HYDROGEN Safety Panel

SAFETY PLAN REVIEW

HTEC Safety Plan Review

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

Background

At the request of the California Energy Commission, members of the Hydrogen Safety Panel (HSP) reviewed the HTEC 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 safety plan is split among four documents and appropriately addresses much of the criteria provided in the safety planning guidance document. A preliminary hazard analysis and HAZOP were not provided, however, a pre-design ISV and risk mitigation strategy listing major vulnerabilities is available, though a few notable deficiencies were identified. Topics not adequately addressed in the safety plan include management of change, project safety reviews and self-audits. The safety plan is considered marginal, but would be good if the applicant considered the comments and recommendations below.

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.

Comment 1: General - Since the project 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 2: Narrative, page 10, states, "all CSD equipment will be listed and labelled under NFPA 2 by Enertek to help ensure approval by local jurisdictions." What does the listing/labeling cover? All mechanical and electrical equipment, enclosure requirements, separation distances, etc.? HTEC 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.

Comment 3: Narrative, page 11 - McPhy's HRS-200 system approvals indicates ETL certification is pending, but it omits key safety standards such as the ANSI/CSA HGV 4.x series.

Comment 4: Narrative, page 16 - McPhy's equipment designs will undergo a hazard analysis, but this was not provided for review.

Comment 5: Narrative, page 21, states that the Powertech hydrogen refueling station will meet all applicable codes, standards, and regulations, but none are listed. As a minimum it is expected that the station will comply with the International Fire Code (2015) and NFPA 2 (2016). If this is the intent it would be beneficial to provide confirmation in the document.

Comment 6: Narrative - Fueling hoses cannot conform to SAE J2600-2012. This document covers fueling nozzles. Fueling hoses should conform to ANSI/CSA HGV 4.2 and nozzles should conform to SAE J2600-2015 (note the correct date).

Safety Plan Comments

Comment 7: General - The safety plans do not discuss how 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.

Comment 8: General – There is no discussion on additional safety reviews, other than those conducted at the design phase of the project. Other safety reviews may be needed during the life of the project.

Comment 9: General – There is no discussion on self-audits, other than that a safety audit may be conducted at the project kickoff stage. Self-audits should verify that safety-related procedures and practices are being followed through the duration of the project and continued use of the equipment.

Comment 10: All intended project phases should be described to ensure safety. The operations portion is the best covered. Installation and maintenance are lacking. This information would help to ensure safety in areas such as how on-site testing will be accomplished without introducing danger to the site personnel (such as pressure testing to over 12,000 psig).

Comment 11: Document 2, Section 2.4.3, Station Operation Phase, appears to be missing a key participant in the operation phase—the operator(s).

Comment 12: Document 2, Section 2.6, Management of Change, provides insufficient detail to understand how potential changes will be evaluated for their impacts on safety. There is no discussion on what a change is or how the documentation will be managed. It is also recommended that the list of potential changes that require review be broadened to include all materials or equipment that are not replaced “in kind.”

Comment 13: Document 2, Section 3, Safety Procedures, covers safe work practices as required for any operational procedures, but no operational procedures are provided, with the exception of working alone and lockout procedures. The plan should describe how the safety policies and procedures are implemented for the work performed, such as steps for each operating phase, including startup, normal operation, normal shutdown, emergency shutdown. Safety considerations should also be included, such as precautions to prevent exposure and measures to be taken if physical contact or airborne exposure occurs. Operating procedures should be updated promptly to reflect changes to chemicals and other materials, equipment, technologies, and facilities.

Comment 14: Document 2, Section 3.3, Contractor/Subcontractor Hiring and Training - Contractor training is referenced per health and safety requirements, but there is no mention of training relevant to hydrogen hazards per installed equipment.

Comment 15: Document 2, Section 3.3.1, Required Training - It is not clear what, if any, training is required or provided for station operators, and there is no discussion on refresher courses after the initial courses are completed.

Comment 16: Document 2, Section 5, Emergency Response Procedures, mentions one scenario only; perhaps it should include other possible major accidents such as a car crashing into the dispenser, etc.

Comment 17: Document 2, Section 5, provides no discussion on the communication and interaction with local emergency response officials.

Comment 18: Document 2, Section 5.4, Critical Emergency, states "if a significant amount of hydrogen has been released (10 kg or more) during the incident, then the following agencies must also be contacted." How will the station operator determine if 10 kg or more has been released? It may be more appropriate to initiate the notifications on any release through the supply system vents.

Comment 19: Document 2, Section 5.4 - The project team should consider reversing the order of presentation of emergency response levels, i.e., critical first, minor second, and so on.

Comment 20: Document 2, Section 8, Incident Investigations - 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 21: Document 2, Section 9 - Safety committee and safety meetings are established, but there is no reference to how actual safety events would be handled, and no lessons learned behavior.

Comment 22: Document 3, Section 4 - The use of flame detection has not been discussed. How are the storage tanks protected against fire and high temperature exposure?

Comment 23: Document 3, Section 4.3, Pre-Design ISV Analysis and Risk Mitigation Strategies - The compressor room and high-pressure storage area contain 5 to 25 gallons of combustible liquid. The hazard is not addressed in the table.

Comment 24: Document 3, Section 4.3 - The pre-design ISV and risk mitigation strategy lists major vulnerabilities, but should also consider the following comments/questions:

- High pressure containment failure should include specific examples such as hose rupture failure (mitigation: use of certified hose per ANSI/CSA HGV 4.2, hose changeout every 6 months, dispenser flow limiter/arrester, etc.). This would be a "medium" likelihood.

- Mitigation for a vehicle driving away during fueling could include use of certified breakaway device per ANSI/HGV 4.4.
- Natural disaster mitigation could include the use of an earthquake sensor.
- Consider adding additional vulnerabilities such as vehicle impact with dispenser or other pressurized equipment.
- How is forced ventilation power backed up per NFPA standby power required by NFPA 2, 6.7.1.1)?
- Are double block and bleeds used between pressure boundaries for maintenance?
- There appears to be no flame detection technology used in any of the systems designs per NFPA 2-10.3.1.18.1. Only hydrogen sensing of the LEL is used to determine hydrogen leakage.
- Additional risks that may need to be considered include:
    - Hydrogen leak inside the electrolyzer stack compartment
    - Movement of the PowerCubes into the filling location and its effect on the public
    - Hydrogen leak from PowerCube hoses
    - PRV or single vent stack blockage
    - During maintenance, hydrogen back flowing between the different pressure sections of the system, such as the electrolyzer (30 bar), the medium-pressure system (450 bar), and the high pressure system (875 bar)
    - Collision between PowerCubes delivery/fork trucks and system
- For the risk descriptions addressed, the mitigation strategies were not fully detailed. For example, in the risk description of “Fire/explosion from hydrogen leak combined with a source ignition,” HTEC indicated that:
    - Vent stacks were used, but did not address a vent stack failure (especially when they direct all hydrogen to a single stack per Plan B HSP-P-012, page 6).
    - Ventilation fans are in areas containing hydrogen gas, but did not address how the vent fans were kept on line during a power failure.
- Pressure checking the piping during commissioning, and leak checking the piping during maintenance could be a mitigation strategy for some of the identified risks.

Comment 25: Document 3, Section 4.3 - Definitions for low, medium, and high for likelihood and consequence are needed to evaluate the risk assessment. In addition, only selected scenarios are highlighted as a contributor to the risk for a station. A risk assessment that identifies and analyzes all the risks will be needed (this may be part of the subsequent HAZOP).

Comment 26: Document 3, Section 4.3 - This plan does a good job of listing mitigation measures for identified events. However, once all the risk scenarios are identified, mitigations should be included for all high-risk scenarios.

Comment 27: Document 3, Section 4.3.3, Emergency Shut Down (ESD) - When the ESD is pressed, it is unclear if the power shutoff affects the safe shutdown operation of the electrolyzer, e.g., a fan is used to extract air (page 16). Is the dispenser purge maintained when the ESD is initiated (page 16)?

Comment 28: Document 3, Section 4.3.4, Ventilation - The compressor room fan is supposed to mitigate “any” hydrogen leaks (page 16). It is unclear how this is confirmed.

Comment 29: Document 3, Section 4.3.5, Dispenser Purge - The first paragraph focuses on the dispenser purging but later states that the fan is located in the electrical room and more than 15 ft distant. Is the fan ducted to the dispenser or is this a typo?

Comment 30: Document 3, Section 5 - HTEC and its partners should provide specific information on what equipment will be listed/labeled and what standards/requirements it will be listed/labeled to. This information should be provided to AHJs and stakeholders. Equipment not included in a listing or labeling will still require approval by the AHJ.

Comment 31: Document 3, Section 5, Equipment and Mechanical Integrity - The document/section does not address the initial testing and commissioning and required documentation for the Section 14 attachments.

Comment 32: Document 3, Attachment – Station Design B – Steady State Operation – Overview - The steady-state operation overview attachment refers to an air compressor, but it is unclear if the unit is compressing air or nitrogen (page 27).

Comment 33: Document 3, Attachment – Station Design B - Steady State Operation – Overview - The steady-state operation of the system description is one of the better seen in the submittals. However, it only covers steady-state operation and is not totally complete. Potential improvements include listing existing and planned procedures for the startup and normal shutdown, and providing additional detail on the system operating limits and the safety systems along with their functions (beyond ESD operation and locations). Additional discussion on other equipment that causes system shutdown would also be beneficial.

Comment 34: Document 3, Attachment – Sample Maintenance Schedule for CSD Equipment - The submission includes a sample maintenance schedule, but it neglects key maintenance items such as hose and nozzle inspections and sensor calibration. The sample maintenance schedule should include a higher frequency check of the fueling hose, e.g., every 6 months, it should include a functionality check of the ESDs, and calibration of safety sensors such as UV/flame detectors, smoke detectors, pressure transducers, thermocouples, etc.

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: HTEC
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 Narrative
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 with Narrative

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
		Yes with comments

Risk Reduction Plan	• Prevention and mitigation measures for significant vulnerabilities	Yes with comments
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	Yes with comments
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.	No
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 with comments
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	Yes with comments
Self-Audits	• How the team will verify that safety related procedures and practices are being followed throughout the life of the project	No