

# **Speaking of Safety: Learning from Safety Reviews**

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# Speaking of Safety: Learning from Safety Reviews

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## 1 Introduction

Safety is an essential element for realizing expanded applications for hydrogen and hydrogen systems, including safe operation in all aspects – from production through storage, distribution and use; from research, development and demonstration to commercialization. The U.S. Department of Energy’s Fuel Cell Technologies Program gives safety paramount importance through its goal to “develop and implement the practices and procedures that will ensure safety in the operation, handling, and use of hydrogen and hydrogen systems for all DOE-funded projects and utilize these practices and lessons learned to promote the safe use of hydrogen.”[1] The Hydrogen Safety Panel (Table 1) formed in 2003 captures the relevant experience from the government, industrial and academic sectors to address this goal by helping DOE integrate effective safety planning into funded projects and by providing expertise and guidance to identify technical data gaps, best practices and lessons learned.

**Table 1: Hydrogen safety panel.**

Richard A. Kallman, Chair	City of Santa Fe Springs, CA
Steven C. Weiner Program Manager	Pacific Northwest National Laboratory
Addison Bain	NASA (ret)
Harold Beeson	NASA White Sands Test Facility
David J. Farese	Air Products and Chemicals
William C. Fort	Shell Global Solutions (ret)
Don Frikken	Becht Engineering
Michael Pero	Hydrogen Safety, LLC
Glenn W. Scheffler	GWS Solutions of Tolland, LLC
Andrew J. Sherman	Powdermet Inc.
Ian Sutherland	General Motors
Robert G. Zalosh	Firexplo
Nick Barilo, Technical Support	Pacific Northwest National Laboratory
Edward G. Skolnik, Technical Support	Energetics Incorporated

This paper describes the role and experiences of the Hydrogen Safety Panel in conducting and reporting on project safety reviews and what has been learned on post-review follow-ups with project teams. Work by the Hydrogen Safety Panel in reviewing project safety plans, conducting project safety reviews and supporting the development of safety knowledge tools has been previously reported.[2-4] For example, the work of the Panel helped in defining the

construct and technical content for H2 Safety Best Practices (<http://h2bestpractices.org>). This website facilitates the availability of the wealth of knowledge and experience related to the safe use and handling of hydrogen that exists as a result of an extensive history in a wide variety of industrial and aerospace settings.

## **2 Safety Reviews Focus on Interaction and Knowledge Sharing**

The project safety review provides one mechanism by which the Panel addresses the DOE program goal previously noted. Safety reviews are conducted as either a one-day site visit or telephone interview and focus interactions with project teams on learning, knowledge sharing and encouragement of thorough, continuous and priority attention to safety rather than as an audit or investigative exercise. For the more in-depth site visit safety reviews, the use of a protocol that is shared with the project team helps achieve the intended purpose. The telephone interview can serve to identify whether a site visit is warranted but it may also serve to focus on the discussion of a more specific topic, e.g. hydrogen storage and handling facilities. Since 2004, the Panel has conducted 36 safety reviews as either site visits or telephone interviews.

Projects for review are selected by a variety of means. For example, the Panel may recommend a site visit based on its review of the project safety plan or the need to discuss the safety aspects of the work because of a new phase/scale of work and/or its broader impact to other projects in the DOE portfolio. The Panel also seeks recommendations from DOE program staff who may request reviews for similar reasons. Safety reviews are conducted at a variety of organizations – government laboratories, large and small companies, and academic institutions. At the latter, students are encouraged to participate in the site visits which provide them an opportunity to learn from the safety related discussions.

Safety reviews are intended to raise safety consciousness directly at the project level by

- discussing various aspects of the project work
- enabling project staff to focus specifically on safety-related topics
- sharing and discussing new insights that bear on safety
- identifying project-specific findings that can have broader benefit

The safety review is meant to focus discussion on how the policies and procedures of the performing organization are applied toward the safe conduct of the project work.

The development of the safety review agenda and implementation of the reporting protocol is done interactively with the project team. This helps to ensure that safety issues and questions are discussed and lessons learned by project teams are captured. Unique to the final report are the project team's responses to specific recommendations made by the review team. In this manner, DOE has a more comprehensive picture of the safety review, outcomes and perspectives of all of the participants when the final report is issued.

## **3 Measuring Outcomes from Safety Reviews**

The final report that is issued to DOE contains a set of recommendations. The authority to require action by the project team on any recommendations resides solely with the

responsible DOE contracting officer. Experience suggests that in some cases, recommendations are voluntarily completed by the project team even before the final report is issued. Nonetheless, the consensus of the Panel suggested a need to establish a follow-up protocol with project teams in order to identify actions, conclusions and findings as one means for measuring the value of this work. Action on report recommendations represents a rich source of safety knowledge that can have broader benefits to others. Weiner reported in May 2009 that 85 recommendations were provided in eight site visit safety review reports issued to DOE in the past two years. [5]

For the first set of follow-up interviews, five projects were selected for which safety review site visits were conducted in 2007 and 51 recommendations were contained in the five final reports. The projects represented both university-based laboratory-scale work as well as hydrogen fueling infrastructure projects. Each interview focused the discussion as follows:

- How were recommendations acted upon?
- What changes were imparted by action on the recommendations?
- Were there other changes made that affect safety aspects?
- Are there any additional lessons learned to share?

Table 2 summarizes the set of recommendations discussed in the five follow-up interviews and characterizes the specific topics of discussion.

**Table 2: Categorizing recommendations and actions taken.**

Category	Recommendations Implemented	Partial or In Progress	No Action or Rejected	Total Recommendations
Safety Vulnerability/Mitigation Analysis	9	2	4	15
System/Facility Design Modifications	3	2	1	6
Equipment/Hardware Installation and O&M	5	3	0	8
Safety Documentation	4	4	0	8
Housekeeping	3	2	0	5
Emergency Response	5	2	2	9
Total	29	15	7	51

Any specific recommendation may actually overlap more than one category. Approximately 30% of the recommendations – 15 in number – focused on some type of safety-related analysis. The identification of safety vulnerabilities (ISV) and subsequent analysis is a significant topic in the safety planning discussion at such safety reviews. Whereas the policies, procedures and methodologies for such work are usually well established at private sector organizations involved in demonstration projects, such is often not the case at universities conducting experimental work. Specific references including the DOE safety guidance document are often provided at these safety reviews to help with such analyses.[6] The first set of follow-up interviews was conducted approximately two years after the initial safety reviews. In one such interview, it was clear to the Panel that the interview process

itself served as a catalyst for the project team to initiate, continue or restart action on the Panel's recommendations. More timely scheduling of future follow-up interviews should help with our objective of achieving priority attention to safety at the project level.

The follow-up interview provides an opportunity for project teams to share and discuss additional safety lessons learned. During the course of two follow-up interviews, the Panel became aware of two safety events involving dispensing/breakaway hose systems. These safety events were discussed at a Panel meeting and each contractor consented to submit and post a safety event record to the publicly available Hydrogen Incident Reporting and Lessons Learned Database (<http://h2incidents.org>).

The Panel concluded that all interviewees have improved the safety aspects of the work they are conducting. Overall, 86% of the recommendations – 44 in number – have been implemented in some manner or are in progress for the set of five projects which were interviewed.

Follow-up with project teams will now become an integral part of the safety review protocol. It is expected that such follow-up will be conducted within 6-9 months after the final report is issued, specifically determined on a project-by-project basis. Factors to be considered include the nature and number of recommendations as well as how safety insights gained might have broader value to the Hydrogen Safety Panel and the DOE program. The Hydrogen Safety Panel has recently taken an action to ask its safety review teams to qualitatively prioritize the set of recommendations for any given report. This prioritization will be helpful to DOE for actions it wishes to take regarding project safety and will also help focus the discussion during future project follow-up interviews.

#### **4 Concluding Thoughts**

Project safety reviews have proven to be an effective means for the Hydrogen Safety Panel to support the goals and objectives of the DOE Fuel Cell Technologies Program. Additionally, safety review follow-up interviews have provided an impetus for projects to refocus on safety. We have noted how safety at the project level is best served. The mechanism used by the Panel for seamless discussion and knowledge sharing at the project level augments the prime responsibility of any organization to ensure the safe conduct of work. One project manager noted “not only did it reinforce the importance of safety, we benefited from having experts available for discussions.”[7] The Hydrogen Safety Panel seeks to replicate that approach and sentiment many times over.

#### **Acknowledgments**

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#### **References**

- [1] “Hydrogen, Fuel Cells and Infrastructure Technologies Program, Multi-Year Research, Development and Demonstration Plan: Planned Program Activities for 2005-2015,” Page 3.8.1. <http://www1.eere.energy.gov/hydrogenandfuelcells/mypp/>

- [2] Weiner, S.C., Kinzey, B. and Skolnik, E.G., "Hydrogen Safety Review Panel: Shaping Safety Awareness," 20<sup>th</sup> Center for Chemical Process Safety International Conference, Atlanta, GA, April 12, 2005.
- [3] Weiner, S.C., Kallman, R.A., Ruiz, A. and Schneider, J.M., "Hydrogen Safety: From Policies to Plans to Practices," Paper 100068, International Conference on Hydrogen Safety, Pisa, Italy, September 8-10, 2005.
- [4] Weiner, S.C. and Barilo, N.F., "Hydrogen Safety Panel: Shaping Safety Awareness and Practice," 2008 Mary Kay O'Connor Process Safety Center International Symposium, College Station, TX, October 28-29, 2008.
- [5] Weiner, S.C., "Hydrogen Safety Panel," Presentation SCS07, 2009 DOE Hydrogen Program and Vehicle Technologies Program Annual Merit Review and Peer Evaluation Meeting, May 22, 2009.
- [6] "Safety Planning Guidance for Hydrogen Projects, November 2007," U.S. Department of Energy, Hydrogen and Fuel Cell Technologies Program.  
(<http://www1.eere.energy.gov/hydrogenandfuelcells/codes/oversight.html>)
- [7] Slattery, D., personal communication, University of Central Florida, 2009.

Safety, Codes & Standards. Weiner " Pacific Northwest National Laboratory. demonstration and deployment work of the DOE Fuel Cell Technologies (FCT) Program Office. Steven C. Weiner, Program Manager Richard A. Kallman, Chair Addison Bain Nicholas F. Barilo David J. Farese William C. Fort Don Frikken Aaron Harris Miguel J. Maes Glenn W. Scheffler Andrew J. Sherman Edward G. Skolnik Ian Sutherland Robert G. Zalosh. PNNL City of Santa Fe Springs, CA NASA (ret) PNNL Air Products and Chemicals, Inc. Shell Global Solutions (ret) Becht Engineering Sandia National Laboratories NASA White Sands Test Facility GWS Solutions of Tolland, LLC Powdermet Inc. Energetics, Inc. General Motors Firexplo. Pacific Northwest National Laboratory (PNNL) 901 D Street SW, Suite 900 Washington, D.C. 20024-2115 Phone: (202) 646-7870; Fax: (202) 646-7825 E-mail: sc.weiner@pnl.gov. DOE Technology Development Manager: Antonio Ruiz. Allentown, PA Don Frikken, Becht Engineering, St. Louis, MO Richard A. Kallman, City of Santa Fe Springs, CA Michael Pero, Hydrogen Safety, LLC, Newington, CT Andrew J. Sherman, Powdermet Inc., Euclid, OH Edward G. Skolnik, Energetics, Inc. Columbia, MD R. Rhoads Stephenson, Motor Vehicle Fire Research. Safety, Codes & Standards. Weiner " Pacific Northwest National Laboratory. development and demonstration of DOE's Hydrogen, Fuel Cells and Infrastructure Technologies (HFCIT) Program Office. Comments on Pacific Northwest National Laboratory (PNNL) Documents can be submitted to the NIOSH Docket Officer electronically by email at [nioshdocket@cdc.gov](mailto:nioshdocket@cdc.gov) or printed comments can be mailed to: NIOSH Docket Office Robert A. Taft Laboratories, MS-C34 1090 Tusculum Avenue Cincinnati, OH 45226 Please include the Site Profile/Docket Number (055) on all comments. Comments Received. At this time, no comments have been submitted on Pacific Northwest National Laboratory (PNNL) documents. Document Archive for Pacific Northwest National Laboratory (PNNL). Site Profile. Introduction.