SAFETY PLAN REVIEW

Shell Hydrogen Fueling Station Safety Plan Review

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

Background

At the request of the California Energy Commission (CEC), members from the Hydrogen Safety Panel (HSP) reviewed the Shell Oil Products U.S. (Shell) 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 risk assessment approach, however, the plan does not identify project-specific accident scenarios, key vulnerabilities, or safety critical equipment. Other topics not adequately addressed in the safety plan include project safety documentation, safety reviews, emergency response and self-audits. 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 (Tab_4_Project_Narrative.docx)

Comment #1: Narrative page 4-62 states, "The HRS are evaluated by third parties such as Underwriters Laboratories LLC (UL) and DMS to all applicable standards for foreseeable safety hazardous and it suitable for installation or use," and "H2 Logic is pursuing a UL Listing for the HRS (as tested, certified, and 'listed') by UL. Pending final UL certification, the HRS is likely to become the first hydrogen fueling station to receive a UL Listing in the world." It is important to understand what the equipment will certified for and what standards it is certified to. Also, will the certification cover only part of the HRS or all equipment, enclosures, etc.? Shell and its partners should make it very clear to AHJs and stakeholders exactly what this listing covers. Unlisted equipment will still require approval by the AHJ.

Comment #2: Many of the fueling stations' hydrogen supply locations (including storage tanks and hydrogen equipment enclosures) do not appear to have adequate separation distances from lot lines and exposures in accordance with NFPA 2. Final siting locations should be in accordance with NFPA 2 or have locations approved by the AHJ based on a technically justified alternative methodology.

Safety Plan (Tab_5_Station1_HarrisonSt_Hydrogen_Safety_Plan.docx through Tab_5_Station9_Sunnyvale_Hydrogen_Safety_Plan.docx)

Comment #3: The safety plan follows the HSP Safety Planning guideline document, including a detailed methodology for identifying safety vulnerabilities (HEMP) and use of HSSE to identify and track preventative maintenance for safety critical equipment, but it lacks specifics on the internal configuration of the H2Logic equipment necessary to allow consideration of its hazards and safety features.

Comment #4: The plan does not address site locations or the frequency of hydrogen refill into the storage system. Protecting the public during the fill process from vehicles and mechanical integrity issues is a concern. The plan should also describe how refueling will occur in conjunction with gasoline and diesel delivery vehicles.

Comment #5: Since the project's design relies on the use of enclosures, it would be beneficial for the project to provide information on how this equipment conforms to NFPA 2 requirements for hydrogen equipment enclosures (7.1.23).

Comment #6: Section 1, page 5, provides a process flow diagram that 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 simultaneous use of two compressor stages 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 safety risk could be avoided by reconfiguring the flow.

Comment #7: It appears that many of the site locations have separation distances that may not be in accordance with NFPA 2. This includes inadequate separation to lot lines and adjacent buildings, air intakes, parking, etc. Additional risk assessments may be needed to support an alternate approach, with the results approved by the AHJ. Since such risk assessments were not included with the submittal documentation, it is not possible to validate the approach.

Comment #8: Section 2 provides a comprehensive review of Shell’s high-level policies, but few details on specific policies and how they will be applied. It would be helpful for the safety plan to including information on how the safety policies and procedures will be implemented for the work being performed.

Comment #9: Sections 2 and 4 of the safety plan provide good discussions of the personnel and procedures covering the design and construction of the station, but do not address operational issues such as training of the personnel running the day-to-day station activities.

Comment #10: The risk analysis and risk management process is covered thoroughly and referred to throughout the Plan. However, details on the specific safety critical equipment, key scenarios, and risk reduction plan are not provided. This information is needed to determine the adequacy of the project's safety planning. It was very clear what process will be carried out, but no results or documentation of the implementation of these methodologies was provided. However, the level of detail provided on the scope of the risk analysis to be conducted (in the future?) was impressive. Additional comments are provided below:

- Section 3(a) describes "as low as reasonable practicable" (ALARP). The HEMP ISV method is shown as an example of a corrosion threat. As H2 Logic uses FEMA and LOPA (Section 3(d)), the plan should describe how both systems will be integrated. It would be more appropriate to share an example of one of the installed stations in service.
- The following safety issues are not identified: significant accident scenarios, significant vulnerabilities, and safety critical equipment.
- The equipment supplier HAZOP identified in Section 2(a) (page 8) is neither referenced in the project safety section of the submission nor is it provided.
- The plan does not describe which hazard associated with this system design, installation, and operation is mostly likely to occur and which hazard has the potential to result in the worst consequence.
- The ISV should include the strategy used to fill the containers and how it will keep the public safe during the fill process.

Comment #11: Section 3(b) – As no specifics are provided in the ISV, the safety plan also lacks specific discussion on the prevention and mitigation measures for significant safety vulnerabilities.

Comment #12: Section 3(c) describes how problems are monitored and the approach to the operations and problems, but does not address specific operations, warnings, alarms, and failures. The plan provides the safety features for equipment, but not for construction or maintenance.

Operational procedures applicable for the location and performance of the work, including sample handling and transport, are not provided. The operating steps for the project, critical variables, their acceptable ranges, and responses to deviations from them are not provided. Additional discussion on the following would be beneficial:

- Initial testing and commissioning
- Preventative maintenance plan
- Calibration of sensors
- Test/inspection frequency basis
- Documentation

Other items that could have supplied the safety information necessary are:

- Shutdown table for safety shutdown strategy.

- Continuous mechanical EX ventilation in hazard areas to avoid occurrence of an explosive atmosphere. How is this managed in loss of power? (Standby power required by NFPA 2-6.7.)
- What are the standards on the use and testing of mechanical safety devices?
- A separated safety PLC is called out for redundancy under the main safety features section. How are other devices implemented to meet this (e.g., pressure and temperature sensors and mechanical safety devices)?
- What are the project's standards on dispenser and delivery fill hose replacement? These hoses are in the public domain.

Comment #13: Section 3(c), page 15, does not include station operating procedures, although good information is provided for remote monitoring and response/actions in the event of an incident. No details on specific safety incidents are provided.

Comment #14: Section 3(c), page 18, identifies the use of UV flame detectors. Newer infrared detectors may be a better option for flame detection and are less susceptible to false alarms. Additionally, how will detector calibrations be handled?

Comment #15: Section 3(c), page 18, does not discuss how hydrogen compatibility will be demonstrated for selected materials, except for a reference to an inappropriate standard (EN/ISO 11114-4), which has been superseded by CSA CHMC 1 and by reference to materials specified in Table B2 in SAE J2579.

Comment #16: Section 3(c), page 18, does not identify specific ventilation requirements in any compartment or detection requirements for the storage compartment. It is not clear if the necessary equipment is being provided in accordance with NFPA 2, Table 7.1.23.9.1.

Comment #17: Section 3(d) provides information on factory equipment fabrication, end testing, and certification, but does not address onsite testing, commissioning, equipment calibration, or post-install testing requirements.

Comment #18: Section 3(d), page 27, is missing key hydrogen component standards: ANSI HGV 4.1, 4.2, 4.4, 4.5, 4.6, 4.7, 4.8 and 4.10.

Comment #19: Section 3(e), page 28, discusses the proposed management of change procedures. In the first bullet, the text suggests that safety should be checked in accordance with applicable requirements. The section appears to be missing the need to evaluate a change for safety vulnerabilities (regardless of whether there is a required standard). Given the additional information provided in this section, it is likely that this is more an editorial comment than an inadequacy of the program.

Comment #20: Section 3(f) describes the safety documentation but not how safety information is communicated and made available to all participants, including partners. Missing items include the HEMP documents, H2 Logic HAZOP, and management of change documents.

Comment #21: Section 4(a) - It would be beneficial if the safety plan more completely described the hydrogen training classes and who will receive the training.

Comment #22: Section 4(b) does not address safety reviews beyond the ISV as discussed in the HSP Safety Planning guideline document (https://h2tools.org/sites/default/files/Safety_Planning_for_Hydrogen_and_Fuel_Cell_Projects-March_2016.pdf).

Comment #23: Section 4(c) - The project team should report near misses and incidents to the California Energy Commission.

Comment #24: Section 4(d) does not provide an emergency response manual or an example of a manual, and there is no description of the plan/procedures for responses to emergencies or how communication and interaction with local emergency response officials occurs.

Comment #25: Section 4(e) provides no details about the self-auditing process, other than stating it is the responsibility of another entity. No information is submitted on what triggers a self-audit, what information and documentation is checked during an audit, or how the audit results are acted upon. The project team should address audits during the operational phase of the station and provide more detail to help the reviewer understand how procedures and practices are being followed throughout the life of the project.

Comment #26: The safety plan approval process includes stewardship information but does not discuss the review and approval process.

Comment #27: The samples of hazards in Tables 1 and 2 (pages 37 and 38) are very general and specific to the chemical process industry, rather than hydrogen fueling stations.

Comment #28: Example 3 bowtie excerpt (page 40) involves a process gas compressor corrosion issue for a non-relevant chemical process application (caustic lines).

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: Shell Oil Products U.S.
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 o ignition sources; explosion hazards o materials interactions o possible leakage and accumulation o detection • Hydrogen Handling Systems o supply, storage and distribution systems o 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

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	Yes with comments
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	No
Self-Audits	• How the team will verify that safety related procedures and practices are being followed throughout the life of the project	No