRD sizing		
7.1.5.5.4	Capacity		
7.1.5.5.5	Pressure Relief Devices		
7.1.5.5.6	Freezing		
7.1.6.1	Labelling Containers		
7.1.6.3.1	Stationary Containers		
7.1.6.3.2	Visible Markings		
7.1.6.4.1	Pipe System Marking		
7.1.6.5.2	No Smoking		
7.1.7.1	Securing Cylinders and Systems		
7.1.7.2	Secured Areas		

7.1.7.3.1	Physical Damage		
7.1.7.3.2	Guard Posts		
7.1.7.4	Securing Cylinders from Falling		
7.1.8.1	Valve Protection		
7.1.8.1.1	Valve Protection exception for DOT	Exception	
7.1.8.1.1.1	Valve Protection exception for stationary	Exception	
7.1.9.1	Separation from hazards		
7.1.9.1.1	Clearance from combustibles		
7.1.9.1.1.1	Combustible exception	Exception	
7.1.9.1.1.2	Noncombustible Partition		
7.1.9.1.2	Ledges		
7.1.9.1.3	Temperature Extremes		
7.1.9.1.3.1	Cylinders Sunlight Exposure		
7.1.9.1.4	Falling objects		
7.1.9.1.7	Chemical Exposure		
7.1.9.1.8	Electrical Exposure		
7.1.9.1.8.1	Electrical Devices		
7.1.14.1	Surfaces and Corrosion		
7.1.14.2	Grading		
7.1.15.1	Piping Systems		
7.1.15.1.1	Piping Systems		
7.1.15.1.2	Brazing Material		
7.1.15.1.5	Backflow		
7.1.15.2.3	Cabinets Ventilation		
7.1.15.2.4	Mobile Equipment Secured		
7.1.15.2.5	Mobile Equipment Secured		
Optional Design Feature Requirements: Does the system have underground piping? Y/N			
7.1.15.3	Underground Piping	Optional Design Feature: Underground Piping	
7.1.15.3.1.1	Underground Boxes	Optional Design Feature Requirement only: Underground Piping	
7.1.15.3.1.2	Loads on Boxes	Optional Design Feature Requirement only: Underground Piping	
7.1.15.3.1.3	Piping in Trenches	Exception	
7.1.15.3.2.1	Direct Contact and Corrosion Protection	Optional Design Feature Requirement only: Underground Piping	
7.1.15.3.3	Bedding	Optional Design Feature Requirement only: Underground Piping	
7.1.15.3.4	Depth Traffic Areas	Optional Design Feature Requirement only: Underground Piping	
7.1.15.3.5	Depth Exception	Exception	
7.1.15.3.6	Depth Exception	Exception	
7.1.15.3.7	Depth	Optional Design Feature Requirement only: Underground Piping	
7.1.15.3.9	Separation	Optional Design Feature Requirement only: Underground Piping	
7.1.15.3.10	Separation	Optional Design Feature Requirement only: Underground Piping	

End of Optional Design Feature Requirements on Underground Piping			
7.1.16.1	Valves Accessible		
7.1.16.2	Valve Handles		
7.1.17	GH_2 Venting Systems per G5.5		
7.1.17.1	Venting inside enclosures	Scope Exclusion	
7.1.17.2	Isolation due to Power Failure		
Optional Design Feature Requirements: Does the system require or include Cathodic Protection? Y/N			
7.1.18	Cathodic Protection	Optional Design Feature: Cathodic Protection	
7.1.18.1	Operation	Optional Design Feature Requirement only: Cathodic Protection	
7.1.18.2	Inspection	Optional Design Feature Requirement only: Cathodic Protection	
7.1.18.2.1	Certified Inspector	Optional Design Feature Requirement only: Cathodic Protection	
End of Optional Design Feature Requirements on Cathodic Protection			
7.1.20	Compression and Processing Equipment		
7.1.20.1	Pressure Relief Devices		
7.1.20.2	High Discharge and Low Suction Shutdown Control for Compressors		
7.1.20.3	Manual Reset		
7.1.21.1 (A)	Isolation Valves		
7.1.21.1 (B)	Check Valves		
7.1.21.2 (A)	Frost Heaving Prevention for Foundations		
7.1.21.2 (B)	Building Code		
7.1.21.3	Emergency Shutdown		
7.1.21.4 (A)	Overpressure protection for Compressors		
7.1.21.4 (B)	Pressure Relief Devices		
7.1.21.5.1	High Pressure Shutdown		
Optional Design Feature Requirements: Does the system include Hydrogen Equipment Enclosures (HEE)? Y/N			
7.1.23	HEE	Optional Design Feature: HEE	
7.1.23.1.2	Noncombustible Material	Optional Design Feature Requirement only, HEE	
7.1.23.2.1	Bonding and Grounding	Optional Design Feature Requirement only, HEE	
7.1.23.3	Venting Internal	Optional Design Feature Requirement only, HEE	
7.1.23.3.1	Vent Pipes	Optional Design Feature Requirement only, HEE	
7.1.23.3.2	Pressure Relief Device Venting	Optional Design Feature Requirement only, HEE	
7.1.23.4	O2 Deficiency	Optional Design Feature Requirement only, HEE	
7.1.23.4.1	O2 Deficiency Alarm	Optional Design Feature Requirement only, HEE	
7.1.23.4.1.1	O2 Warning Devices	Optional Design Feature Requirement only, HEE	
7.1.23.4.1.2	O2 Detector Exception	Exception	
7.1.23.5.1	Access Doors	Optional Design Feature Requirement only, HEE	
7.1.23.5.1.1	Access Doors Exception	Exception	

7.1.23.5.2	Locks	Optional Design Feature Requirement only, HEE	
7.1.23.6	Egress Exception	Exception	
7.1.23.6.1	Egress	Optional Design Feature Requirement only, HEE	
7.1.23.6.1.1	Egress	Optional Design Feature Requirement only, HEE	
7.1.23.8	Secured to Foundations	Optional Design Feature Requirement only, HEE	
7.1.23.9.2	Automatic Shutoff	Optional Design Feature Requirement only, HEE	
7.1.23.9.3	Automatic Shutoff	Optional Design Feature Requirement only, HEE	
7.1.23.9.4	Automatic Shutoff	Optional Design Feature Requirement only, HEE	
7.1.23.9.5	Automatic Shutoff	Optional Design Feature Requirement only, HEE	
7.1.23.9.6	Automatic Shutoff	Optional Design Feature Requirement only, HEE	
7.1.23.10.1	Ventilation per Table	Optional Design Feature Requirement only, HEE	
7.1.23.10.2	Ventilation	Optional Design Feature Requirement only, HEE	
7.1.23.10.3	Ventilation Separation	Optional Design Feature Requirement only, HEE	
7.1.23.10.3.1	Ventilation Separation	Optional Design Feature Requirement only, HEE	
7.1.23.11.2	Internal Fire Wall Rating	Optional Design Feature Requirement only, HEE	
7.1.23.12.1	Electrical	Optional Design Feature Requirement only, HEE	
7.1.23.12.2	Electrical	Optional Design Feature Requirement only, HEE	
7.1.23.13.1	ESS	Optional Design Feature Requirement only, HEE	
7.1.23.13.1.1	ESS	Optional Design Feature Requirement only, HEE	
7.1.23.13.1.2	Manual ESD	Optional Design Feature Requirement only, HEE	
7.1.23.13.1.3	Multiple HEE ESD	Optional Design Feature Requirement only, HEE	
7.1.23.13.1.4	ESS Action	Optional Design Feature Requirement only, HEE	
7.1.23.13.1.5	Manual ESD	Optional Design Feature Requirement only, HEE	
7.1.23.13.1.5 (A)	Sign for ESD	Optional Design Feature Requirement only, HEE	
7.1.23.13.1.6	Remote Shutoff Location	Optional Design Feature Requirement only, HEE	
7.1.23.14.2	H2 Detection	Optional Design Feature Requirement only, HEE	
7.1.23.14.2.1	H2 Detection	Optional Design Feature Requirement only, HEE	
7.1.23.14.3	Heat Detectors	Optional Design Feature Requirement only, HEE	

7.1.23.14.4	Ventilation Failure	Optional Design Feature Requirement only, HEE	
7.1.23.14.4.1	Ventilation Failure	Optional Design Feature Requirement only, HEE	
7.1.23.15.1	Explosion Control	Optional Design Feature Requirement only, HEE	
7.1.23.15.1.1	Explosion Control Venting	Optional Design Feature Requirement only, HEE	
End of Optional Design Feature Requirements on HEE			
7.1.24.1	Emergency Shutoff Valves		
7.1.24.1.1	Sign for Emergency Shutoff Valve		
7.1.24.2	Emergency Shutoff Valve Location		
7.1.25.1	Emergency Isolation		
7.1.25.2	Approved Means of Emergency Isolation		
7.1.25.3	Exceptions on Emergency Isolation	Exception	
7.1.25.4	Exceptions on Emergency Isolation	Exception	
7.1.26.1	Static Producing Equipment		
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7.3.1.2	Bulk GH2 system Bond/Ground		
7.3.2.1.3	Vault Requirements		
7.3.2.3.1.1	Setback Distances		
Optional Design Feature Requirements: Does the system include Fire Walls? Y/N			
7.3.2.3.1.2	Reduction of Distances	Optional Design Feature: Fire Walls	
7.3.2.3.1.2 (A)(1)	Without Openings	Optional Design Feature Requirement only: Fire Walls	
7.3.2.3.1.2 (A)(2)	Fire Resistance	Optional Design Feature Requirement only: Fire Walls	
7.3.2.3.1.2 (A)(3)	Line of Sight	Optional Design Feature Requirement only: Fire Walls	
7.3.2.3.1.2 (A)(4)	Natural Ventilation	Optional Design Feature Requirement only: Fire Walls	
7.3.2.3.1.2 (A)(5)	Number of Walls	Optional Design Feature Requirement only: Fire Walls	
7.3.2.3.1.2 (A)(6)	Configuration of Walls	Optional Design Feature Requirement only: Fire Walls	
7.3.2.3.1.2 (A)(7)	Building Code	Optional Design Feature Requirement only: Fire Walls	
7.3.2.3.1.2 (A)(8)	maintenance	Optional Design Feature Requirement only: Fire Walls	
7.3.2.3.1.2 (A)(9)	Exterior Wall	Optional Design Feature Requirement only: Fire Walls	
End of Optional Design Feature Requirements on Fire Walls			
7.3.2.3.1.2 (B)	Active Means		
7.3.2.3.1.3 (A)	Unloading Connections		
7.3.2.3.1.3 (B)	Gas and Liquid Systems		
7.3.2.3.1.3 (C)	System Elevation		
7.3.2.3.1.4	Colocation when mixed	Scope Exclusion	
7.3.2.3.1.5	Electrical Classification and Distance		
7.3.2.3.1.3	Required Separation Distance for All Systems		
Optional Design Feature Requirements: Does the system include Underground System? Y/N			
7.3.2.4	Underground System	Optional Design Feature: Underground Systems	

7.3.2.4.1	Container Design	Optional Design Feature Requirement only: Underground Systems	
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7.3.2.4.1.2 (A)	Container Examination	Optional Design Feature Requirement only: Underground Systems	
7.3.2.4.1.2 (B)	Container Examination	Optional Design Feature Requirement only: Underground Systems	
7.3.2.4.2	Corrosion Protection	Optional Design Feature Requirement only: Underground Systems	
7.3.2.4.3.1	Primary/Secondary Seals	Optional Design Feature Requirement only: Underground Systems	
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7.3.2.4.5.1	Underground location	Optional Design Feature Requirement only: Underground Systems	
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7.3.2.4.5.4	Foundation Design	Optional Design Feature Requirement only: Underground Systems	
7.3.2.4.5.5	Distance between Containers	Optional Design Feature Requirement only: Underground Systems	
7.3.2.4.5.6	Foundations	Optional Design Feature Requirement only: Underground Systems	
7.3.2.4.6.1	Foundations	Optional Design Feature Requirement only: Underground Systems	
7.3.2.4.7.1	Depth/Coverage	Optional Design Feature Requirement only: Underground Systems	
7.3.2.4.8	Anchoring	Optional Design Feature Requirement only: Underground Systems	

7.3.2.4.9	Venting	Optional Design Feature Requirement only: Underground Systems	
7.3.2.4.10	Overfill protection	Optional Design Feature Requirement only: Underground Systems	
7.3.2.4.11	Physical Protection	Optional Design Feature Requirement only: Underground Systems	
End of Optional Design Feature Requirements on Underground Systems			
7.3.4.2.1	Unloading Training	Operations Practices	
7.3.4.2.2	Unloading Connection Location		
7.3.4.2.3	Brake Applied	Operations Practices	
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7.3.4.2.6.1	Depressurize Connection		
7.3.4.2.6.2	Connection to Vent		
7.3.4.2.7	Check Valves on Fill Connection		
7.3.4.2.8	Smoking/Open Flame	Operations Practices	
7.3.4.2.9	Emergency Stop on Fill		
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8.1.3.1.1.3	Piping Systems		
8.1.3.1.2	Joints		
8.1.3.1.2.1	Brazing		
8.1.3.1.3	Valves		
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8.1.3.1.4.1	Shutoff Valves on Containers		
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8.1.4.7.2.2	Multiple PRD's		

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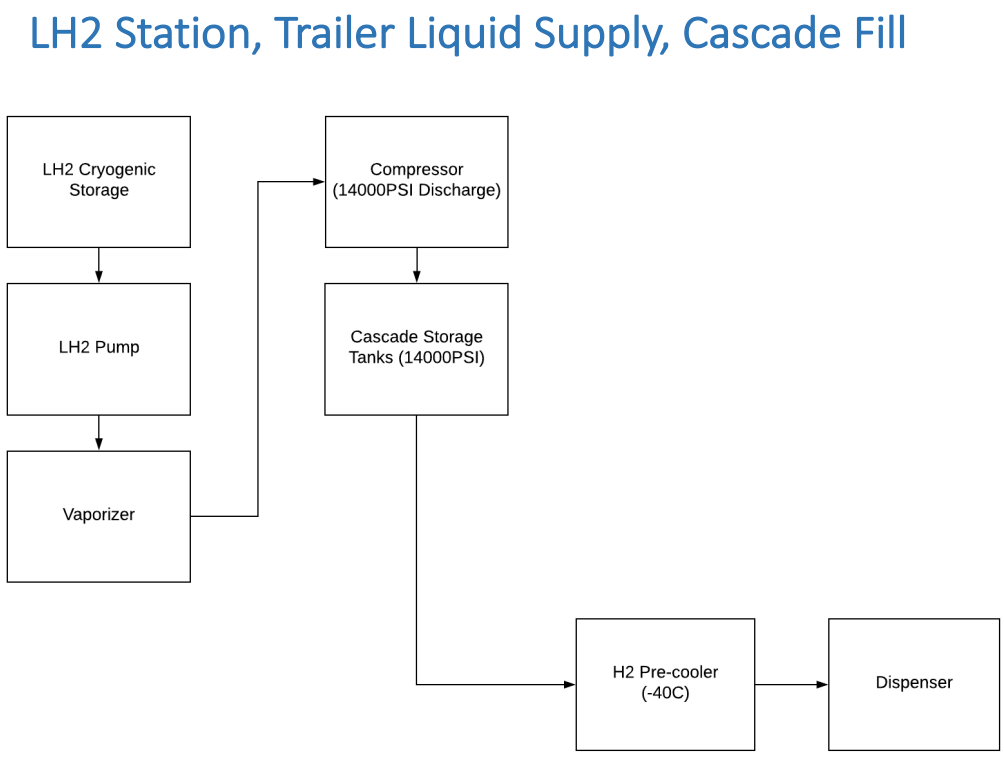
Section 4. Outdoor H2 Fueling Station Schematic



Location	Requirements Referenced in NFPA-2
LH2 Cryogenic Storage	Chapter 8
LH2 Pump and Vaporizer	Chapter 8
Compressor	Chapter 7/10
Cascade Storage	Chapter 7
Pre-cooler	Chapter 10
Dispenser	Chapter 10