HYDROGEN Safety Panel

SAFETY PLAN REVIEW

Everfuel Hydrogen Fueling Station Safety Plan Review

Submission for the California Energy Commission General Fuding Opportunity GFO-15-605

Background

At the request of the California Energy Commission, members from the Hydrogen Safety Panel (HSP) reviewed the Everfuel U.S., Inc. (Everfuel) H2Station® Hydrogen Safety Plan. The Panel's feedback on the plan is summarized below, followed by specific comments on the plan. Annex A provides the Panel's evaluation on how adequately the safety plan addresses the required topics.

Summary of Results

The project team has provided a well-organized safety plan that follows the formatting identified in the HSP safety planning guideline document. The safety plan describes a sound ISV approach for qualitative and semi-quantitative risk assessment, linked to ISO/IEC methodology to achieve an acceptable level of risk. However, the plan does not identify specific accident scenarios, key vulnerabilities, or safety critical equipment. Other topics not adequately addressed in the safety plan include equipment and mechanical integrity, management of change, safety reviews and emergency response. As result of the lack of project-specific detail, the HSP team members could not perform a thorough review of the applicant's submission, and therefore, the safety plan is incomplete, but promising.

Comments

The following comments include specific observations and recommendations that the HSP review team believes will result in a safer hydrogen fueling station. Many of the comments are based on the lack of detail in the safety plan and do not necessarily reflect inadequate safety planning. Alternative approaches may result in a station with equivalent safety, and these specific recommendations are not intended to limit the approach taken by the project team. The project team is encouraged to consider these comments early in the design of the hydrogen fueling station.

Narrative Document (4_ProjectNarrative_Everfuel_GFO15605.docx)

Comment #1: Page 10 of the Narrative document states, "H2Station® is a fully developed and tested product, with UL and other third-party certifications, and designed for high-volume manufacturing at the world's largest factory for hydrogen stations." It would be helpful to understand what it is certified for and what standards it is certified to.

Comment #2: Many of the site location code reviews in the Narrative document have identified separation distances not in accordance with NFPA 2. Per page 125, additional risk assessments will need to be performed, with the results approved by the AHJ. Since the risk assessments were not included with the submittal documentation, it is not possible to validate the approach. Specific comments relative to this approach:

- In many cases, the storage equipment is located directly adjacent to a property line. Parking spaces in close proximity are typically not permitted by NFPA 2, and this will specifically need to be addressed where this occurs on the opposite side of the property line (and with the consideration that the property owner may not be part of the siting discussions).

- PSP1.1 on page 36 – The table identifies distance to air intakes as OK, likely based on the wall next to the storage area. However, since the adjoining property has a building right on the property line (and the picture on page 34 doesn't reveal enough detail), it is unclear if there are air intakes within the required separation distance.
- Pages 79 and 85 – Though not identified in the table or shown on the drawings, this location may not provide adequate separation from exposed building openings.
- Page 25 – As shown on the picture, the delivery vehicle drop location for TP1 is directly in the vehicle travel path to the gasoline dispensers, presenting a safety and logistical concern.

Comment #3: There is no information in the Narrative document on how the hydrogen will be piped from the delivery location (up to 500 ft away per page 98) to the storage tanks (e.g., is it by open trenches? Underground piping?). Page 98 refers to a manifold. Is this above ground or below ground? This drop location is also subject to NFPA 2 separation distance requirements per 7.3.4.2.2, and it is not clear if this has been or will be considered.

Comment #4: Section 4.4.5 of the Narrative document incorrectly cites SAE J2600 and ISO 17268 as fueling hose standards. These documents refer to the fueling nozzle, whereas ANSI HGV 4.2 covers the fueling hose and ANSI HGV 4.4 covers the breakaway.

Comment #5: The HSP is very interested in understanding what elements will be certified by UL and to what standards/requirements (Section 4.6.5.7 on page 125 of the Narrative document). Everfuel and its partners should make it very clear to AHJs and stakeholders exactly what this covers. Unlisted equipment will still require approval by the AHJ.

Safety Plan (5_H2Station_CAR200_Safety_Plan_Everfuel_GFO15605.docx)

Comment #6: General – The safety plan has all the sections of a project safety plan addressed, but at a high level. Many of the sections lack detail and examples.

Comment #7: General – The safety plan lacks specific information on the internal configuration of the H2Station CAR-200 to allow consideration of its hazards and safety features.

Comment #8: General – The safety plan approval process includes stewardship information but does not mention the review and approval process.

Comment #9: General – Since the project's design relies on the use of enclosures, documentation should be provided that identifies how this equipment conforms to the hydrogen equipment enclosure requirements of NFPA 2 (7.1.23).

Comment #10: General – Site evaluations are critical items that need more safety review from both the system and fill location perspective. The site evaluations appear to not follow NFPA 2, as from the pictures, the hydrogen systems appear to be on the lot lines. Per NFPA 2, the systems (including the fill connection) must be at least ~17 ft from the lot lines with a firewall per Table 7.3.2.3.1.1 (a) and 7.3.3.3.1.2 (allowing for a 50% reduction from 34 ft).

Comment #11: General – At some locations, the delivery tankers appear to block station ingress and egress during a fill.

Comment #12: Section 1.1 – The scope of work is full of high-level details and describes what equipment is to be provided, but there are few specifics on design criteria. The plan should describe the intended project phases, and it would be helpful to quantify the amount of hazardous materials generated, used, and stored. The plan should also discuss the location of activities and describe how the activities will be coordinated. Currently the plan does not provide specifics on flow, pressure, temperature, refill schedules, construction, etc. This is necessary to fully vet the safety of the proposal. For instance, how large is the H2 storage, how much will be offloaded per delivery, and how often will a delivery will be made? As the deliveries will most likely occur near the public, this could have an impact on public safety.

Comment #13: Section 2.1 – The project makes good use of a split governance structure involving product compliance/safety and personnel training/public safety.

Comment #14: Section 2.1 discusses the end results and who is responsible; however, there are no examples of the procedures to be used, such as piping design, lockout tag out, operational readiness inspections, and pressure testing.

Comment #15: Section 3.1 – The project appears to be using a sound ISV approach involving qualitative and semi-quantitative risk assessment, linked to ISO/IEC methodology to achieve an acceptable level of risk; however, there is no identification of accident scenarios, significant vulnerabilities, and safety critical equipment, nor does the plan provide discussion or detail on the actual risks and resulting risk reduction measures for the intended equipment. This is a key missing element of the safety plan; without this information, it is not possible to determine the adequacy of the project's safety planning.

Comment #16: Section 3.1 – The plan should describe prevention and mitigation measures for the significant safety vulnerabilities. One line examples are supplied in Section 5.4. A clear example of a "semi" quantitative risk assessment (page 6 in the safety plan) should be included. While there is a one-line example, it is not clear how this would apply to the entire project.

Comment #17: Section 3.1.4 implies that change management is only applied to "improvements on safety." The management of change process should review all proposed changes to materials, technology, equipment, procedures, personnel, and facility operation for their effect on safety vulnerabilities.

Comment #18: Section 3.1.5 identifies a good process for in-house leak testing of the equipment before it is transported to the project site. However, it is not clear what leak testing will be performed onsite, as verification of leak tightness should be also performed after transportation and installation.

Comment #19: Section 3.1.6 should identify the applicable codes and standards the equipment is certified to.

Comment #20: Section 3.1.6 does not mention how to approve components that are unlisted per the requirements in NFPA 2, such as breakaways, fueling hoses, nozzles, etc.

Comment #21: Section 3.2 – Maintenance procedures provided are minimal (do not include H2 sensor and UV flame sensor calibration). A much more detailed checklist of the inspection should be provided under Section 3.2.2. The plan should also include examples of some of the operating procedures/checklists. While there is discussion of maintenance procedures, there is no mention of construction, ongoing operations, or design procedures, such as an operational readiness inspections, pressure testing, site evaluation, and drawing reviews.

Comment #22: Section 3.2.1 does not identify specific ventilation requirements in any compartment or detection requirements for the storage compartment. It is not clear if this equipment is being provided in accordance with NFPA 2, Table 7.1.23.9.1.

Comment #23: Section 3.2.1 does not discuss how hydrogen compatibility will be demonstrated for selected materials, except for a reference to an inappropriate standard (EN/ISO 11114-4). This document has been superseded by CSA CHMC 1 and by reference to materials specified in Table B2 in SAE J2579.

Comment #24: Section 3.2.1 does not include an overpressure protection strategy and fire protection strategy for ASME ground storage.

Comment #25: Section 3.2.2 does not include oxygen, UV/flame, or smoke detector calibrations in the preventative maintenance plan.

Comment #26: There are missing operating procedures for the equipment and the system, although some procedures are included for maintenance and repair (Section 3.2.3) and end of line testing (3.4.2).

Comment #27: Section 3.3 – The management of change procedures provided are more suitable for inside equipment manufacturing than onsite installation.

Comment #28: Section 3.4 provides information on equipment fabrication end testing and certification; however, it does not address preventative maintenance, site calibration, or post install testing requirements.

Comment #29: Section 3.4.2 – Tables and charts are illegible.

Comment #30: Section 3.5 meets most of the criteria for a safety; however, there are additional items that should be included: initial testing and commissioning, calibration of sensors, test/inspection frequency basis.

Comment #31: Section 4.2 – The safety review process is not well identified, as it does not address safety reviews beyond the ISV as discussed in the safety guidance document (https://h2tools.org/sites/default/files/Safety_Planning_for_Hydrogen_and_Fuel_Cell_Projects-March_2016.pdf).

Comment #32: Section 4.3 – The project team should report near misses and incidents to the California Energy Commission. It is also recommended that hydrogen-related incidents and near misses be submitted to the Lessons Learned database (https://h2tools.org/lessons).

Comment #33: Section 4.4 should include specific information included in the emergency response plan.

Comment #34: Section 4.5 discusses self-audits but does not address audits during the operational phase of the station.

Comment #35: Section 5.1 – The simplified process flow diagram shows an unusual approach for compression to storage flow. Typically, a low-pressure stage (first stage) compressor will feed medium-pressure storage, then this medium-pressure storage will feed the high-pressure stage (second stage) compressor, which feeds the high-pressure storage. The flow diagram shows the first-stage compressor feeding the second stage compressor, which in turn feeds either the medium-pressure or high-pressure storage. The compressors also feed the pre-cooler, which possibly provides the option of a direct compressor fill. Presumably, the use of two compressor stages at the same time increases flow rate for the medium-pressure storage fill. However, this concept relies heavily on the successful operation of the control valve on the medium-pressure storage. Failure of this valve could result in over-pressurization of the medium-pressure storage. This is a safety risk that could be avoided by reconfiguring the flow.

Comment #36: Section 5.2 – The station configuration flow diagram shows low/medium/high-pressure storage feeding a compressor. This is likely an error in the figure.

Comment #37: Section 5.3 – Listing of codes and standards omits some key documents: ANSI HGV 4.2 (fueling hoses) and SAE J2600 or ISO 17268 (fueling nozzles).

ANNEX A: CEC Safety Plan Review Checklist

This checklist is a summary of desired elements for safety plans taken from Safety Planning for Hydrogen and Fuel Cell Projects – March 2016.[1] The checklist is intended to help project teams verify that their safety plan addresses the important elements and can be a valuable tool over the life of the project. The items below should not be considered an exhaustive list of safety considerations for all projects.

GFO SUBMITTER OR TITLE: Everfuel U.S., Inc.
DATE: December 20, 2016

Element	The Safety Plan Should Describe	Adequately Addressed? (Yes or No)
Scope of Work	• Nature of the work being performed	Yes with comments
Organizational Policies and Procedures	• Application of safety-related policies and procedures to the work being performed	Yes with comments
Hydrogen and Fuel Cell Experience	• How previous organizational experience with hydrogen, fuel cell and related work is applied to this project	Yes

Identification of Safety Vulnerabilities (ISV)	• What is the ISV methodology applied to this project, such as FMEA, What If, HAZOP, Checklist, Fault Tree, Event Tree, Probabilistic Risk Assessment, or other method
	• Who leads and stewards the use of the ISV methodology
	• Significant accident scenarios identified
	• Significant vulnerabilities identified
	• Safety critical equipment
	• Storage and Handling of Hazardous Materials and related topics
	  ○ ignition sources; explosion hazards
	  ○ materials interactions
	  ○ possible leakage and accumulation
	  ○ detection
	• Hydrogen Handling Systems
	  ○ supply, storage and distribution systems
	  ○ volumes, pressures, estimated use rates
		No

Risk Reduction Plan	• Prevention and mitigation measures for significant vulnerabilities	No
Operating Procedures	• Operational procedures applicable for the location and performance of the work including sample handling and transport • Operating steps that need to be written for the particular project: critical variables, their acceptable ranges and responses to deviations from them	Yes with comments

[1] URL: https://h2tools.org/sites/default/files/Safety_Planning_for_Hydrogen_and_Fuel_Cell_Projects-March_2016.pdf

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Element	The Safety Plan Should Describe	Adequately Addressed? (Yes or No)
Equipment and Mechanical Integrity	• Initial testing and commissioning • Preventative maintenance plan • Calibration of sensors • Test/inspection frequency basis • Documentation	No
Management of Change Procedures	• The system and/or procedures used to review proposed changes to materials, technology, equipment, procedures, personnel and facility operation for their effect on safety vulnerabilities	No
Project Safety Documentation	• How needed safety information is communicated and made available to all participants, including partners. Safety information includes the ISV documentation, procedures, references such as handbooks and standards, and safety review reports.	Yes with comments
Personnel Training	• Required general safety training - initial and refresher • Hydrogen-specific and hazardous material training - initial and refresher • How the organization stewards training participation and verifies understanding	Yes
Safety Reviews	• Applicable safety reviews beyond the ISV described above	No
Safety Events and Lessons Learned	• The reporting procedure within the team • The system and/or procedure used to investigate events • How corrective measures will be implemented • How lessons learned from incidents and near-misses are documented and disseminated	Yes with comments
Emergency Response	• The plan/procedures for responses to emergencies • Communication and interaction with local emergency response officials	No
Self-Audits	• How the team will verify that safety related procedures and practices are being followed throughout the life of the project	Yes with comments