

VII.8 Hydrogen Safety Review Panel

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Start Date: FY 2004

Projected End Date: Project continuation and
direction determined annually by DOE

Objectives

- Provide expertise and guidance to DOE and assist with identifying safety-related data gaps, best practices and lessons learned.
- Help DOE integrate safety planning into funded projects to ensure that all projects address and incorporate hydrogen safety practices.

Technical Barriers

This project addresses the following technical barriers from the Hydrogen Safety section (3.7.4.2) of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

- (A) Limited Historical Database
- (B) Proprietary Data
- (C) Validation of Historical Data
- (D) Liability Issues
- (E) Variation in Standard Practice of Safety Assessments for Components and Energy Systems
- (F) Safety is not Always Treated as a Continuing Process
- (G) Expense of Data Collection and Maintenance

Accomplishments

- Conducted two meetings of the Hydrogen Safety Review Panel: December 6-7, 2005, West Sacramento, CA; June 27-28, 2006, Washington, DC.
- Conducted five safety review site visits and telephone interviews of hydrogen projects and submitted reports with recommendations to DOE.
- Reviewed 60 safety plans since June 2005 for new projects in hydrogen storage and production and delivery.
- Revised *Guidance for Safety Aspects of Proposed Hydrogen Projects, October 2005*.
- Developed *Safety Plan Checklist for DOE Projects, April 2006* for use by project teams to improve the quality, relevance and value of their safety plans.
- Provided technical guidance for other Hydrogen Safety sub-program elements: (1) first responder training curriculum; (2) incident reporting/best practices database.

Introduction

Safety is an essential element for realizing the “hydrogen economy” – safe operation in all of its aspects from hydrogen production through storage, distribution and use; from research, development and demonstration to commercialization. As such, safety is given paramount importance in all facets of the research, development and demonstration of the U.S Department of Energy’s (DOE) Hydrogen, Fuel Cells and Infrastructure Technologies (HFCIT) Program Office.

Recognizing the nature of the DOE program and the importance of safety planning, the Hydrogen Safety Review Panel was formed in December 2003 to bring a broad cross-section of expertise from the industrial, government and academic sectors to help ensure the success of the program as a whole. The Panel provides guidance on safety-related issues and data gaps, reviews individual DOE-supported projects and their safety plans and explores ways to bring best practices and lessons learned to broadly benefit the DOE program.

Approach

The experience of the Panel resides in industrial hydrogen production and supply, government R&D and hydrogen use, process safety and engineering, materials technology, industrial liability and facility insurance, risk analysis, accident investigation and fire

protection. The cross-section of relevant experience is brought to bear on specific tasks to accomplish the objectives of the work. Panel-conducted safety reviews focus on engaging project teams through site visits and telephone interviews that encourage open discussion of safety practices and lessons learned. Project safety plans are reviewed in order to encourage thorough and continuous attention to safety aspects of the specific work being conducted.

Through this approach, DOE and the Hydrogen Safety Review Panel are trying to achieve safe operation, handling and use of hydrogen and hydrogen systems for all DOE projects by ensuring that

- safety-related gaps are being identified and addressed,
- project teams are aware of all the safety issues associated with their work, and
- project teams give sufficient priority to safety in that work.

Results

The Hydrogen Safety Review Panel conducted its first meeting in December 2003. The Panel conducted its fifth and sixth meetings in FY 2006: December 6-7, 2005, West Sacramento, CA; June 27-28, 2006, Washington, D.C. The former meeting was hosted by the California Fuel Cell Partnership and this venue facilitated the presentation and discussion of several topics of mutual interest, e.g. safety event reporting, lessons learned and emergency response guides for hydrogen-fueled vehicle and infrastructure projects.

As noted in Table 1, the Panel has conducted five safety reviews, both as site visits and telephone interviews, since July 1, 2005 and reports with recommendations have been submitted to DOE for consideration and action.

TABLE 1. Hydrogen Project Safety Reviews Since July 1, 2005

Program Area	Project Title	Contractor
Technology Validation	Microgrid and Hydrogen Fueling Facility, Phase I	NextEnergy Center, Detroit, MI (sv)
Technology Validation	Microgrid and Hydrogen Fueling Facility, Phase II	NextEnergy Center, Detroit, MI (sv)
Storage	Metal Hydride Center of Excellence	University of Hawaii, Honolulu, HI (sv)
Storage	Development of Advanced Chemical Hydrogen Storage and Generation System	Millennium Cell, Eatontown, NJ (ti)
Storage	Sub-Nanostructured Non-Transition Metal Complex Grids for Hydrogen Storage	Cleveland State Univ., Cleveland, OH (ti)

sv = site visit; ti = telephone interview

In total, 19 safety reviews have been conducted by the Panel since March 2004. Although funding constraints limited the number of safety reviews over the past year, the Panel has noted common themes related to safety practices and lessons learned from such safety reviews. Key topical themes include:

- Safety planning
- Hydrogen storage/handling facilities
- Equipment maintenance and sensor calibration
- Management of change
- Asphyxiating gases
- Hydrides and other hydrogen storage materials
- Safety event reporting

Discussion of these themes has been detailed in several presentations and publications noted at the end of this report.

In addition to providing recommendations to DOE in the form of safety review reports, the Panel has also considered and made recommendations to DOE in the following areas:

- Safety event reporting
 - Definitions for incidents and near-misses
 - Protocol
- Fueling station tests
 - Station dispenser to vehicle pad resistance quantification
 - Vehicle fueling demonstration
 - Hydrogen fuel quality
- Extinguishing agents for metal powders

The Panel supported a DOE-led investigation (September 2005) of a safety incident involving the laboratory-scale synthesis of hydrogen storage material. The subsequent report and communications throughout the Hydrogen Storage sub-program identified key lessons learned:

- Materials at various stages of synthesis may have a different composition than expected.
- One needs to assume a worst-case scenario when dealing with unknown or not-well-characterized materials; safeguards such as a “what-if” analysis may be helpful in such cases.
- Laboratory procedures should reflect thorough safety vulnerability analyses, appropriate risk mitigation steps and written documentation.

Teams of Panel members have reviewed 60 safety plans since June 2005 covering projects in hydrogen storage and production and delivery. Review comments are provided to DOE and subsequently to the contractor

for consideration in revising and improving the quality and value of the safety plan. Recognizing that safety is a continuing process that requires sufficient priority in project work, a safety plan checklist was prepared to identify the key elements of a good safety plan and what should be described. The checklist was adopted by DOE and is available to all project teams. It is expected that the checklist will be incorporated more completely into a planned revision to *Guidance for Safety Aspects of Proposed Hydrogen Projects*.

Panel members and supporting staff have also served to provide expertise, input and review in a number of related areas in the DOE Hydrogen Program including the following:

- 2006 Annual Merit Review
- HAMMER's (Hazardous Materials Management and Emergency Response Training and Education Center) *Introduction to Hydrogen Safety for First Responders*
- FreedomCAR Challenge X Competition: Safety and Technical Inspection

Over the course of the past year, several Panel members have completed their service to the DOE Hydrogen Program: Carol Bailey, Sentech, Inc.; William Doerr, FM Global Research; and James Hansel, Air Products and Chemicals, Inc. Addison Bain completed a two-year term as Panel chair. The present membership of the Panel is noted in Table 2.

TABLE 2. Hydrogen Safety Review Panel

Don Frikken, Chair	Becht Engineering
Steven Weiner, Coordinator	PNNL
Ed Skolnik, Technical Support	Energetics, Inc.
Addison Bain	NASA (ret)
Harold Beeson	NASA White Sands
David Farese	Air Products and Chemicals, Inc.
Richard Kallman	City of Santa Fe Springs, CA
Michael Pero	Hydrogen Safety, LLC
Harold Phillippi	ExxonMobil Research and Engineering
Jesse Schneider	DaimlerChrysler
Andrew Sherman	Powdermet Inc.
R. Rhoads Stephenson	Motor Vehicle Fire Research Institute
Robert Zalosh	Worcester Polytechnic Institute

Conclusions and Future Directions

During the sixth Panel meeting, a brainstorming session was conducted to address the question: What are we trying to achieve? The discussion affirmed the comments noted in the Approach section of this report. At the same time, DOE and the Panel will seek to utilize and communicate the knowledge gained and lessons for the broader benefit of the emerging hydrogen economy.

To these ends, it is expected that the priority of future work of the Panel will include, but not be limited to, the following areas:

- Safety reviews (site visits and telephone interviews)
- Safety plan guidance and reviews
- Incident investigation
- Safety-related information for project teams

The seventh and eighth meetings of the Hydrogen Safety Review Panel are planned for December 2006 and June 2007, respectively.

FY 2006 Publications/Presentations

1. Weiner, S.C., Kallman, R.A., Ruiz, A., and Schneider, J.M., "Hydrogen Safety: From Policies to Plans to Practices," International Conference on Hydrogen Safety, Pisa, Italy, September 8-10, 2005. <http://www.pnl.gov/energy/eed/policy-prog/pub.stm>
2. Weiner, S.C., "Hydrogen Safety Review Panel: Safety Planning, Practices and Lessons Learned, National Hydrogen Association Annual Hydrogen Conference," Long Beach, CA, March 12-16, 2006. <http://www.pnl.gov/energy/eed/policy-prog/pub.stm>
3. Weiner, S.C., "Safety Practices and Lessons Learned: The Work of the Hydrogen Safety Review Panel," Hydrogen Safety and Risk Workshop, University of Nevada, Las Vegas, April 10, 2006. <http://www.pnl.gov/energy/eed/policy-prog/pub.stm>
4. Weiner, S.C., "Hydrogen Safety Review Panel," DOE Hydrogen Program Annual Merit Review, Arlington, VA, May 19, 2006.
5. Weiner, S.C., "From Laboratory to Demonstration: Safety Practices and Lessons Learned," First European Summer School Hydrogen Safety (ESSHS), University of Ulster, Belfast, UK, August 15-24, 2006.

References

1. Guidance for Safety Aspects of Proposed Hydrogen Projects, October 2005. http://www.eere.energy.gov/hydrogenandfuelcells/codes/doe_activities.html
2. Safety Plan Checklist for DOE Projects, April 2006. http://www.eere.energy.gov/hydrogenandfuelcells/codes/doe_activities.html