

2006 DOE Hydrogen Program H2 Incident Reporting and Best Practices Database

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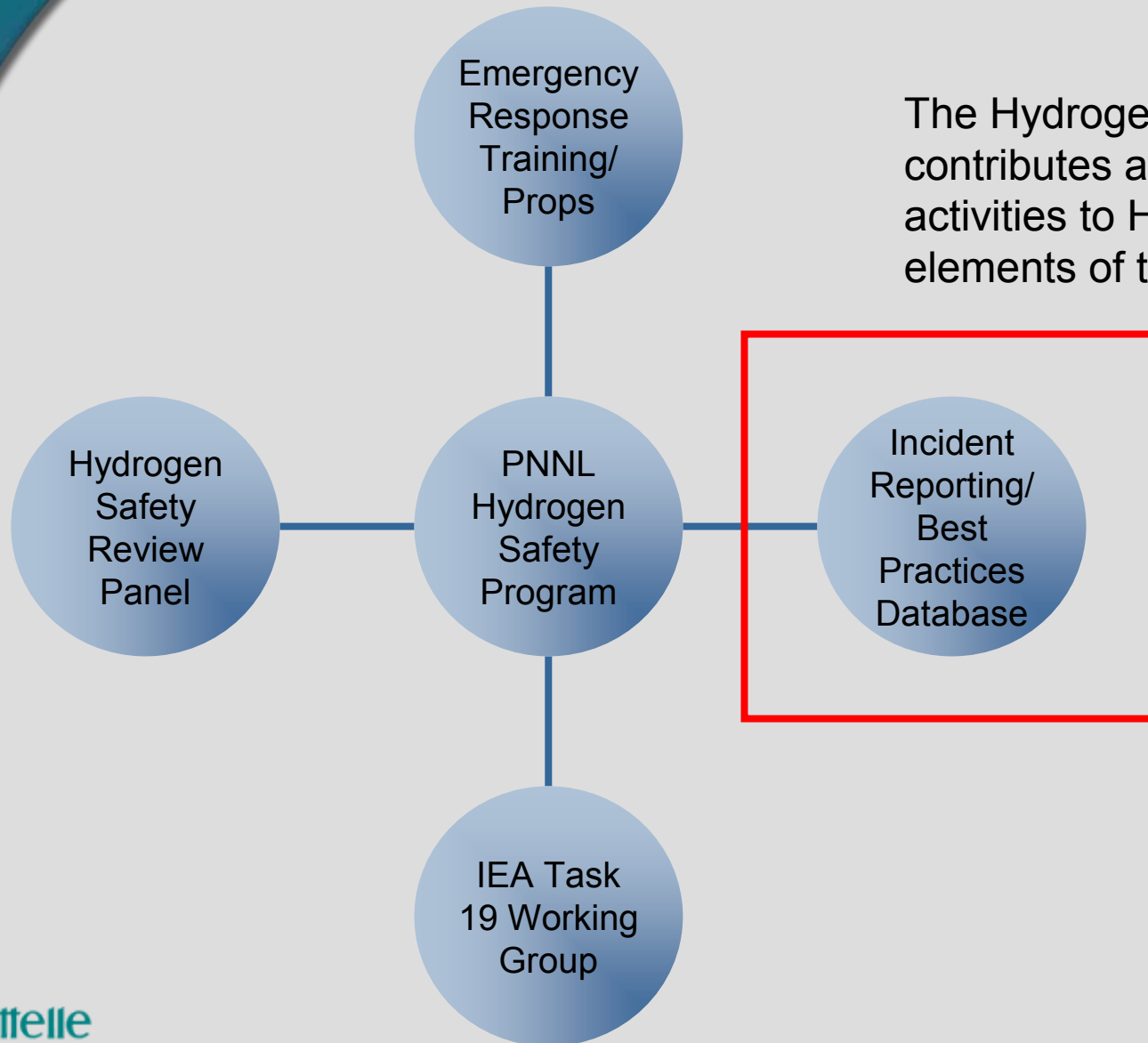
May 19, 2006

Project ID # SA4

This presentation does not contain any proprietary or confidential information

PNNL Hydrogen Safety Program

The Hydrogen Safety Program contributes a number of important activities to HFCIT. The current main elements of the program are shown here.



Overview

Timeline

- ▶ Project start 10/05
- ▶ Initial release of IR database: 5/06
- ▶ Best Practices draft: 12/06
- ▶ Percent complete: 50%
- ▶ Note that addition of incident reports and new best practices are ongoing

Budget

- ▶ Total project funding
 - \$120K in FY06
 - Many external sources utilized for incidents and Best Practices
- ▶ Funding received in FY05: \$0K

Barriers

- ▶ A. Limited Historical Database.
- ▶ B. Proprietary Data.

Only a small number of hydrogen technologies, systems and components are in operation. Only limited data is publicly available on the operational and safety aspects of these technologies. Sharing safety data is important for hydrogen projects funded under the Program as well as all others.

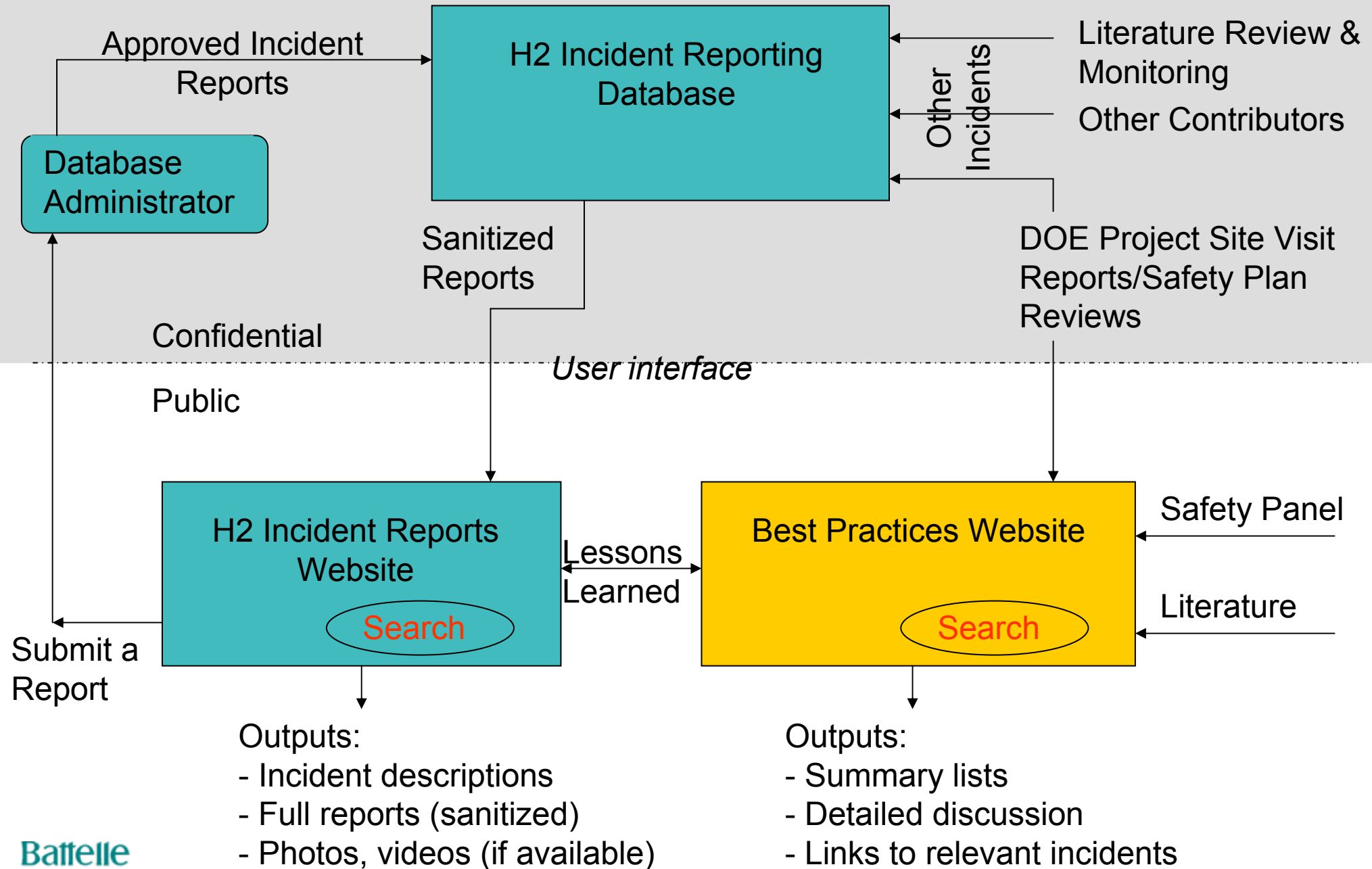
Partners/Contributors

- ▶ Hydrogen Safety Review Panel and potentially all HFCIT projects
- ▶ Any external organization willing to share incident reports

Objectives

- 1) Establish a web-based system for open sharing of lessons learned from hydrogen incidents and near misses, and provide a confidential tool for reporting any occurrence of same.
- 2) Provide a Hydrogen Safety Best Practices document to enable widespread benefit from the wealth of knowledge and experience already attained in industry, aerospace and elsewhere.

H2 Incident Reporting and Best Practices Database



Approach

H2 Incident Reporting (IR) Database

1. Review literature, restricted access databases, and other sources for gathering information on past incidents and to identify other ongoing collection efforts.
2. Examine other (i.e., non-hydrogen) safety incident databases for data collection formats, output methods, etc.
3. Construct a user-friendly, intuitive interface.
4. Input and sanitize all approved records.
5. Publicly launch website.
6. Continue to monitor the literature, other databases, and submissions to this database for new incident reports/lessons learned.

Hydrogen Safety Best Practices (BP) Website

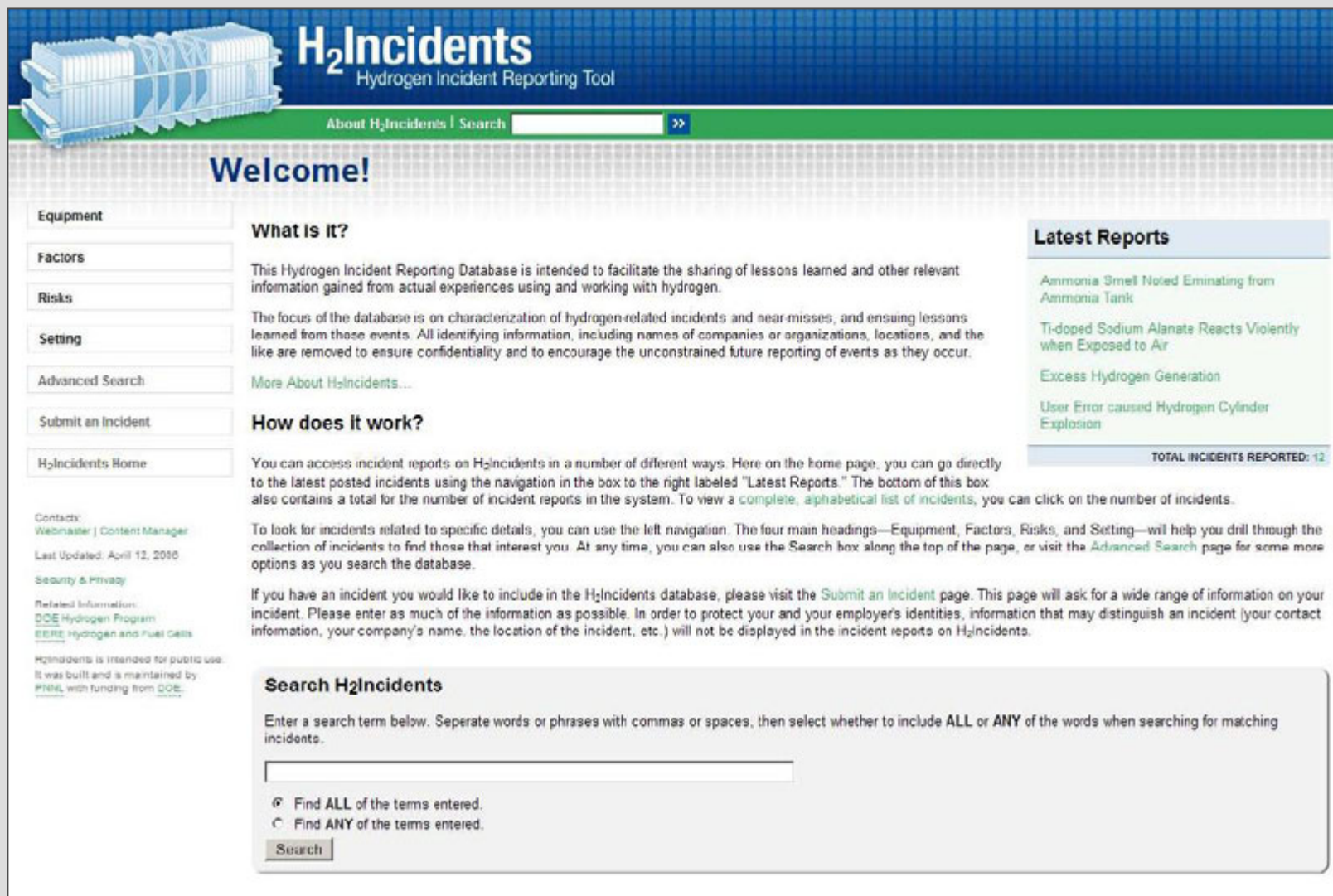
1. Review plans for document with Hydrogen Safety Review Panel.
2. Compile BP from HFCIT project safety site reviews and submitted safety plans.
3. Obtain additional BP from Safety Panel and from the extensive literature.
4. Link BP with IR websites.



Technical Accomplishments/ Progress/Results

- ▶ Initial IR Database is up and running at h2incidents.pnl.gov
- ▶ Currently there are 130-140 records in the database, derived from a variety of sources. Note that the vast majority at present are historical incidents, reaching back as far as the 1960s.
- ▶ Have identified a number of additional sources of potential incident information.
- ▶ Best Practices information collection and website has begun and is expected for first public appearance around the December 2006 timeframe. HFCIT milestone for this document established for FY2008.

Working Draft IR Database



The screenshot shows the H2Incidents website interface. At the top, there is a blue header with the text "H₂Incidents Hydrogen Incident Reporting Tool" and a search bar. Below the header, a green navigation bar contains "About H₂Incidents | Search" and a search input field. The main content area is titled "Welcome!" and is divided into several sections:

- Equipment**: A sidebar menu with buttons for "Equipment", "Factors", "Risks", "Setting", "Advanced Search", "Submit an Incident", and "H₂Incidents Home".
- What is it?**: A section explaining the purpose of the database, which is to facilitate the sharing of lessons learned and other relevant information gained from actual experiences using and working with hydrogen. It also mentions the focus on characterization of hydrogen-related incidents and near-misses, and ensuring lessons learned from those events. All identifying information, including names of companies or organizations, locations, and the like are removed to ensure confidentiality and to encourage the unconstrained future reporting of events as they occur. A link "More About H₂Incidents..." is provided.
- How does it work?**: A section explaining how to access incident reports on H₂Incidents in a number of different ways. Here on the home page, you can go directly to the latest posted incidents using the navigation in the box to the right labeled "Latest Reports." The bottom of this box also contains a total for the number of incident reports in the system. To view a complete, alphabetical list of incidents, you can click on the number of incidents. It also explains how to look for incidents related to specific details using the left navigation and the Search box.
- Latest Reports**: A section listing recent incidents, including "Ammonia Smell Noted Eminating from Ammonia Tank", "Ti-doped Sodium Alanate Reacts Violently when Exposed to Air", "Excess Hydrogen Generation", and "User Error caused Hydrogen Cylinder Explosion". A total of 12 incidents reported is shown.
- Search H₂Incidents**: A section with a search input field and radio buttons to select whether to include ALL or ANY of the words when searching for matching incidents. A "Search" button is provided.

At the bottom left, there is a "Contacts" section with the following information:

- Webmaster | Content Manager
- Last Updated: April 12, 2010
- Security & Privacy
- Related Information: DOE Hydrogen Program, EERE Hydrogen and Fuel Cells
- H₂Incidents is intended for public use. It was built and is maintained by PNNL with funding from DOE.

Working Draft IR Database

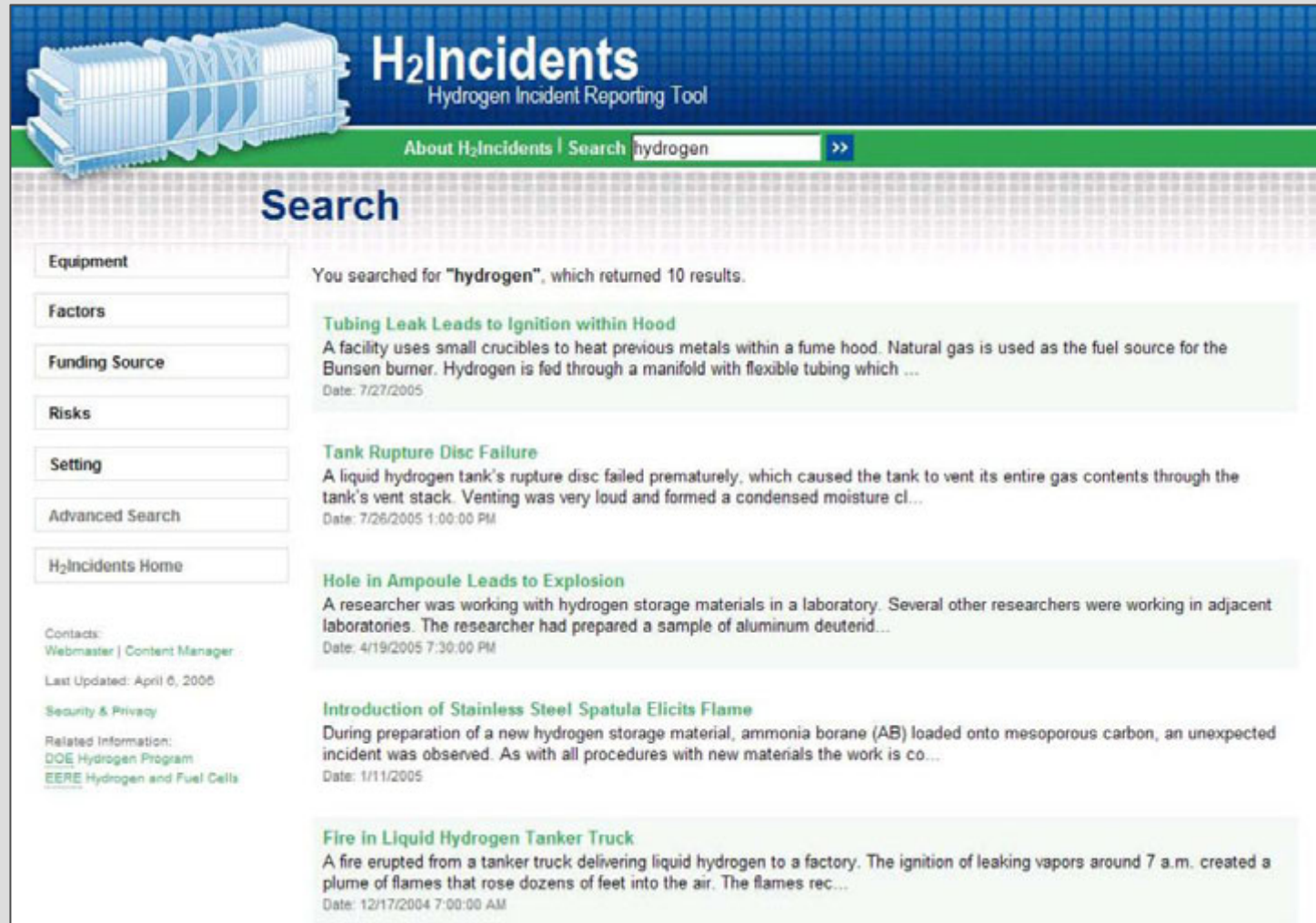
Intuitive, simple interface allows user to drill down to the individual incident level through either characteristics of the incident, such as the equipment involved...



The screenshot displays the H2Incidents Hydrogen Incident Reporting Tool interface. At the top, there is a blue header with the title "H2Incidents" and the subtitle "Hydrogen Incident Reporting Tool". Below the header is a green navigation bar with the text "About H2Incidents | Search" and a search input field. The main content area is titled "Equipment" and is divided into two columns. The left column, titled "Equipment", lists various equipment types with their respective counts: Ammonia Tank (1), Compressor (0), Dispenser (4), Glove Box (2), Hydrogen Storage (5), Measurement/Sensing Device (0), Piping/Fitting (0), Pressure Relief Device (0), and Valve (0). The right column, titled "Hydrogen Storage", lists specific incidents: Excess Hydrogen Generation, Hole in Ampoule Leads to Explosion, Tank Rupture Disc Failure, Introduction of Stainless Steel Spatula Elicits Flame, and Fire in Liquid Hydrogen Tanker Truck. Below the equipment list are several filter buttons: Factors, Funding Source, Risks, Setting, Advanced Search, and H2Incidents Home. At the bottom of the page, there is a footer with the text "Contacts: Webmaster | Content Manager", "Last Updated: April 6, 2006", and "Security & Privacy".

Working Draft IR Database

Or through use of simple and advanced search capabilities.



The screenshot shows the H2Incidents website interface. At the top, there is a blue header with the text "H2Incidents Hydrogen Incident Reporting Tool" and a search bar containing the word "hydrogen". Below the header, a green navigation bar contains the text "About H2Incidents | Search" and a search button. The main content area is titled "Search" and displays the results for the search term "hydrogen". The results are listed in a column, each with a title, a brief description, and a date. The results include:

- Tubing Leak Leads to Ignition within Hood**: A facility uses small crucibles to heat previous metals within a fume hood. Natural gas is used as the fuel source for the Bunsen burner. Hydrogen is fed through a manifold with flexible tubing which ...
Date: 7/27/2005
- Tank Rupture Disc Failure**: A liquid hydrogen tank's rupture disc failed prematurely, which caused the tank to vent its entire gas contents through the tank's vent stack. Venting was very loud and formed a condensed moisture cl...
Date: 7/26/2005 1:00:00 PM
- Hole in Ampoule Leads to Explosion**: A researcher was working with hydrogen storage materials in a laboratory. Several other researchers were working in adjacent laboratories. The researcher had prepared a sample of aluminum deuterid...
Date: 4/19/2005 7:30:00 PM
- Introduction of Stainless Steel Spatula Elicits Flame**: During preparation of a new hydrogen storage material, ammonia borane (AB) loaded onto mesoporous carbon, an unexpected incident was observed. As with all procedures with new materials the work is co...
Date: 1/11/2005
- Fire in Liquid Hydrogen Tanker Truck**: A fire erupted from a tanker truck delivering liquid hydrogen to a factory. The ignition of leaking vapors around 7 a.m. created a plume of flames that rose dozens of feet into the air. The flames rec...
Date: 12/17/2004 7:00:00 AM

On the left side of the page, there is a sidebar with several menu items: Equipment, Factors, Funding Source, Risks, Setting, Advanced Search, and H2Incidents Home. At the bottom of the sidebar, there is a "Contacts" section with the text "Webmaster | Content Manager" and "Last Updated: April 6, 2005". There is also a "Security & Privacy" section and a "Related Information" section with links to "DOE Hydrogen Program" and "EERE Hydrogen and Fuel Cells".

Working Draft IR Database

H₂Incidents
Hydrogen Incident Reporting Tool

About H₂Incidents | Search

Incident Report

Equipment: Introduction of Stainless Steel Spatula Elicits Flame

Factors: [Empty]

Funding Source: NO FUNDING SOURCES DEFINED

11 January 2005

Severity: **Incident**

Was Hydrogen released? **No**

Was there Ignition? **Yes**

No Ignition Source Defined

Description

During preparation of a new hydrogen storage material, ammonia borane (AB) loaded onto mesoporous carbon, an unexpected incident was observed. As with all procedures with new materials the work is conducted on a small scale and in a laboratory fume hood. They followed the procedures that they had used for absorption of ammonia borane onto mesoporous silica without incident.

To absorb the solid AB into a scaffold material they dissolve AB in a dry aprotic polar solvent, THF. The saturated solution of AB in THF is added to the mesoporous carbon material in a round bottom flask, stirred for 10 minutes to saturate the mesoporous scaffold with AB and then the solvent is slowly removed under vacuum. At this point the sample is assumed to be prepared and ready for transfer to a sample vial for storage.

The material (1.1 mesoporous carbon-AB) was exposed to the atmosphere for close to five minutes without incident and the round bottom flask containing the material was cool to the touch as they have always noted for the silica materials. In order to transfer the material from the round bottom flask to the storage vessel a stainless steel spatula was introduced to the round bottom flask. Upon touching the stainless steel spatula against the inside of the flask, the flask became warm to touch and then a small flame was observed to arise from the round bottom flask. The flask was immediately placed under a large glass crystallizing dish to remove oxygen and the flame was extinguished. After the flame was extinguished, the flask was then placed under nitrogen atmosphere.

Dry carbon materials have been reported to develop a static charge under vacuum. It is likely that using the metal spatula provided a means to release the charge. This static charge may have been responsible for the flame and the subsequent

Risks

- Environmental (0)
- Human Life (2)
- Last Time Injury (0)
- Minor Injuries (10)
- Property Damage (11)
- Unknown (0)

Setting

Advanced Search

H₂Incidents Home

Contact: Webmaster | Content Manager

Last Updated: April 6, 2005

Security & Privacy

Related Information: DOE Hydrogen Program, EERE Hydrogen and Fuel Cells

Reports contain summaries and at-a-glance information, and links to related information such as full reports, photos or videos, etc.

H₂Incidents
Hydrogen Incident Reporting Tool

About H₂Incidents | Search

Incident Report

Equipment: Wrong Hydrogen Concentration Introduced into Glove Box

Factors: [Empty]

Funding Source: NO FUNDING SOURCES DEFINED

No Incident Date defined

Severity: **Incident**

Was Hydrogen released? **Yes**

Was there Ignition? **No**

Description

An individual inadvertently connected a pure hydrogen gas bottle to the chamber/glove box as opposed to a 10% hydrogen (in nitrogen) bottle that should have been used. [The wrong bottle had mistakenly been delivered, and the inexperienced individual did not know the difference.] The hydrogen concentration increased within the chamber to about 9%. Since there was insufficient

Risks

- Environmental (0)
- Human Life (2)
- Last Time Injury (0)
- Minor Injuries (10)
- Property Damage (11)
- Unknown (0)

Setting

Advanced Search

H₂Incidents Home

Contact: Webmaster | Content Manager

Last Updated: April 6, 2005

Security & Privacy

Related Information: DOE Hydrogen Program, EERE Hydrogen and Fuel Cells

H₂Incidents
Hydrogen Incident Reporting Tool

About H₂Incidents | Search

Incident Report

Equipment: Ti-doped Sodium Alanate Reacts Violently when Exposed to Air

Factors: [Empty]

Funding Source: NO FUNDING SOURCES DEFINED

No Incident Date defined

Severity: **Incident**

Was Hydrogen released? **Yes**

Was there Ignition? **Yes**

No Ignition Source Defined

Description

An incident occurred when Ti-doped sodium alanate was exposed to air, apparently resulting in an unstable compound that experienced a rapid exothermic reaction. One needs to take extreme care with both new and supposedly spent hydride samples; the spent materials may contain pockets of unoxidized alanates that could react violently when being transferred.

Lessons Learned/Specific Suggestions for Avoidance

Take extreme care with both new and supposedly spent hydride samples. Work with small samples so if something does go wrong, the possibility of serious injury is low. The lab believes that the slow exposure to room air is the greatest concern.

Supporting Documents

Hydride Development Project (DOC, 2005)

Primary Cause(s)

- Laboratory Equipment

Setting:

- Laboratory

Risks

- Environmental (0)
- Human Life (2)
- Last Time Injury (0)
- Minor Injuries (10)
- Property Damage (11)
- Unknown (0)

Setting

Advanced Search

H₂Incidents Home

Contact: Webmaster | Content Manager

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Working Draft IR Database

Submitting an incident report can be done via an online form, or by emailing attachments to the database administrator.

H₂Incidents
Hydrogen Incident Reporting Tool

About H₂Incidents | Search »

H₂Incidents Submission

* Indicates required information.

Equipment

Factors

Risks

Setting

Advanced Search

Submit an Incident

H₂Incidents Home

Title*
Enter a title by which to uniquely identify this incident. We recommend not using any details that can specifically identify you personally or your employer.
Title:

Severity*
(see [definitions](#)):

Incident

Near Miss

Incident Identification Information
This information will not be available to users via the H₂Incidents website.

Primary ←
Your information.

Salutation:

First Name:

Last Name:

Position:

Employer:

Phone:

Email:

Secondary
Contact the following person first regarding any questions/comments (if other than you).

Incident Date
Date of incident and specific time of day, if known (Ex: 4/19/2006 4:30PM):

Contacts:
[Webmaster](#) | [Content Manager](#)
Last Updated: April 12, 2006

[Security & Privacy](#)

Related Information:
[DOE Hydrogen Program](#)
[EERE Hydrogen and Fuel Cells](#)

H₂Incidents is intended for public use. It was built and is maintained by [PNNL](#), with funding from [DOE](#).

Future Work

- ▶ Continue pursuing historic incident reports through other databases and the literature, and through the knowledge of other researchers and organizations.
- ▶ Follow up and input new incident reports when they are submitted or otherwise identified.
- ▶ Continue adding functionality to the database, including features both already planned and other useful ideas suggested via feedback on the site.
- ▶ Begin developing the Hydrogen Safety Best Practices website and establish relevant links between the two.

Summary

- ▶ An excellent safety record will aid commercialization and public acceptance.
- ▶ Sharing of incident related information, including circumstances surrounding the incident and any lessons learned, is one of the surest ways to help prevent recurrence of similar events.
- ▶ The goal of this database and website is to enable all the benefits of sharing safety-related information, while eliminating any negative impacts from sharing it.
- ▶ It is hoped that visitors to the site will come both to share information and to learn from the information already there.



Back-up Slides

Responses to Previous Year Reviewers' Comments

- ▶ This is a new project, not reviewed last year.

Publications and Presentations

The H2 Incident Reporting Database is located at h2incidents.pnl.gov

Critical Assumptions and Issues

- ▶ Success requires that people use the system and not fear negative consequences from reporting.
 - We hope that inclusion of historical incident reports will sufficiently demonstrate the value of the system while assuring that any identifying information remains confidential.