Pacific Northwest
NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

PNNL-SA-86587

Hydrogen Safety Knowledge Tools

LINDA FASSBENDER

Hydrogen Program Annual Merit Review and Peer Evaluation Meeting

Arlington, VA

May 15, 2012

This presentation does not contain any proprietary, confidential, or otherwise restricted information.

Project ID # SCS006

Overview

Pacific Northwest NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

Timeline

- Project Start: 2003
- Continuing

Budget

- Funding received in FY11: $175K
- Planned funding for FY12: $125K

Partners

- Hydrogen Safety Panel
- IA HySafe's Hydrogen Incident and Accident Database (HIAD)

Barriers

- 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

Technical Plan – Safety, Codes and Standards, Section 3.7.5, Multi-Year Research, Development and Demonstration Plan, 2011.

Relevance – Objectives

Pacific Northwest NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

H_2 Incident Reporting and Lessons Learned ("H_2incidents.org")

- 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.

H_2 Safety Best Practices ("H_2bestpractices.org")

- Capture vast and growing knowledge base of hydrogen experience and make it publicly available.
- Update existing content and add relevant new content based on Hydrogen Safety Panel guidance and other means.

Approach – "H_2incidents.org"

Pacific Northwest NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

- Establish and maintain a mechanism for online submission of records.
- Encourage all DOE projects to submit records of incidents and near-misses with clear descriptions of lessons learned.
- Pursue addition of new records by actively reviewing media reports of hydrogen incidents.
- Contact private-sector companies who experience hydrogen incidents and near-misses to solicit permission to publish records.
- Publish quarterly Lessons Learned Corner to analyze, summarize, and expand upon lessons learned for specific hydrogen safety vulnerabilities.
- Add links to "H_2bestpractices.org" to correlate between each incident and the relevant safe practices for working with hydrogen.
- Provide expert review of all incident records and lessons learned by Hydrogen Safety Panel and other subject matter experts.

Approach – "H_2bestpractices.org"

Pacific Northwest NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

- 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.
- Proposed new content is discussed at Panel meetings and with other subject matter experts.
- PNNL staff compile draft materials.
- Panel members and other subject matter experts review drafts and provide comments.
- Draft material is revised based on the comments before posting online.
- PNNL staff, with assistance from Panel members, respond to user questions and comments submitted through the website.

"H_2incidents.org" Emphasizes Lessons Learned from Incidents and Near-Misses

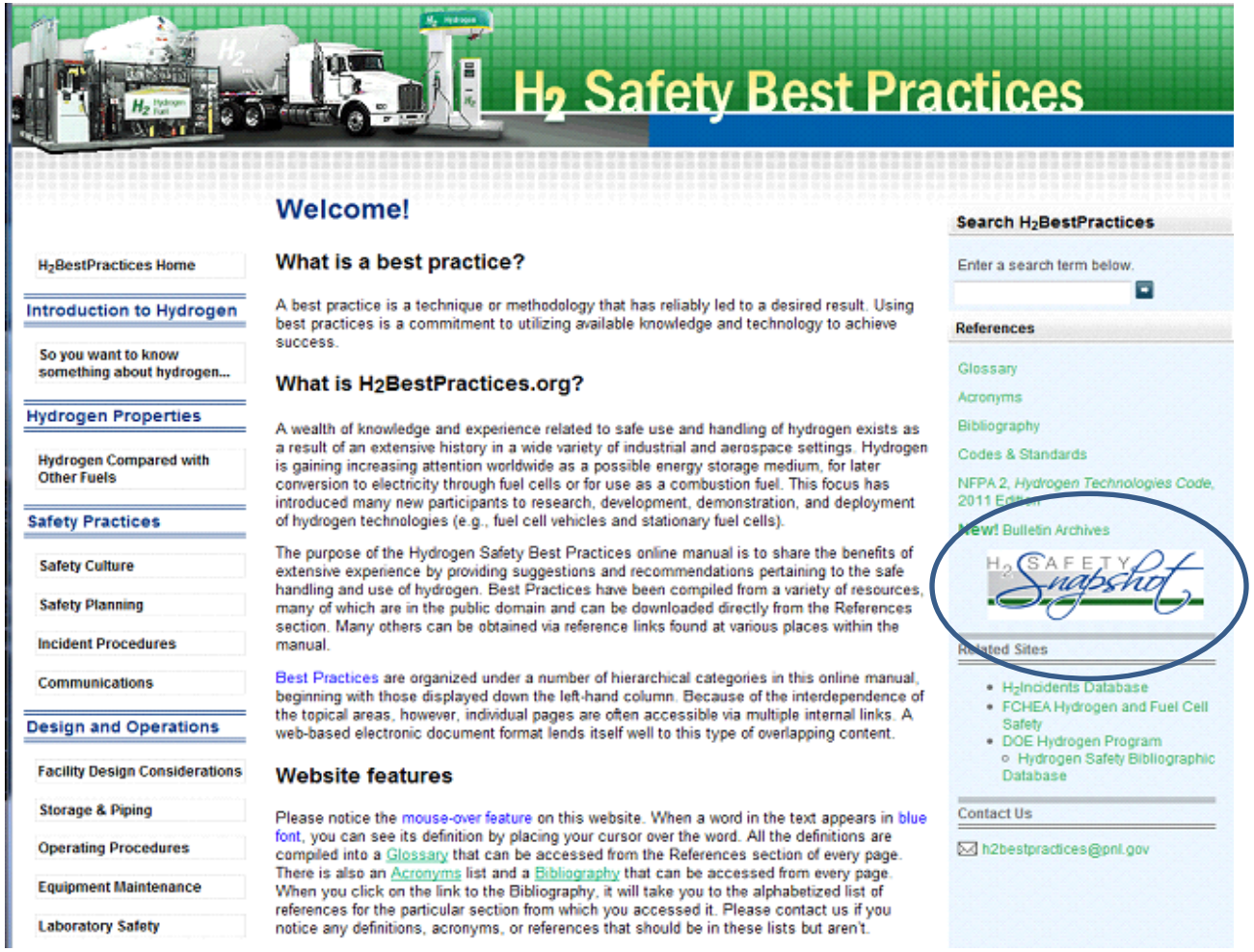
Pacific Northwest NATIONAL LABORATORY
Proudly Operated by Battelle *Since 1965*

Lessons Learned Corner *Archives*

- Hydrogen Compatibility of Materials
- Learning from Burst Disk Failures
- Adequate Ventilation of Battery Charging Facilities
- Hydrogen Use in Anaerobic Chambers
- The Importance of Purging Hydrogen Piping and Equipment
- Working with Reactive Metal-Hydride Materials in the Laboratory
- Management of Change

H_2 Safety Snapshot Added to "H_2bestpractices.org" References

Pacific Northwest NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965



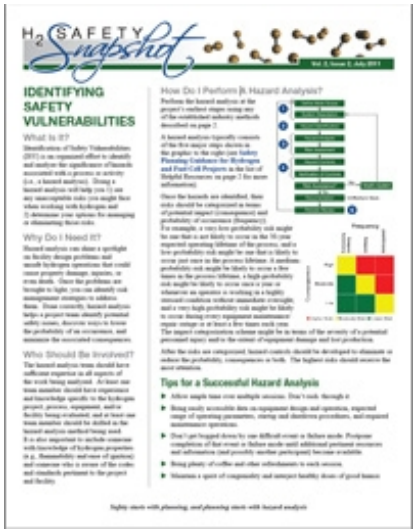
- Identifying Safety Vulnerabilities
- Handling Compressed Hydrogen Gas Cylinders
- Hydrogen Safety Knowledge Tools

H_2 Safety Snapshot

Pacific Northwest NATIONAL LABORATORY
Proudly Operated by Battelle *Since 1965*

- Cylinder Safety
  - Good practices for safe handing of gas cylinders
  - Specific “Dos” and “Don’ts” for
    - Training personnel who handle cylinders
    - Transporting, receiving, and staging cylinders
    - Connecting a cylinder to piping or tubing
    - Storing cylinders
  - References for handling compressed gas cylinders

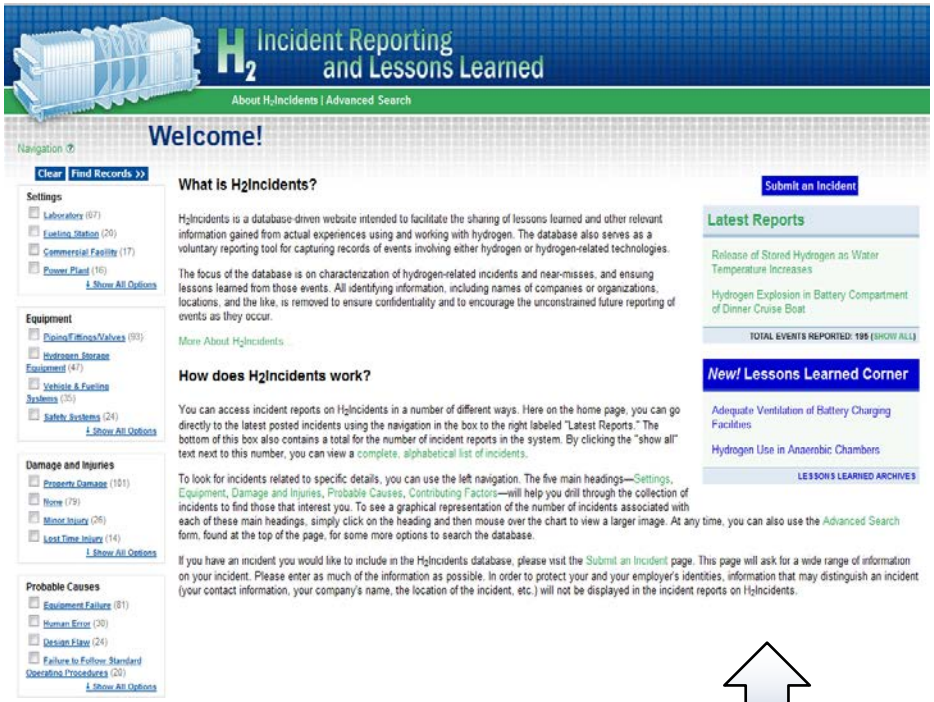
- Identifying Safety Vulnerabilities
  - How to perform a hazard analysis
  - Tips for a successful hazard analysis
  - Hazard analysis methodologies
  - Hydrogen hazards to consider
  - Helpful resources for further information

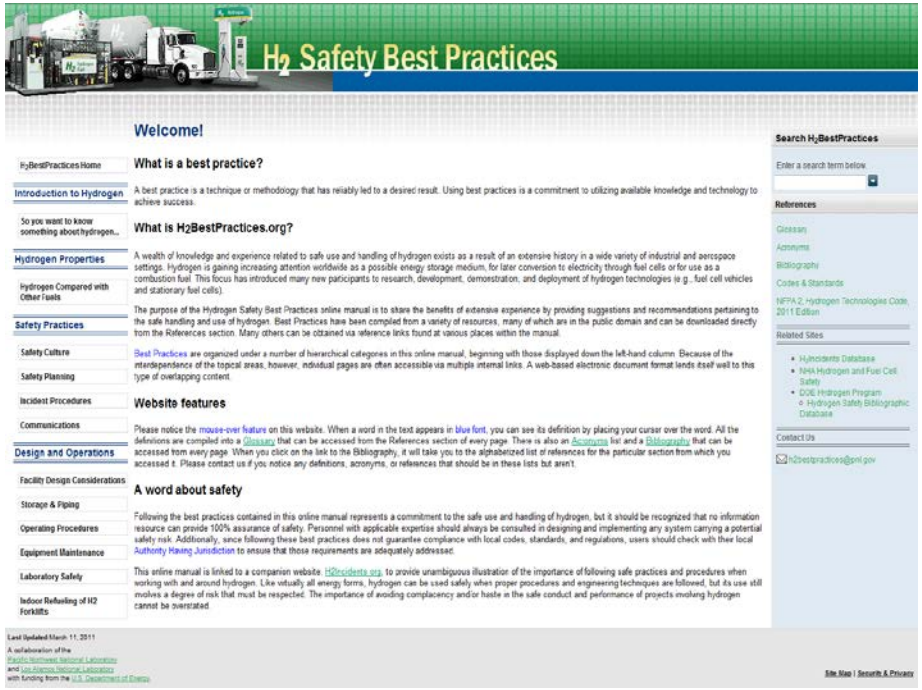


Linking "H_2incidents.org" and "H_2bestpractices.org" Enhances the Value of Both

Pacific Northwest NATIONAL LABORATORY
Proudly Operated by Battelle *Since 1965*

Safety event links illustrate what can go wrong if best practices are not followed.





Safety event lessons learned content enhanced by links to best practices and/or LLC content.

Accomplishments – "H_2incidents.org"

Pacific Northwest NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

Year	Total Visitors	Max Visitors in 1 Month
2006	3,357	751
2007	15,797	1,928
2008	25,539	4,568
2009	17,081	2,084
2010	17,502	1,954
2011	20,936	2,339

Visitors = unique visits as 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.

Lessons Learned Corner is the most popular website feature, especially:

- Burst disk failures
- Battery charging facility ventilation
- The importance of purging

Accomplishments – "H_2bestpractices.org"

Pacific Northwest NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

Year	Total Visitors	Visitors to "Laboratory Safety"	Max Visitors in 1 Month
2008	703	191	87
2009	1,029	555	113
2010	1,373	804	166
2011	1,373	930	167

Visitors = unique visits as 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.

Accomplishments Since FY11 AMR

Pacific Northwest NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

- 201 safety event records in database (6 added since FY11 AMR)
- 55 safety events currently under review in backlog
- 7 Lessons Learned Corners posted (2 added since FY11 AMR and 1 in progress)
- Collaborated on presentations and demonstrations of "H_2incidents.org" and HIAD at ICHS meeting in San Francisco in September 2011
- Participated in national dialogue on laboratory safety by providing information on "H_2incidents.org" and our efforts to capture lessons learned from hydrogen incidents and near-misses (see CSB citation noted on next slide)
- Approximately 30 new links added from safety event records to Lessons Learned Corners and/or "H_2bestpractices.org" since FY11 AMR

Positive Feedback

- U.S. Chemical Safety and Hazard Investigation Board
  - *"For an example of an online near-miss database, view the Department of Energy's (DOE) Hydrogen Program website, which facilitates the sharing of lessons learned while working with hydrogen: http://h2incidents.org."*
- FY2011 AMR reviewers
  - *"The project is effective and has improved each year."*
  - *"…critical to deployment of new technologies, especially a technology like this one where accident consequences could be severe."*
  - *"Additions to both websites have improved the information provided and the relevance of that information."*
  - *"There is too limited funding to expand this work and increase its relevance."*
  - *"The project is a good approach, although resource limited. It seems this project should have more funding since it has a great impact on safety and sustainability."*

Collaborations

Pacific Northwest NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

Organization	Role
Hydrogen Safety Panel	Provided input for updating/adding best practices. Reviewed incident records to ensure that lessons learned were fully captured.
IEA Hydrogen Implementing Agreement Task 31 (Hydrogen Safety)	Added safety event records to "H_2incidents.org" from Canada, Italy, U.K., Japan, Switzerland, France, European Commission, The Netherlands, Germany, and Norway
IEA Hydrogen Implementing Agreement Task 22 (Fundamental and Applied H_2 Storage Materials Development)	Developed best practices for Metal Hydride Storage and Handling for "H_2bestpractices.org"
IA HySafe	Shared incident records between Hydrogen Incident and Accident Database (HIAD) and "H_2incidents.org"
LANL	Collaborated with PNNL to create the initial version of "H_2bestpractices.org"
SNL	Provided technical review of Lessons Learned Corner on Compatibility of Materials
NREL	Provided information on Codes and Standards for "H_2bestpractices.org"

Proposed Future Work

- 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 Lessons Learned Corner (next is Ventilation)
- Continue to create H_2 Safety Snapshots and post on DOE website and on "H_2bestpractices.org"
- Conduct a best practices gap analysis with the Hydrogen Safety Panel
- Continue collaborations with IA HySafe by sharing records between "H_2incidents.org" and HIAD
- Conduct a stakeholder survey to obtain feedback on the utility of the two websites and suggestions for improvement
- Brainstorm ideas to increase visitors to "H_2bestpractices.org"

Summary

- Rate of progress has declined due to significant budget reductions.
- 201 safety event records in database, with a backlog of 55.
- 7 Lessons Learned Corners posted and 1 currently in progress.
- 30 new links added from safety event records to LLCs and/or best practices.
- Issues of H_2 Safety Snapshot posted on "H_2bestpractices.org".
- Total unique visitors to "H_2incidents.org" increased by a factor of 6 between 2006 and 2011.
- Total unique visitors to "H_2bestpractices.org" doubled between 2008 and 2011, but still an order of magnitude below "H_2incidents.org".
- Collaboration is continuing with HIAD database to share safety event records and lessons learned for the benefit of both.
- Feedback on both websites has been extremely positive.