

Air Products 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 Air Products 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 follows the formatting identified in the HSP safety planning guideline document. While the project team clearly has the expertise and experience to provide a comprehensive hydrogen safety plan, most items in this safety plan are generalized, and more project-specific information is needed to validate its adequacy. Topics not adequately addressed in the safety plan include identification of safety vulnerabilities, risk reduction plan, project safety documentation, project 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

- Comment 1:** The Narrative document does a good job of describing the proposed configuration as well as some of the safety equipment and features that will be incorporated into the station configuration.
- Comment 2:** The Narrative, page 13, states that the dispenser will use SAE-certified dispensing nozzles (this is a correct statement), gas piping (this is an incorrect statement; should be ASME), valves (this is an incorrect statement; should be ANSI/CSA HGV 4.4 and 4.6), and all of the other safety features associated with fueling a pressurized gas. The listing should have included ANSI/CSA HGV 4.2 for hoses, ANSI/HGV 4.4 for breakaway devices, and CSA S-1.1, S-1.2 and S-1.3 for PRVs, etc.
- Comment 3:** On page 13 of the Narrative, there are some good additional safety features added to the dispenser design, including secondary controls to stop filling when the hose breaks, idle hose leak detection, and protective hose jackets. The use of a breakaway connector is not an enhancement as it required per NFPA 2.
- Comment 4:** On page 17 of the Narrative, there is no acknowledgement of the project seeking ANSI/CSA HGV 4.1 certification of the dispenser design.

- Comment 5:** Page 17 of the Narrative incorrectly states that fueling hose will meet SAE J2600 and/or ISO 17268. This has since been identified as an incorrect statement in the CEC PON.
- Comment 6:** Third party certification of components statement (page 33 of the Narrative) is not supported by a comprehensive list of relevant codes and standards, nor is it supported by details regarding the stated “work process” to accomplish this. Of particular importance would be the process to seek approvals for components that are not yet certified by the respective suppliers.
- Comment 7:** The planned maintenance description on page 54 of the Narrative does not indicate annual safety device calibrations. The phrase “perform required annual safety tests/inspections” is too vague.

Safety Plan

- Comment 8:** Section 1, Scope of Work - A flow diagram is provided but does not show the critical safety circuits and devices used to ensure the adequacy of the safety plan, such as safety relief devices and set point, transmitters/switches, and shut down set points.
- Comment 9:** Section 2.A, 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 10:** Section 3.A, Identification of Safety Vulnerabilities, includes a good discussion on what appears to be a robust approach for 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 11:** Section 3.A, Identification of Safety Vulnerabilities – The HSP recommends that the following items be addressed in the ISV:
- A block flow diagram or simplified process flow diagram was supplied, but it did not identify relief and safety devices, pressure change areas, and protection in between. For instance, how is high pressure hydrogen storage assured to not flow into the lower pressure systems?
 - Pressure relief system design and design basis
 - Safety systems (e.g. alarms, interlocks, detection, or suppression systems)

- Comment 12:** Section 3.B, Risk Reduction Plan, 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 5.C, Safety and Alarm Systems) to reduce risks. This equipment is likely the result of previous risk assessments and experience from 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 13:** Section 3.B 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 14:** Section 3.C, 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 15:** Section 3.F 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 16:** Section 4.A, Training, and 4.D, Emergency Response - The training and emergency response actions for station operators are 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 17:** Section 4.B – The section does not adequately 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 18:** 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 19: Section 4.E, Self Audits, 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: Air Products

DATE: December 20, 2016

Element	The Safety Plan Should Describe	Adequately Addressed? (Yes or No)
Scope of Work	<ul style="list-style-type: none"> Nature of the work being performed 	Yes
Organizational Policies and Procedures	<ul style="list-style-type: none"> Application of safety-related policies and procedures to the work being performed 	Yes with comments
Hydrogen and Fuel Cell Experience	<ul style="list-style-type: none"> How previous organizational experience with hydrogen, fuel cell and related work is applied to this project 	Yes
Identification of Safety Vulnerabilities (ISV)	<ul style="list-style-type: none"> 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 <ul style="list-style-type: none"> ignition sources; explosion hazards materials interactions possible leakage and accumulation detection Hydrogen Handling Systems <ul style="list-style-type: none"> supply, storage and distribution systems volumes, pressures, estimated use rates 	No
Risk Reduction Plan	<ul style="list-style-type: none"> Prevention and mitigation measures for significant vulnerabilities 	No
Operating Procedures	<ul style="list-style-type: none"> 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

SAFETY PLAN REVIEW

Element	The Safety Plan Should Describe	Adequately Addressed? (Yes or No)
Equipment and Mechanical Integrity	<ul style="list-style-type: none"> Initial testing and commissioning Preventative maintenance plan Calibration of sensors Test/inspection frequency basis Documentation 	Yes
Management of Change Procedures	<ul style="list-style-type: none"> 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
Project Safety Documentation	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Applicable safety reviews beyond the ISV described above 	No
Safety Events and Lessons Learned	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> The plan/procedures for responses to emergencies Communication and interaction with local emergency response officials 	No
Self-Audits	<ul style="list-style-type: none"> How the team will verify that safety related procedures and practices are being followed throughout the life of the project 	No

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