From Laboratory to Demonstration: Safety Practices and Lessons Learned

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Outline

- DOE Hydrogen Safety Program Goal
- Hydrogen Safety Review Panel: Its Role and Work
- Safety Practices and Lessons Learned
- Q&A and Discussion

Hydrogen Safety Program Goal

Develop and implement the practices and procedures that will ensure safety in the operation, handling, and use of hydrogen and hydrogen systems for all U.S. Department of Energy (DOE) projects and to utilize these practices and lessons learned to promote the safe use of hydrogen throughout the emerging hydrogen economy.

See www.eere.energy.gov/hydrogenandfuelcells/mypp/

- *Multi-Year Research, Development and Demonstration Plan: 2003-2010 (February 2005)*

Hydrogen Safety Review Panel

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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

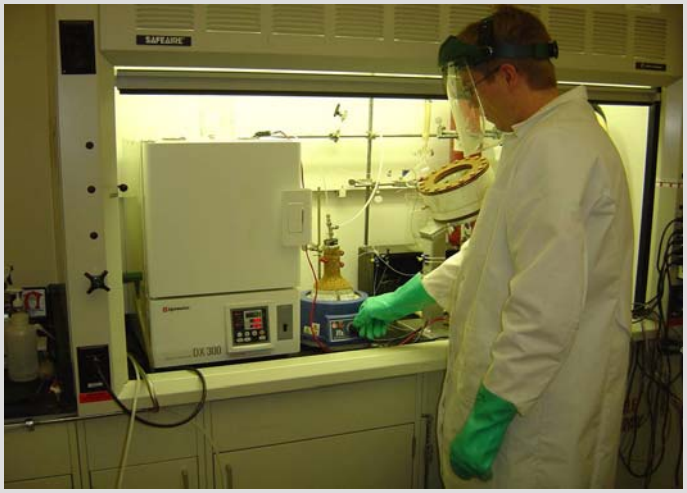
Hydrogen Safety Review Panel serves to…

- provide expertise and guidance to the 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 requirements…
- …through safety plan reviews, telephone interviews, safety questionnaires and project site visits.

Project Safety Reviews from Laboratory to Demonstration

The National Renewable Energy Laboratory is examining the integration of renewable energy with electrolysis to produce hydrogen. The Panel conducted a review of NREL's development work.

DTE Energy and their partners demonstrate an "end-to-end" hydrogen energy system in Southfield, MI. The Panel captured lessons learned from the project during a safety review meeting.



The use of personal protective equipment is an important aspect of laboratory safety. The Panel has discussed numerous laboratory safety issues with project teams.

Capturing Safety Practices and Lessons Learned…

- …from project safety site visits and safety plan reviews for broader benefits
  - 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

Safety Planning

"Living" plans require the comprehensive identification and analysis of safety vulnerabilities, effective measures to mitigate risks and ongoing communications to enhance and implement safety practices and lessons learned.

See www.eere.energy.gov/hydrogenandfuelcells/codes/doe_activities.html

- *Guidance for Safety Aspects of Proposed Hydrogen Projects (October 2005)*
- *Safety Plan Checklist*

Hydrogen Storage/Handling Facilities

The design and siting of hydrogen systems present several options. The safety vulnerability analysis for handling, moving and distributing hydrogen should include the likelihood that increasing quantities of hydrogen will be required for future work in a given facility/location.

Equipment Maintenance and Sensor Calibration

Written procedures and logs for equipment maintenance and calibration of safety-related sensors serve a similar functionality as standard procedures for experiments and operations. Procedures should follow manufacturer recommendations or other accepted standards.

Management of Change

Any proposed change to materials, technology, equipment, procedures or facility operation should be reviewed for its effect on the analysis of safety vulnerabilities. This principle applies to hazardous work at the frequently changing laboratory scale.

See www.csb.gov/index.cfm?folder=safety_publications&page=index

- *Management of Change, U.S. Chemical Safety and Hazard Investigation Board Safety Bulletin, August 2001.*

Asphyxiating Gases

Nitrogen (and other gas) asphyxiation incidents occur in a variety of facilities including industrial plants, laboratories and medical facilities. The use of enclosed spaces, such as laboratories or glove boxes, requires the assessment of the quantity, storage and flow rate of asphyxiating gases, the adequacy of ventilation and the need for oxygen depletion sensors.

See www.csb.gov/index.cfm?folder=safety_publications&page=index

- *Hazards of Nitrogen Asphyxiation, U.S. Chemical Safety and Hazard Investigation Board Safety Bulletin, June 2003.*

Hydrides and Other Hydrogen Storage Materials

Small quantities of hydrogen-containing materials, which are not well characterized, should be handled with procedures that assume a “worst case” for that class of materials, intermediates or precursors. To ensure integrity, hazard analysis might include calculating the maximum volume of hydrogen that could evolve from an otherwise sealed container.

Safety Event Reporting

A reporting system delivers valuable lessons learned to participants in the DOE Hydrogen Program and others. This system requires information sharing, degrees of confidentiality and a commitment to create higher learning value from incidents and near-misses.

See www.h2incidents.org

- *Hydrogen Incident Reporting Tool*

Safety Event Reporting
Incidents and Near-Misses

- An ***incident*** is an event that results in
  - a lost-time accident and/or injury to personnel,
  - damage and/or unplanned downtime for equipment, facilities or property,
  - impact to the public or environment,
  - any hydrogen release that unintentionally ignites or is sufficient to sustain a flame if ignited,
  - any hydrogen release which accumulates above the lower flammability limits within an enclosed space.
- A ***near-miss*** is an event that under slightly different circumstances could have become an incident.

Summary

- Safety should be treated as a continuing process that raises consciousness most directly at the project level.
- Approaches taken provide a resource of safety knowledge that can have impact across a broad cross-section of hydrogen programs and throughout the emerging hydrogen economy.

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Additional Information

- U.S. Department of Energy's Hydrogen Program
  - www.hydrogen.energy.gov
  - Hydrogen Safety Bibliographic Database (www.hydrogen.energy.gov/biblio_database.html)
- Hydrogen Safety Review Panel
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