HYDROGEN Safety Panel

SAFETY PLAN REVIEW

StratosFuel 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 StratosFuel 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 appears to be a cut, paste, and merge of two safety plans: one from the proponent, StratosFuel, and one from Air Products. As such, it is not possible to determine who is responsible for the safety of the overall project. Both safety plans lack necessary project-specific detail and include gaps, with the most significant being a lack of ISV and safety reduction strategies. Other topics not adequately addressed in the safety plan include organizational policies and procedures, operating procedures, equipment and mechanical integrity, management of change, project safety documentation, project safety reviews, emergency respose 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.

Comments on the StratosFuel portion of the safety plan

Comment 1: The safety plan includes a StratosFuel safety plan and an Air Products safety plan. It is unclear how the project's safety aspects will be integrated between these two plans. For example, while neither safety plan discusses project-specific equipment in its ISV, when it is performed, will there be one risk assessment or a risk assessment by each company? Who will determine the scope of each risk assessment and how will the project avoid missing issues or covering similar issues with different results? A clear path forward should be identified to ensure that all topics are adequately addressed.

Comment 2: Overall, the StratosFuel safety plan appears very cursory and does provide not detailed information on project-specific equipment and hazards. Many sections are only covered at a very high level and general manner and lack the details discussed in the safety planning guidance document (https://h2tools.org/sites/default/files/Safety_Planning_for_Hydrogen_and_Fuel_Cell_Projects-March_2016.pdf). Additionally, no discussion is provided on refilling hydrogen and how it affects the safety of personnel in the area and vehicle ingress/egress.

Comment 3: The narrative refers to fueling hoses being compliant with SAE J2600/ISO 17268, but should have also referred to fueling nozzle compliance.

Comment 4: Section 2.1 provides an overview of StratosFuel's goals, objectives, and risk analysis tools, but lacks sufficient detail on the application of specific safety-related policies and procedures to the work being performed.

Comment 5: Section 2.3 – The proponent, StratosFuel, seems to have limited hydrogen station design experience. Will StratosFuel be relying on its other partners to lead the design and ensure safety of the station operation?

Comment 6: Section 3, Identification of Safety Vulnerabilities, and Section 3.1, Risk Management Plan, read more like an overview of general hazards associated with hydrogen and industry codes/standards than a discussion of the ISV methods and results for the proposed stations, and Section 3.1 seems to imply that risk can be managed via compliance to codes and standards alone. Although the Risk Management Plan section mentions an FMEA and HAZOP performed on the system, no details are provided on the risk identified, methods used, the scenarios of concern, or prevention and mitigation measures for the significant safety vulnerabilities. Without detailed discussion on the actual risks and associated risk reduction measures for the intended equipment, the HSP is unable to determine adequacy of the project's safety planning.

Comment 7: Section 3.1 – Although several safety features were provided, these are not linked to a risk analysis, so the mitigation features provided cannot be linked back to risk scenarios of concern. As a result, the feasibility and adequacy of the risk reduction plan could not

Comment 8: Section 3 includes an incorrect reference to NFPA 52; this code no longer includes requirements for hydrogen installations.

Comment 9: Section 3.1 states that "All StratosFuel fuelling station systems are inspected and certified as fit for purpose at the point of manufacture by a qualified 'listing' third party." StratosFuel and its partners should make it very clear to AHJs what this certification covers and what standards the equipment is certified to.

Comment 10: Section 3.2, Operating Procedures, does not provide information on operational procedures applicable for the location and performance of the work, or operating steps that need to be written for the particular project. The procedures should include:

- Steps for each operating phase, such as startup, normal operation, normal shutdown, emergency shutdown
- Operating limits
- Safety systems and their functions

It should also be noted that the existing information provided in this section may fit btter in the Risk Reduction section, as it focuses on reducing risk instead of referencing specific safe work practices used to control hazards during operations.

Comment 11: Section 3.3, Equipment and Mechanical Integrity – Although a few details are provided about the evaluation of systems during commissioning, no preventative maintenance plans are discussed. This section does not address calibration for safety related devices, types and frequencies of inspections, validation of hydrogen materials compatibility, and training and documentation of same.

Comment 12: Section 3.4, Management of Change Procedures – Detailed information is needed to better understand what the MOC process entails and how it will be managed throughout the life of the station. StratosFuel does not sufficiently outline the MOC procedures. Good coverage for MOC is provided by Air Products, but they are presumably not the primary project proponents. The section should discuss the checks needed ensure that changes to the system are analyzed by qualified personnel to ensure that they will not impact safety. The discussion here does say that a responsible person should authorize changes, but there should be more discussion to ensure that safety is not overlooked.

Comment 13: Section 4, Communications Plan, does not adequately describe how project safety information is communicated and made available to all relevant participants, including project team members and external partners.

Comment 14: Section 4.2, Employee Training, does not describe the necessary training and emergency response actions for station operators. No discussion on specific classes required for training is listed, particularly hydrogen-specific courses. Such discussion is necessary to enable operators to understand hydrogen and equipment hazards and ensure appropriate response to off-normal conditions.

Comment 15: Section 4.3, Safety Reviews, does not provide detailed information on safety reviews that will be conducted by the project team and operators of the station. Although the initial FMEA and HAZOP are discussed in this section, additional safety reviews should be conducted during the operational phases of the station. Also, any additional safety reviews required by organizational policies and procedures should be mentioned here.

Comment 16: Section 4.4 does not describe the system and/or procedure used to investigate events, and how corrective measures will be implemented. The project team should also 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 17: Section 4.7, Self Audits – Although StratosFuel has established an audit process, no detailed information is provided. The section should identify how the team will verify that safety related procedures and practices are being followed throughout the life of the project.

Comment 18: Section 5.1 provides a list of national codes and technical standards, but a number of notable component level standards are not listed: ANSI/HGV 4.x series, SAE J2600, and J2799.

Comment 19: There is no indication that materials will be selected for their resistance to hydrogen embrittlement, nor are there reference to the applicable references that could support compliance (CSA CHMC 1, SAE J2579 Table B2, etc.).

Comments on the Air Products portion of the safety plan, Section 6

Comment 20: Section 6, Page 12 – Since the project's design appears to rely 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 21: Organizational Policies and Procedures – This section provides a good overview of the applicant's overall commitment to safety, however, no specific information is provided on the Air Products safety-related procedures for the proposed work.

Comment 22: Identification of Safety Vulnerabilities – This section includes a good discussion on what appears to be a robust approach to evaluating hazards and risk for the intended project as well as example general safeguards. However, the section does not provide project-specific discussion or detail on the actual risks and associated risk reduction measures for the intended equipment (see https://h2tools.org/sites/default/files/Safety_Planning_for_Hydrogen_and_Fuel_Cell_Projects-March_2016.pdf). While it is clear that Air Products conducts ISV and mitigates risk using techniques such as HAZOP, FTA, LOPA, dispersion analysis, radiation analysis, and others, none of this material is provided in the submission. Without this information it is not possible to determine adequacy of the project's safety planning.

Comment 23: Section 3.A, Identification of Safety Vulnerabilities – The HSP recommends that the following items be addressed in the ISV:

- Pressure relief system design and design basis
- Safety systems (e.g. alarms, interlocks, detection, or suppression systems)

Comment 24: Risk Reduction Plan – This section provides cursory discussion on how Air Products will, at some point, identify applicable risk reduction features/equipment, but does not provide any project-specific prevention and mitigation measures for significant vulnerabilities associated with the anticipated work. It is recognized that there are a common set of safety and alarm systems that Air Products typically provides for its stations (as discussed in Safety and Alarm Systems) in order to reduce risks. This equipment is likely the result of previous risk assessments and experience gained on previous station deployments. That said, it would be good to see the ISV to understand how these features tie to specific hazards and risks.

Comment 25: Risk Reduction Plan – This section states "the Air Products fueling systems are evaluated and inspected by a third party certification body to ensure compliance with the relevant and applicable codes." Air Products and its partners should make it very clear to AHJs what this certification covers and what standards the equipment is certified to.

Comment 26: Operating Procedures – The intent of this section is to list existing and planned procedures that describe the operating steps for the system. Although an operating manual with procedure titles is provided, more detailed information is needed on steps for operation, operating limits, and safety systems and their functions for the project-specific equipment.

Comment 27: Project Safety Documentation – This section includes an extensive list of general OHS&E safety requirements, but fails to adequately include specific safety documentation for the hydrogen fueling station. There is no specific acknowledgement that safety documentation should also include information pertaining to the technology of the station including equipment, safety systems, ISV, operating procedures, MSDS, etc. The section should also describe how needed safety information is communicated and made available to all participants, including partners

Comment 28: Personnel Training and Emergency Response – The training and emergency response actions for station operators is not described in the safety plan. Such discussion is necessary to enable operators to understand hydrogen and equipment hazards and ensure appropriate response to off-normal conditions. In addition, no details are listed on training courses, and, in particular, no hydrogen-specific training course are listed.

Comment 29: Safety Reviews – The section does not aduately describe safety reviews that will be conducted for the project during the design, development and operational phases. The involvement and responsibilities of individual project staff in such reviews and how the reviews will be documented should be included. The ISV is expected to be one of the safety reviews performed for the project. Other safety reviews may be needed during the life of the project, including those required by organizational policies and procedures.

Comment 30: Safety Events and Lessons Learned – Air Products 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 29: Self Audits – This section does not provide details on how the project team will verify that safety-related procedures and practices are being followed throughout the life of the project. The plan states that the project team is subject to audit at any time, but this does not infer that self-audits for safety-related procedures and practices will occur on every project.

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: StratosFuel
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	No
Hydrogen and Fuel Cell Experience	• How previous organizational experience with hydrogen, fuel cell and related work is applied to this project	Yes with comments

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	No

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

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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.	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