

VIII.11 Hydrogen Safety Knowledge Tools

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

Fiscal Year (FY) 2012 Objectives

- Hydrogen Incident Reporting and Lessons Learned
 - Collect information and share lessons learned from hydrogen incidents and near-misses, with a goal of preventing similar safety events from occurring in the future.
 - Increase number of records in database by encouraging “incident owners” to share lessons learned with the hydrogen community.
 - Analyze and summarize lessons learned from incidents and near-misses.
- Hydrogen Safety Best Practices
 - Capture vast and growing knowledge base of hydrogen experience and make it publicly available.
 - Update existing content and develop relevant new content utilizing the Hydrogen Safety Panel and other subject matter experts.

Technical Barriers

This project addresses the following technical barriers from the Hydrogen Safety, Codes & Standards section of the Fuel Cell Technologies Program Multi-Year Research, Development and Demonstration Plan:

- (A) Safety Data and Information: Limited Access and Availability
- (C) Safety is Not Always Treated as a Continuous Process
- (D) Lack of Hydrogen Knowledge by AHJs

Contribution to Achievement of DOE Safety, Codes & Standards Milestones

This project contributes to meeting the following DOE milestones from the Hydrogen Safety, Codes & Standards section of the Fuel Cell Technologies Program Multi-Year Research, Development and Demonstration Plan:

- Milestone 1.3: Publish final Best Practices Manual for Hydrogen Safety. (3Q, 2013)
- Milestone 5.1: Update safety bibliography and incidents databases. (4Q, 2011-2020)

FY 2012 Accomplishments

- Hydrogen Incident Reporting and Lessons Learned
 - Added 12 new safety event records from national laboratories, universities, and private-sector firms in the U.S. and other countries since the 2011 Annual Merit Review and Peer Evaluation Meeting, for a total of 206 records currently in the database.
 - Created three postings of the Lessons Learned Corner (LLC) to analyze hydrogen safety themes illustrated with database content.
 - Collaborated with IA HySafe on sharing safety event records between “H₂incidents.org” and the Hydrogen Incidents and Accidents Database (HIAD) and made joint presentations at the International Conference on Hydrogen Safety in September 2011.
 - Participated in the national dialogue on laboratory safety after the Texas Tech University laboratory explosion (which was not a hydrogen incident). “H₂incidents.org” was recognized by the U.S. Chemical Safety and Hazard Investigation Board as “an example of an online near-miss database that should be emulated by laboratories to foster learning from incidents and near-misses”.
 - Added 30 new links between safety event records and best practices.
- Hydrogen Safety Best Practices
 - Two issues of *H₂ Safety Snapshot* added to website as references:
 - Handling Compressed Hydrogen Gas Cylinders [1]
 - Identifying Safety Vulnerabilities [2]



Introduction

The Pacific Northwest National Laboratory (PNNL) has developed and continues to improve two software tools to support the DOE Hydrogen and Fuel Cell Program's Safety, Codes & Standards Sub-Program. This report covers the Hydrogen Incident Reporting and Lessons Learned database (<http://h2incidents.org>) and the Hydrogen Safety Best Practices online manual (<http://h2bestpractices.org>). We believe that these web-based resources play a key role in reaching, educating, and informing stakeholders whose contributions will help enable the deployment of new hydrogen and fuel cell technologies. Based on all the positive feedback we have received, we are confident that our tools are well respected in the U.S. and within the international hydrogen safety community.

Approach

Hydrogen Incident Reporting and Lessons Learned –

The purpose of “h2incidents.org” is to facilitate open sharing of lessons learned from hydrogen safety events to help avoid similar events from occurring in the future. Our approach includes encouraging DOE-funded project teams and others to voluntarily submit records of incidents and near-misses, along with specific lessons learned. We continue to pursue the addition of new records by actively seeking news reports on hydrogen events and searching existing databases and other sources for hydrogen-related safety event records. We contact private-sector companies and universities who experience hydrogen-related safety events to solicit their permission to publish such records. We continue to maintain a mechanism for online submission of records. Specific safety event records are linked to best practices online manual content to emphasize safe practices for working with hydrogen and avoiding future incidents. Expert review of all safety event records and lessons learned is provided by PNNL subject matter experts and Hydrogen Safety Panel members.

Hydrogen Safety Best Practices – Best practices are compiled from learnings and observations from Hydrogen Safety Panel site visits, safety plan reviews, and other work, and available reference materials tailored specifically to working with hydrogen. There are many references and resources that deal with the safe use of hydrogen, and our intent is to organize and compile relevant information in an easy-to-use web-based manual without duplicating existing resources. PNNL teams with the Hydrogen Safety Panel, other national laboratory staff, and other subject matter experts to compile hydrogen-specific best practices from a variety of references. Links to web-based resources and actual files are provided on the website. PNNL staff members, with assistance from the Hydrogen Safety Panel, respond to user questions and comments submitted through the website.

Results

We have collaborated with three other national laboratories on our two websites over the years (Los Alamos National Laboratory, Sandia National Laboratories, and the National Renewable Energy Laboratory), as well as the Hydrogen Safety Panel, the National Aeronautics and Space Administration, two task groups under the International Energy Agency (IEA) Hydrogen Implementing Agreement, and IA HySafe's Hydrogen Incident and Accident Database. The IEA task groups provided a number of safety event records to “h2incidents.org” in past years, and also developed best practices for Hydride Storage and Handling for “h2bestpractices.org”.

Linking our two websites enhances the value of both. Links from best practices to relevant safety event records illustrate what can go wrong if best practices are not followed. Likewise, the lessons learned from safety events are enhanced by links to relevant best practices that should have been followed in order to avoid the occurrence of the events in the first place.

This year, our rate of progress has declined due to significant budget reductions. There are currently 206 safety event records in the database, and we are working on a backlog of about 55 safety events. There are now eight LLCs posted and 30 new links were added from safety event records to LLCs and/or best practices. Past issues of *H₂ Safety Snapshot* were posted on “h2bestpractices.org”.

We are pleased to report that the total number of unique visitors to “h2incidents.org” increased by a factor of six between 2006 and 2011. Unique visits are tracked by PNNL on a monthly basis. Regardless of how many times a particular individual may access a website during a particular month, they are counted as one unique visitor. The LLC is the most popular website feature and the following three themes were the most popular of the archives: 1) burst disk failures, 2) battery charging facility ventilation, and 3) the importance of purging. Although the total number of unique visitors to “h2bestpractices.org” doubled between 2008 and 2011, the traffic is still an order of magnitude below what is achieved for “h2incidents.org”. Visitors to the Laboratory Safety section of the website have been steadily increasing over the past four years, but we are seeking ways to increase the volume of traffic.

Conclusions and Future Directions

Our hydrogen safety knowledge tools help remove barriers to the deployment and commercialization of hydrogen and fuel cell technologies. Feedback on both of our websites has been extremely positive. But in order to remain vital and useful, databases and websites require a concerted effort beyond just general maintenance. The content must

be current, relevant to the community being served, and valuable to the users.

Some of the work we have planned for the future includes:

- Continue to encourage DOE projects and private-sector incident owners to submit records of incidents and near-misses to share their lessons learned with the hydrogen community.
- Continue to analyze and summarize hydrogen safety themes in the LLC.
- Conduct a best practices gap analysis with the Hydrogen Safety Panel.
- Continue collaborations with IA HySafe by sharing records between “H₂incidents.org” and HIAD for the benefit of both databases.
- Conduct a stakeholder survey to obtain feedback on the utility of the two websites and suggestions for improvement.
- Brainstorm ideas to increase visitors to “H₂bestpractices.org”.

FY 2012 Publications/Presentations

1. Weiner, S.C. and Fassbender L.L., “Lessons Learned from Safety Events,” PNNL-SA-86551, International Journal of Hydrogen Energy (manuscript HE9746, <http://dx.doi.org/10.1016/j.ijhydene.2012.03.152>, published online April 28, 2012).
2. Weiner, S.C., Fassbender, L.L., Blake, C., Aceves, S., Somerday, B.P. and Ruiz, A., “Web-based Resources Enhance Hydrogen Safety Knowledge,” PNNL-SA-82812, International Journal of Hydrogen Energy (manuscript HE-D-12-00823 submitted March 22, 2012).
3. Weiner, S.C., Fassbender, L.L., Blake, C., Aceves, S.M., Somerday, B.P., and Ruiz, A. PNNL-SA-82812. “Web-Based Resources Enhance Hydrogen Safety Knowledge,” HYPOTHESIS IX, San José, Costa Rica, December 12-15, 2011.
4. Weiner, S.C. and Fassbender, L.L. “Lessons Learned from Safety Events,” PNNL-SA-78868, International Conference on Hydrogen Safety, San Francisco, CA, September 12-14, 2011.

References

1. Barilo, N.F. and Fassbender, L.L., “Handling Compressed Hydrogen Gas Cylinders,” *H2 Safety Snapshot*, Volume 2, Issue 1, PNNL-SA-75299, November 2010.
2. Barilo, N.F. and Fassbender, L.L., “Identifying Safety Vulnerabilities,” *H2 Safety Snapshot*, Volume 2, Issue 2, PNNL-SA-77099, July 2011.