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Hydrogen Safety Knowledge Tools

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Hydrogen Program Annual Merit Review and Peer Evaluation Meeting

Arlington, VA

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

Project ID # SCS006

Overview

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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

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"

- 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"

- 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

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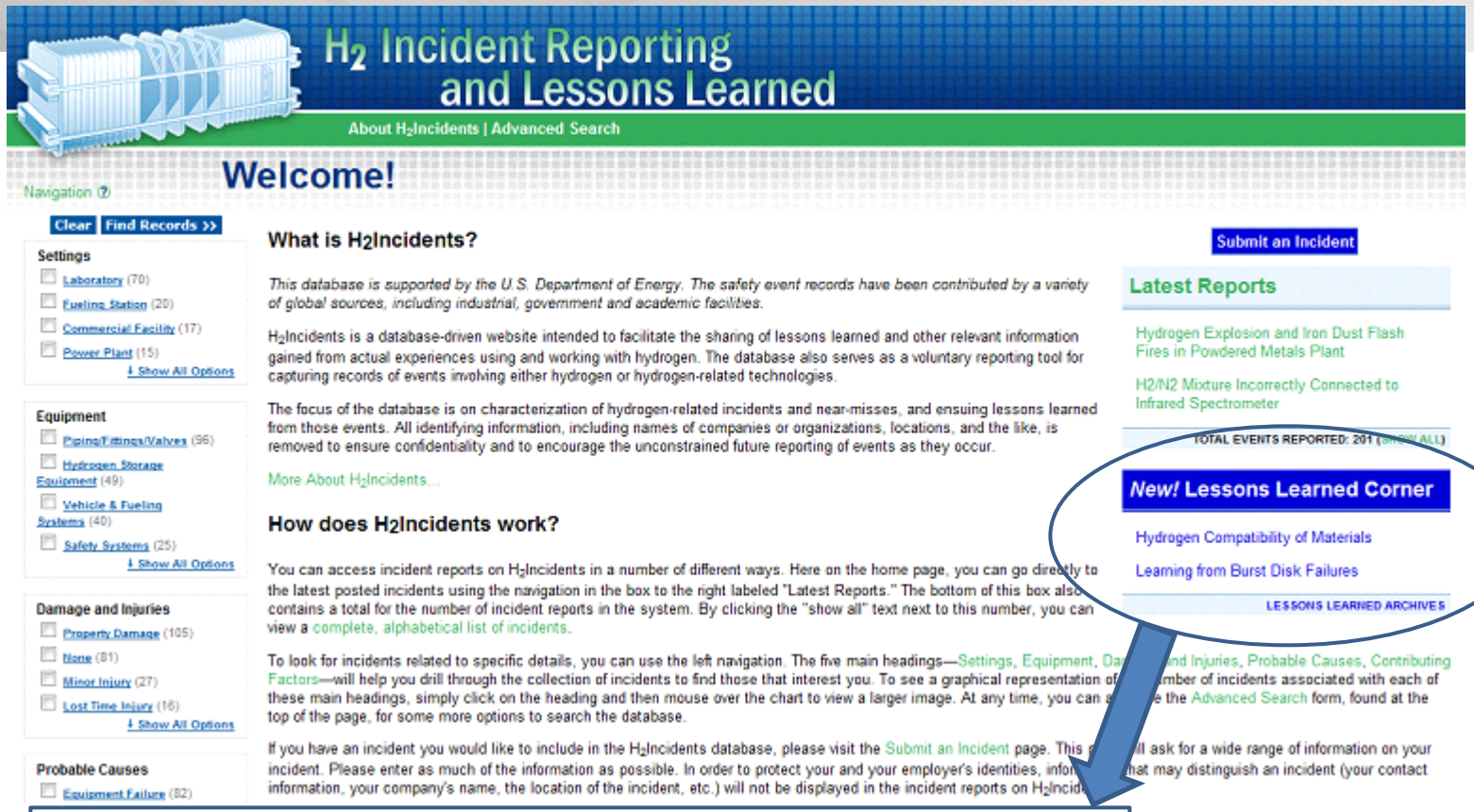
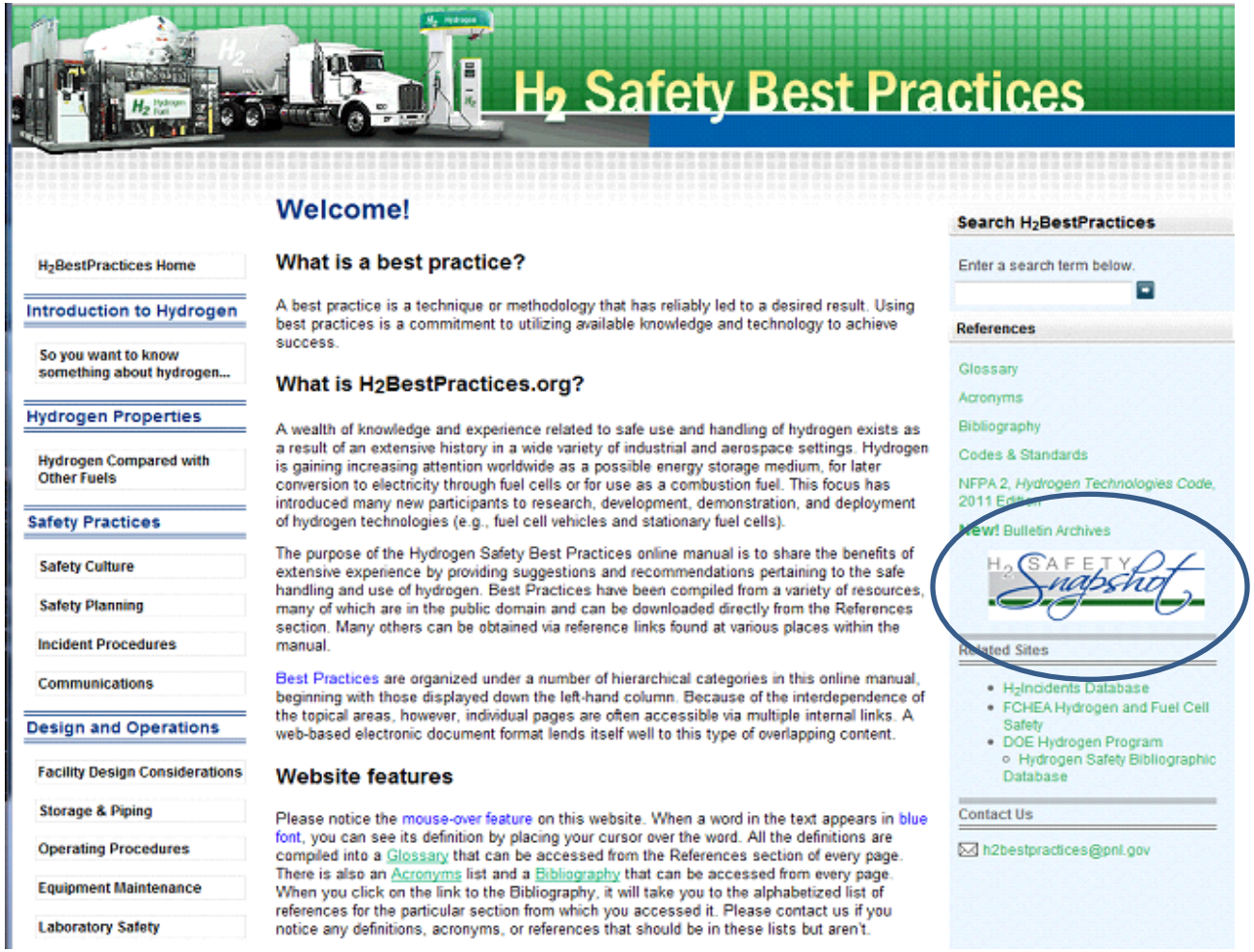


Lessons Learned Corner *Archives*

- 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

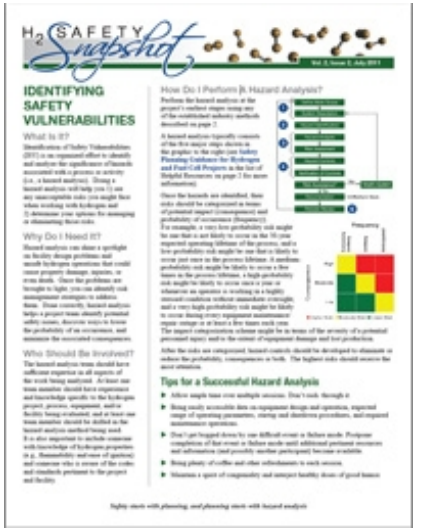
H_2 Safety Snapshot Added to "H_2bestpractices.org" References



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

H_2 Safety Snapshot

- 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

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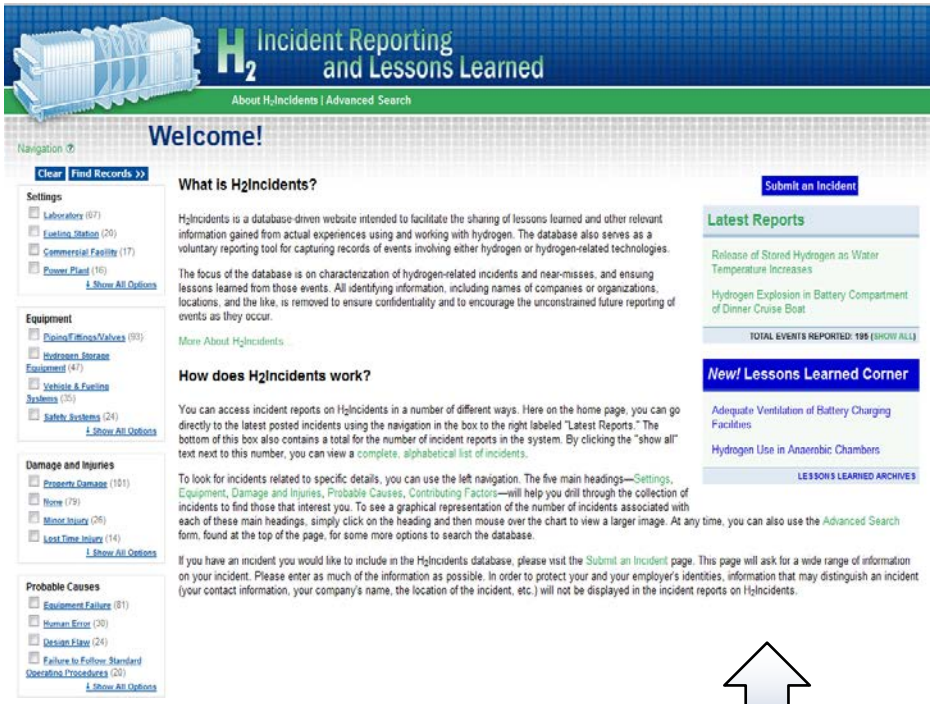
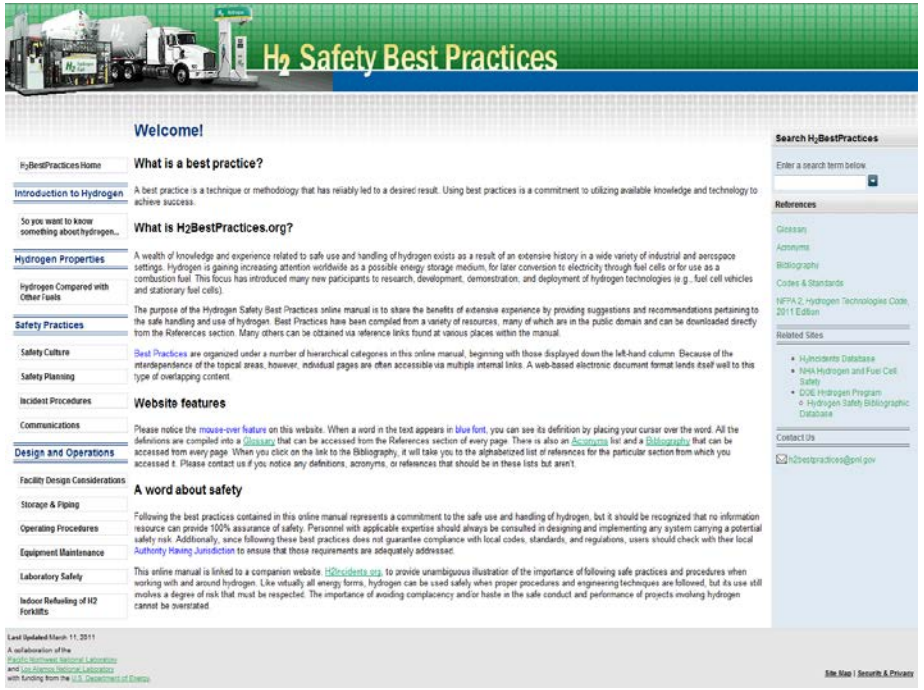
Safety event links illustrate what can go wrong if best practices are not followed.





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

Accomplishments – "H_2incidents.org"

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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"

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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

- 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

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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.